EXPLANATORY NOTES

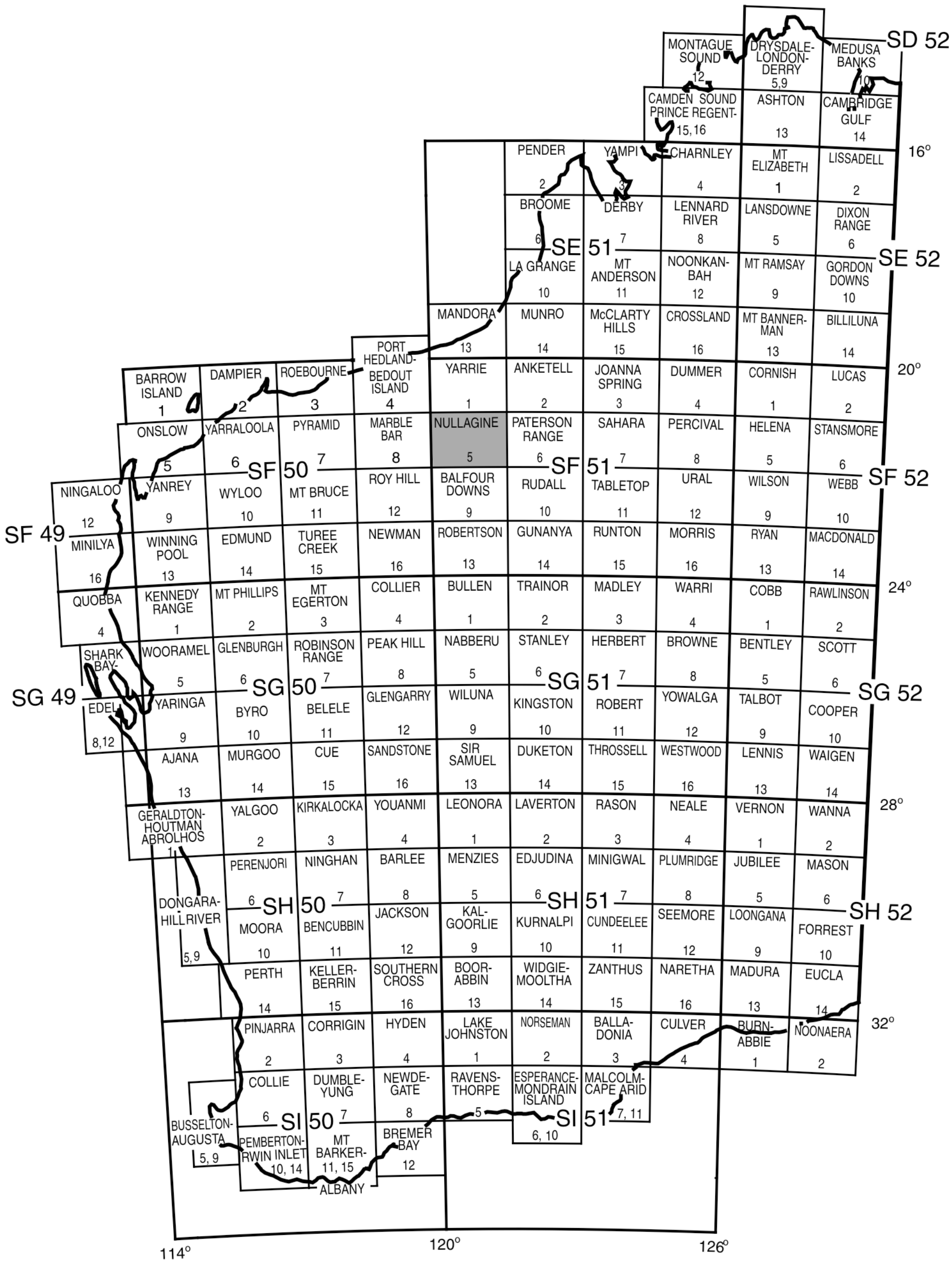
Department of
Industry and Resources

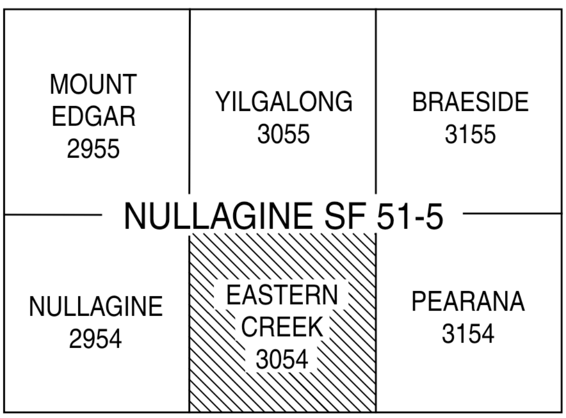
GEOLOGY OF THE EASTERN CREEK 1:100 000 SHEET

by T. R. Farrell

1:100 000 GEOLOGICAL SERIES

Geological Survey of Western Australia





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GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

GEOLOGY OF THE EASTERN CREEK 1:100 000 SHEET

by
T. R. Farrell

Perth 2006

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Cover photograph:
View to the south-southeast over rocks of the Mosquito Creek Formation near the Eastern Creek mining centre

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Geology of the Eastern Creek 1:100 000 sheet

by

T. R. Farrell

Abstract

The EASTERN CREEK 1:100 000 geological map sheet covers part of the eastern margin of the Archean Pilbara Craton in Western Australia, straddling the boundary between the granite–greenstone basement and the overlying Hamersley Basin. Three major tectonic subdivisions of the granite–greenstone basement are present on EASTERN CREEK: the East Pilbara Granite–Greenstone Terrane, the Mosquito Creek Basin, and the Kurrana Terrane.

The East Pilbara Granite–Greenstone Terrane outcrops in the northwest of the sheet, and is represented by deformed monzogranite and granodiorite (Yilgalong Granitic Complex, c. 3.29 Ga), and a belt of metamorphosed basalt, ultramafic rock, chert, and clastic sedimentary rock (Mount Elsie greenstone belt, c. 3.40 – 3.31 Ga). Deeply weathered exposures of strongly deformed monzogranite and orthogneiss in the southwest corner of EASTERN CREEK belong to the Kurrana Terrane. Separating the two terranes is the Mosquito Creek Basin, which contains a basal sediment–mafic–ultramafic succession (Coondamar Formation) and an upper turbidite succession (Mosquito Creek Formation). Rocks of the Mosquito Creek Basin are in tectonic contact with adjacent terranes, except on the northeast margin of the basin, where the Mosquito Creek Formation lies unconformably on the East Pilbara Granite–Greenstone Terrane.

The three tectonic units have a long history of deformation and metamorphism with at least eleven recognizable tectonic events. The early events, which affected the Mount Elsie greenstone belt and the Yilgalong Granitic Complex, involved the development of a strong bedding-parallel foliation, followed by the development of north-northwesterly trending folds and shear zones. Later deformation events were focused mainly on the Kurrana Terrane and Mosquito Creek Basin to the south. Intense deformation during north–south shortening of the Mosquito Creek Basin at c. 2.90 Ga produced tight east–west chevron folds, and culminated in south-over-north thrusting.

Greenstones in the Mount Elsie greenstone belt were predominantly metamorphosed under ?lower greenschist facies conditions, with higher grades, up to amphibolite facies, attained only near the contact with the Yilgalong Granitic Complex. Within the Mosquito Creek Basin, metamorphism in the Coondamar Formation ranged from lowermost greenschist facies to amphibolite facies along the contact with the Kurrana Granitic Complex. Low-pressure-style metamorphism in the Mosquito Creek Formation reached a peak prior to folding and south-over-north thrusting, ranging from zeolite facies in some areas through to lower greenschist facies.

The Hamersley Basin is represented on EASTERN CREEK by the Fortescue Group and the Carawine Dolomite of the Hamersley Group. The Fortescue Group lies unconformably on the granite–greenstone basement, and dips gently to the east and southeast. It is conformably overlain by the Carawine Dolomite and a related Proterozoic chert breccia, which are exposed in the northeast and southeast corners of the sheet.

KEYWORDS: Pilbara Craton, Mosquito Creek Formation, Coondamar Formation, Nullagine, Archean, greenstone.

Introduction

The EASTERN CREEK* 1:100 000 geological map sheet (SF 51-05, 3054) covers the area between latitudes 21°30'S and 22°00'S, and longitudes 120°30'E and 121°00'E (Fig. 1) in the Pilbara region of Western Australia. The map occupies the central-southern part of the NULLAGINE 1:250 000 sheet, and is named after the Eastern Creek mining centre in the centre of the map area. The nearest town is Nullagine, which lies about 45 km to the west of the western boundary of the sheet.

Access to EASTERN CREEK is either by the Skull Springs road from Nullagine (Fig. 2), or via the Nullagine – Woodie Woodie road from the east. The area can also be reached by station tracks from the Balfour Downs and Noreena Downs homesteads to the south and southeast (Fig. 2). Much of the map area is difficult to access due to the rugged nature of the terrain and a scarcity of tracks. Easy access to the Mount Elsie greenstone belt is limited

* Capitalized names refer to standard 1:100 000 map sheets, unless otherwise indicated.

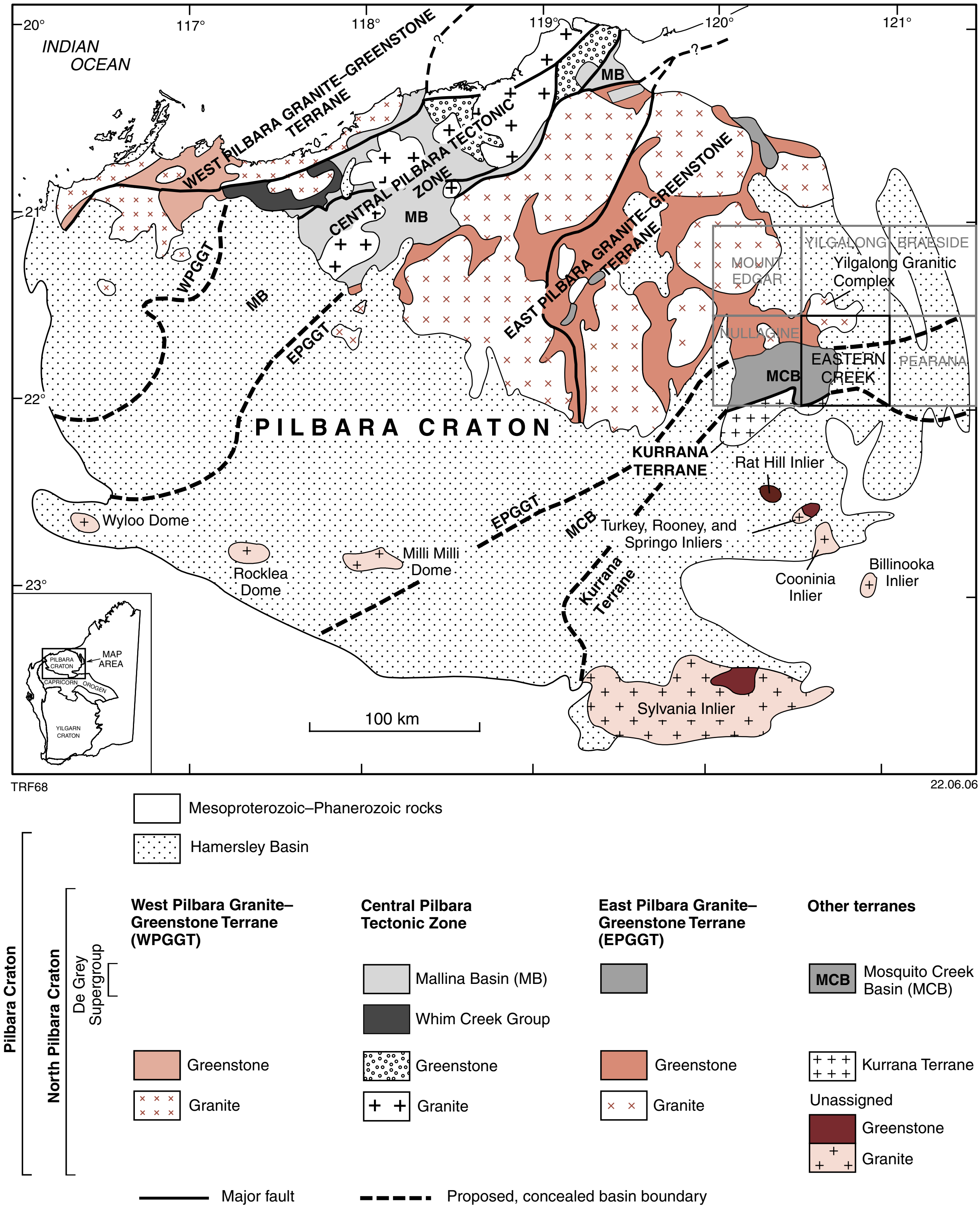

Figure 1. Location of Eastern Creek and regional geological setting in the Pilbara Craton

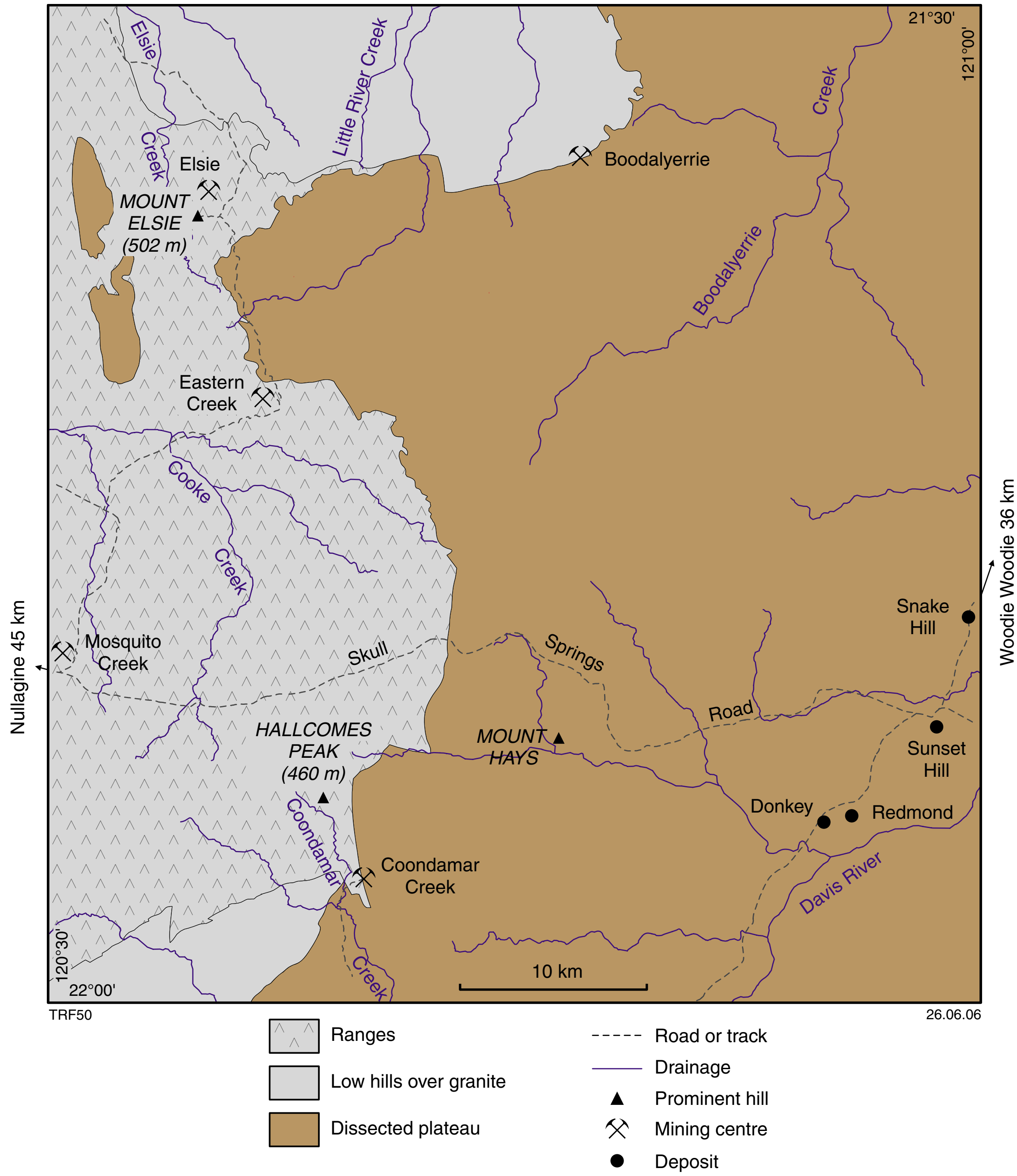

Figure 2. Simplified physiographic map of Eastern Creek

to areas adjacent to the track between Mount Elsie* and the Warrawagine homestead north of Eastern Creek, and a few mineral exploration tracks around Mount Elsie. The central-western part of the area, along the Skull Springs road and the road to the Mosquito Creek mining centre on Nullagine to the west, is easily accessible along numerous gold prospecting tracks. However, areas west and northwest of the Eastern Creek mining centre, north and west of Hallcomes Peak, and large parts of the northeast quadrant of Eastern Creek are virtually inaccessible to four-wheel drive vehicles.

* MGA coordinates of localities mentioned in the text are listed in Appendix 1.

Mapping of Eastern Creek was carried out between July 1999 and September 2001 using 1:25 000-scale colour aerial photographs from the Department of Land Information (DLI, formerly DOLA) 1998, Landsat TM5 (Thematic Mapper) images, and 1996 400 m line-spaced radiometric data from Geoscience Australia (formerly AGSO) and the Geological Survey of Western Australia (GSWA).

Climate and vegetation

Eastern Creek has a hot ('winter drought'), desert to grassland climate characterized by relatively low rainfall, dry winters, and mean temperatures above 18°C (Commonwealth Bureau of Meteorology, 2003). Data for the town of Nullagine, west of EASTERN CREEK, show that December is the hottest summer month on average, with a mean maximum temperature of 39.7°C. Winters are cool to mild, with rare nights where the temperature falls below zero. The coldest month, on average, is July, with a mean maximum temperature of 24°C, and a mean daily minimum of 7.5°C. The average annual rainfall is about 327 mm, most of which falls between December and June (Commonwealth Bureau of Meteorology, 2003). The rainfall is extremely variable, depending on the development of monsoonal lows and tropical cyclones between December and April.

EASTERN CREEK lies in the eastern part of the Pilbara Region (or Fortescue Botanical District) of the Eremaean Province of Beard (1990). The region is typified by extensive spinifex grassland (*Triodia* sp.) with scattered small trees (*Eucalyptus leucoploia* and *E. brevifolia*) and shrubs (mainly *Acacia* sp.). Denser vegetation is commonly found along drainage lines.

Physiography

EASTERN CREEK is undulating to hilly, with local areas of rugged rangeland with high relative relief (Fig. 2). The altitude above sea level ranges from a maximum of just over 500 m at Mount Elsie in the northwest, and in the southwest, to a minimum of about 240 m in the northeast. There are two main drainage catchments on EASTERN CREEK (Fig. 2), separated by a divide that follows a line between Little River Creek and Elsie Creek in the north, along the western edge of the Fortescue Group between Mount Elsie and Hallcomes Peak, and then trends west-southwesterly to the western edge of the sheet. East of the divide the watercourses flow into the Davis and Oakover rivers, whereas west of the divide they drain into the Nullagine River.

The physiography of EASTERN CREEK (Fig. 2) is largely controlled by the underlying geology. Areas underlain by greenstone and metamorphosed sedimentary rocks are characterized by long strike ridges of resistant rock with narrow intervening valleys. Areas underlain by granitic rocks are typified by subdued rocky hills, and are traversed by sandy creeks. In contrast, the area underlain by the Fortescue Group is best described as a dissected plateau, with scattered plateau remnants capped by deeply weathered rock that are possibly relics of an old erosional surface.

Previous work

Noldart and Wyatt (1962) first mapped the area covered by EASTERN CREEK during the preparation of the first edition of the NULLAGINE 1:250 000 geological sheet. A second edition of the map was prepared by Thom et al. (1973), and a brief description of the main rock types on EASTERN CREEK was presented in the accompanying explanatory notes (Hickman, 1978). More detailed studies on parts of the Mosquito Creek Formation have examined aspects of the structural geology (Hickman, 1975) and sedimentology (Eriksson, 1982; Eriksson et al., 1994). The structure of lode-gold deposits in the western end of the Mosquito Creek Formation, just to the west of EASTERN CREEK, was described by Blewett et al. (2002), and isotope chemistry and Sm–Nd dating of the granitic rocks in the Kurrana Terrane, which extend onto the southwest corner of EASTERN CREEK, was presented by Tyler et al. (1992). Previous work on the lithostratigraphy and chemistry of the Fortescue Group relevant to EASTERN CREEK includes a regional synthesis by Thorne and Trendall (2001), and a geochemical traverse through the Kylena, Tumbiana, and Maddina Formations near Mount Hays by Glikson et al. (1986).

A summary of mineral occurrences and mining on EASTERN CREEK was presented by Ferguson and Ruddock (2001), and a limited number of open-file company reports are available in the Western Australian mineral exploration (WAMEX) database held by GSWA. Descriptions of old mine workings in the Elsie, Eastern Creek, and Boodalyerrie mining centres can be found in Finucane (1939a,b).

Archean Pilbara Craton

EASTERN CREEK encompasses parts of three major tectonic components of the Archean Pilbara Craton (Fig. 3a), which forms the granite–greenstone basement to the Hamersley Basin. The craton has been studied extensively, particularly in the last 15 years (e.g. Arndt et al. 1991; Blake and Barley, 1992; Thorpe et al., 1992a; Barley, 1993; Krapez, 1993; McNaughton et al., 1993; Buick et al., 1995; Barley et al., 1998; Collins et al., 1998; van Haften and White, 1998; Barley and Pickard, 1999; Blake, 2001; Kloppenburg et al., 2001; Zegers et al., 2001; Blewett, 2002; Buick et al., 2002; Huston et al., 2002; Van Kranendonk et al., 2002; Blake et al., 2004). The oldest components of the craton are the 3.58 – 2.83 Ga East Pilbara Granite–Greenstone Terrane (EPGGT, which includes the Yilgalong Granitic* Complex and the Mount Elsie greenstone belt), exposed in the northwest of the sheet, and the 3.23 – 2.84 Ga Kurrana Terrane in the southwest. These terranes are separated by the c. ?3.04 – 2.90 Ga Mosquito Creek Basin (Fig. 3a).

All Archean rocks in the Pilbara Craton on EASTERN CREEK have been metamorphosed and deformed. Multiple phases of deformation have been identified using the overprinting of outcrop-scale structures, geochronological age constraints, and broad-scale stratigraphic and structural relationships (Table 1). The complete sequence of deformation events is not recognized in all tectonic units; the first three deformation events are thought to have occurred in the East Pilbara Granite–Greenstone Terrane, prior to development of the Mosquito Creek Basin. Subsequent deformation appears to have focused mainly on the Mosquito Creek Basin and Kurrana Terrane, and later generations of structures are not common in the granite–greenstone terrane. The last recognized event involved extensive faulting that affected all Archean rocks,

* Granitic Complexes were labelled as Granitoid Complexes on the EASTERN CREEK map (Farrell, 2005).

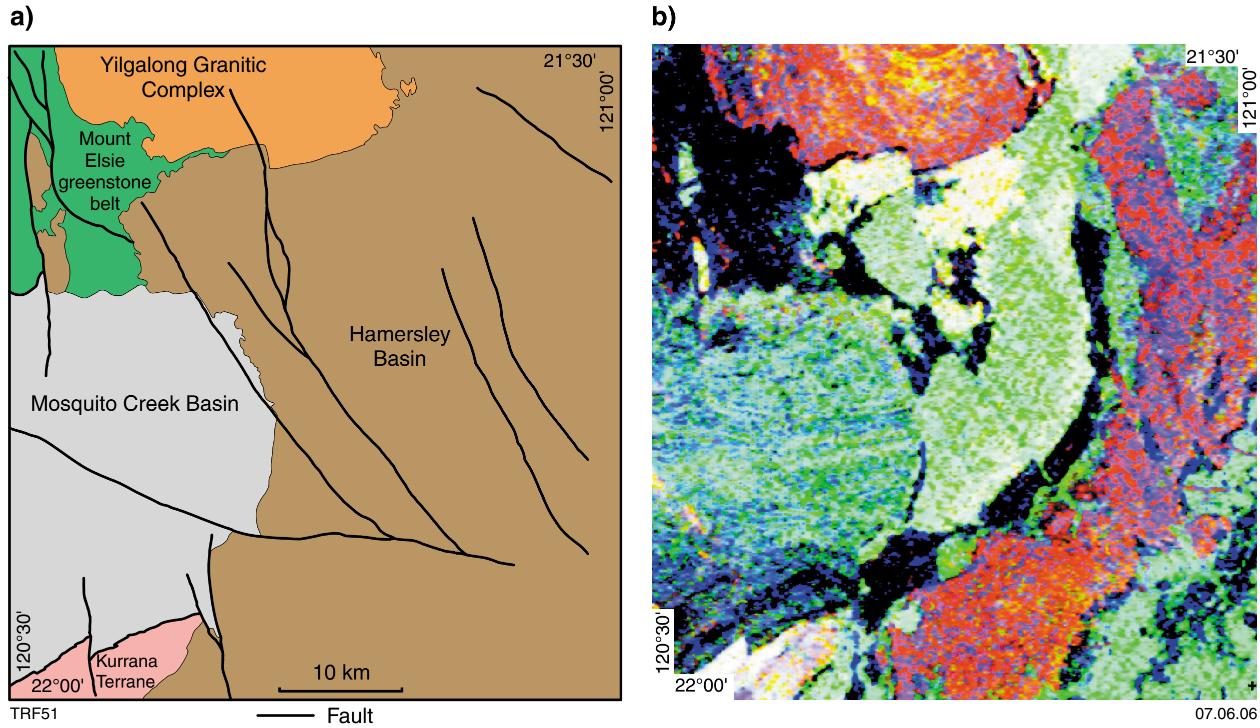

Figure 3. Geological and radiometric maps of Eastern Creek: a) geological sketch map showing the principal tectonic subdivisions; b) ternary radiometric map (400-m line spacing, AGSO/GSWA, 1996, with K, Th, U as red, green, blue) highlights the differences in chemistry between the various units in the Hamersley Basin

and probably occurred during, and shortly after, deposition of the Fortescue Group (Table 1).

East Pilbara Granite–Greenstone Terrane

The East Pilbara Granite–Greenstone Terrane comprises ovoid granitic complexes separated by linear to arcuate belts of multiply deformed and metamorphosed greenstones. The granitic complexes show evidence for a long history of magmatism and deformation, and contain the oldest rocks in the Pilbara Craton, ranging in age from 3.58 Ga (McNaughton et al., 1988) to 2.83 Ga (Nelson, 2004a). The greenstones were deposited between 3.52 Ga (Buick et al., 1995) and c. 2.94 Ga (Van Kranendonk et al., 2002), and are dominated by basalt, chert–BIF (banded iron-formation), and ultramafic rocks, with locally abundant felsic and sedimentary rock. The greenstone successions were assigned by Hickman (1983) to the Pilbara Supergroup.

Pilbara Supergroup

The Pilbara Supergroup, as defined by Hickman (1983), comprised the Archean layered succession in the granite–greenstone basement exposed in the northern part of the Pilbara Craton. At the time that Version 2.0 of the Eastern Creek 1:100 000 map (Farrell, 2005) was compiled, the supergroup was subdivided into the following units, from base to top: Coonterunah Group, Warrawoona Group, Wyman Formation, Golden Cockatoo Formation, Sulphur Springs Group, Gorge Creek Group, and De Grey Group (Van Kranendonk et al., 2001, 2002). On Eastern Creek the Pilbara Supergroup was represented by the Warrawoona Group, in the Mount Elsie greenstone belt in the northwest corner of the map sheet (Fig. 3), and the De Grey Group, in the Mosquito Creek Basin.

In a subsequent revision of the stratigraphy of the Pilbara Craton (Van Kranendonk et al., 2004), the greenstone successions in the Pilbara Craton were divided into two supergroups: the Pilbara Supergroup, comprising the Warrawoona, Kelly, Sulphur Springs, and Gorge Creek Groups; and the De Grey Supergroup, which is a redefinition of the former De Grey Group. However, for consistency with Version 2.0 of the Eastern Creek map (Farrell, 2005), the stratigraphic scheme in these Notes follows that of Van Kranendonk et al. (2001, 2002), although it should be noted that in the revised stratigraphy of Van Kranendonk et al. (2004), all rocks assigned to the Warrawoona Group on Eastern Creek (Farrell, 2005) are now part of the Kelly Group (formerly the Kelly Subgroup of the Warrawoona Group). Appendix 2 contains a table showing the translation of stratigraphic names into the revised scheme of Van Kranendonk et al. (2004).

Warrawoona Group

The Warrawoona Group (Hickman, 1983; Barley, 1993) is a thick succession of mafic volcanic rocks, with subordinate chert and felsic rocks, that accumulated between 3.49 and 3.33 Ga (McNaughton et al., 1993; Van Kranendonk et al., 2002, and references therein).

Table 1. Summary of the geological history of EASTERN CREEK

Age (Ma)	*Event*
c. 3395–3312	Deposition of greenstones in Mount Elsie greenstone belt (Euro Basalt, Wyman Formation, and unassigned Warrawoona Group)
?	Early foliation in Yilgalong Granitic Complex and Mount Elsie greenstone belt (D_{EP1})
c. 3291–3274	Intrusion of Yilgalong Granitic Complex
?3280–3260	?Intrusion of older components of Golden Eagle Orthogneiss Main foliation in Mount Elsie greenstone belt (D_{EP2}) Northerly to northwesterly trending folds and shear zones in Mount Elsie greenstone belt (D_{EP3})
?	(?Localized) uplift of Yilgalong Granitic Complex (D_{EP4})
3225–3178	Intrusion of granite precursor to Golden Eagle Orthogneiss
>c. ?3035	Deposition of the Coondamar Formation Early foliation in Golden Eagle Orthogneiss and Coondamar Formation (D_{MB1}) ?during development of the Kurrana Shear Zone
<c. 2926	Deposition of Mosquito Creek Formation Second deformation event in Golden Eagle Orthogneiss and first deformation event in Mosquito Creek Formation (D_{MB2}) ?Local reclined folds in Golden Eagle Orthogneiss and Coondamar Formation Peak metamorphism of the Mosquito Creek Formation
c. 2905	East–west folding and south-over-north thrusting in Mosquito Creek Basin (D_{MB4}) and local thrusting in Yilgalong Granitic Complex (D_{EP5})
c. 2860	Intrusion of Bonney Downs Granite
2860–2775	Dextral shearing in Kurrana Granitic Complex and Mosquito Creek Basin and kink folds in Mosquito Creek Formation (D_{MB5})
2775–2629	Deposition of Fortescue Group
2755	Intrusion of diorite plugs (?related to Bamboo Creek Member)
c. 2541	Deposition of Carawine Dolomite (Hamersley Group)
1803	Intrusion of Bridget Suite

Regionally, the group has been subdivided into several formations based on lithostratigraphic correlations and geochronological data. Correlations were not attempted on Version 1.0 of EASTERN CREEK (Farrell, 2003) due to the uncertainty in assigning the rocks to specific formations in the absence of geochemical and geochronological data. The rocks in the Mount Elsie greenstone belt were mapped as undivided Warrawoona Group, although it was recognized that the lower part of the succession shows similarities to the Euro Basalt (Hickman, 1977, 1983). Subsequent mapping of adjacent NULLAGINE (Bagas et al., 2004a) and YILGALONG (Williams, 2005) has more strongly supported the stratigraphic subdivision of the greenstone belt, and these changes were incorporated into Version 2.0 of EASTERN CREEK (Farrell, 2005). Units of the Warrawoona Group that outcrop on Eastern Creek are the Euro Basalt and the Wyman Formation.

Euro Basalt (AWebk, AWebs, AWed, AWeb, AWebkc, AWebx, AWebkz, AWeu, AWeuk, AWeup, AWeux, AWesl, AWefv, AWeccw)

The Euro Basalt is the oldest unit of the Warrawoona Group on EASTERN CREEK, occupying the lower part of the succession in the Mount Elsie greenstone belt (Fig. 4). The base of the unit is not exposed on EASTERN CREEK, and to the north and northeast of Mount Elsie the basalt is intruded by granites of the Yilgalong Granitic Complex. The top of the basalt is either a paraconformity with the Wyman Formation or an angular unconformity with rocks of the Fortescue Group. Estimates of the thickness of the basalt are complicated by multiple deformation, and possible loss of section due to faulting. A thickness of up to 9 km has been inferred on NORTH SHAW (Van Kranendonk, 2000) to the west-northwest. The Euro Basalt has not been directly dated on EASTERN CREEK, but a depositional age of c. 3395 to 3325 Ma has been interpreted by Van Kranendonk et al. (2002).

On EASTERN CREEK the Euro Basalt consists mainly of basalt and mafic schist, with subordinate gabbro, chert, ultramafic rocks, and clastic sedimentary rocks. Metamorphosed komatiitic basalt (*AWebk*) is the dominant mafic rock, constituting about 60–70% of the succession. Mafic schist (*AWebs*) and fine-grained gabbro (*AWed*) are common, but much less volumetrically abundant.

Metamorphosed komatiitic basalt (*AWebk*) in the Euro Basalt is variously foliated, grey-green in colour, and contains locally abundant varioles (up to 5 mm in diameter) and vesicular zones. Pyroxene-spinifex textures are recognizable in many outcrops. Carbonate alteration is widespread and strongly affected rocks are typically foliated and deeply weathered. Partial silicification of the basalt is also common in some areas, as evidenced by bleaching and cherty fracture characteristics. Pillow

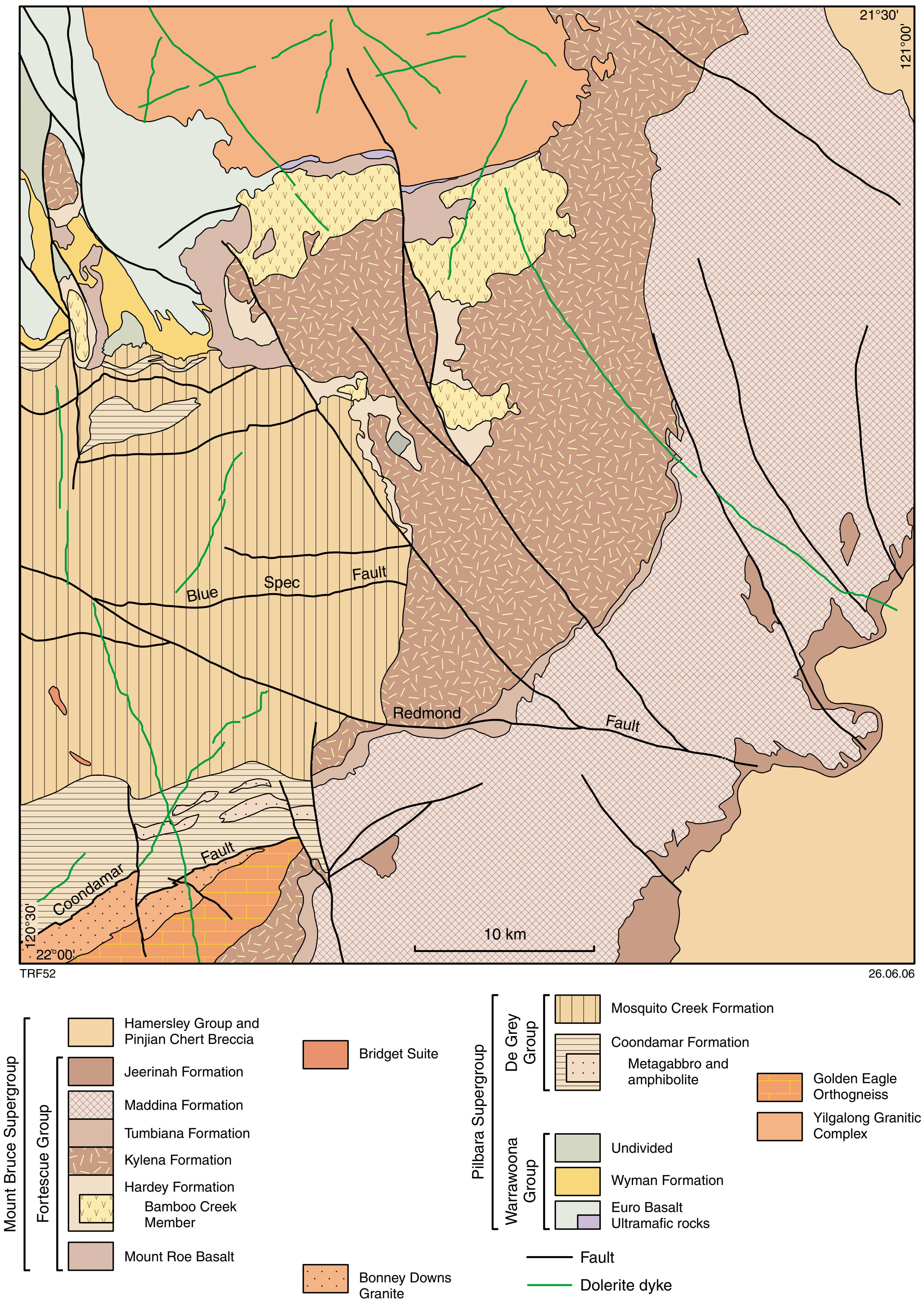

Figure 4. Simplified geological interpretation map of Eastern Creek

structures are well preserved in many locations, commonly with chilled margins and radial concentrations of vesicles now filled with various proportions of chlorite, actinolite, epidote, albite, and carbonates. In a few areas the pillows have elongate, partly quartz-filled, convex cavities close to the upper margin. These cavities may have originally been filled with quartz and calcite, with subsequent dissolution of the calcite during surface weathering. In a few areas the komatiitic basalt has small, relict ?olivine phenocrysts (<0.5 mm) replaced by aggregates of chlorite and calcite, or albite and calcite.

In areas of more extensive outcrop the komatiitic basalt appears to be in flows between 1 and 3 m thick, with local concentrations of vesicles towards the tops of individual flows. A good exposure of a succession of flows up to 1.5 m thick is about 3 km south-southwest of Mount Elsie (MGA 247490 7607310). At this location there is a succession of columnar-jointed flows with vesicular tops, interspersed with pillowed intervals.

Tholeiitic basalt (*AWeb*) is more abundant in the western part of the Mount Elsie greenstone belt, particularly along the western edge of the map. Here, the basalt is dark blue-green to grey-green, and weakly foliated with local zones of quartz veining.

Thin units of mafic schist interleaved with minor amounts of metamorphosed komatiitic basalt and slate (*AWebs*) are exposed near Mount Elsie. The mafic schist is a strongly foliated rock containing chlorite, albite, accessory opaque minerals and actinolite, and locally abundant carbonate. The schist commonly has zones of strong carbonate alteration, and in places contains weathered carbonate veins and Fe-hydroxide pseudomorphs of (?)pyrite up to 3 mm (MGA 250070E 7611990N). The protolith is uncertain due to the effects of metamorphism, strong deformation, and carbonate alteration, but it may have originally been a fine-grained mafic volcaniclastic rock. The interleaved komatiitic basalt is also strongly deformed, but has a relict pyroxene-spinifex texture in some areas. Thin layers of associated very fine grained, chloritic slaty rock are possibly metamorphosed penecontemporaneous interflow sediments. Some locations also contain poorly exposed thin units of talc-bearing ultramafic rock.

Minor mafic rock types include metamorphosed carbonate-altered komatiitic basalt (*AWebkc*) and metamorphosed basaltic fragmental rock (*AWebx*). Carbonate-altered komatiitic basalt (*AWebkc*) is typically weathered and partly capped by calcrete. Carbonate alteration is common in the mafic rocks, but in most cases carbonate-altered mafic rocks do not form readily mappable units. Metamorphosed basaltic fragmental rock (*AWebx*) forms thin units at several locations within the Mount Elsie greenstone belt. The best exposure lies 5 km southwest of Mount Elsie, where a 2–3 m-thick layer of fragmental rock contains a variety of clasts, including flow-banded (?)basalt, up to 300 mm in size. At another location, 3 km west-southwest of Mount Elsie, a poorly sorted fragmental rock has well-rounded to angular clasts of vesicular and variolitic basalt up to 400 mm. Some of the clasts at this location also show flow banding.

Outcrops of metamorphosed gabbro and dolerite (*AWed*) are common throughout the greenstone belt, but are mostly too small to be shown separately on the map. The rocks are typically fine to medium grained, massive, and granular to intergranular textured. The gabbro and dolerite bodies may represent small, shallow-level sills or plugs emplaced in the mafic volcanic pile during ongoing volcanic activity.

Narrow vein-like zones of fractured, strongly silicified, and weathered komatiitic basalt (*AWebkz*) are common in the area around Mount Elsie. These zones contain veins of chert and milky quartz, and are locally brecciated and associated with deeply weathered altered rock. They are mostly confined to one stratigraphic interval, and may possibly represent synvolcanic faults and associated zones of hydrothermal alteration.

Ultramafic rocks typically form small elongate pods and thin layers that outcrop discontinuously over strike lengths of up to 3 km. Larger bodies of ultramafic rock are present in a narrow sliver of greenstone exposed along the southern margin of the Yilgalong Granitic Complex (Fig. 4). The ultramafic rocks have a weak to moderate foliation in the central part of the belt, but are more highly deformed in areas of higher metamorphic grade close to the contact with the Yilgalong Granitic Complex north of Mount Elsie. A range of ultramafic rock types are exposed on EASTERN CREEK, including peridotite, pyroxenite, and minor talc–carbonate and tremolite–chlorite schist. Undivided ultramafic rocks (*Aweu*) are generally either weathered or poorly exposed.

Thin layers of metamorphosed komatiite (*AWeuk*), with relict olivine-spinifex textures, are locally within units of mafic schist (Fig. 5). The only significant exposure lies 500 m southeast of Mount Elsie, where partly silicified komatiite is intercalated with mafic schist and (?)talc–carbonate schist.

Metamorphosed peridotite (*AWeup*) forms thin layers in the central part of the Mount Elsie greenstone belt, and two large lenses on the southern margin of the Yilgalong Granitic Complex east of Mount Elsie.

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Figure 5. Partly silicified komatiite with relict bladed olivine-spinifex texture, Mount Elsie greenstone belt (MGA 252360E 7610850N)

The rock is characteristically fine to medium grained, granular textured, and weakly foliated. Most exposures are pervasively serpentinized and appear to be relatively homogeneous, apart from a few talc-bearing horizons. The peridotite is locally associated with metapyroxenite. In a few locations metamorphosed peridotite contains actinolite pseudomorphs of pyroxene phenocrysts up to 40 mm (e.g. 4 km north of Mount Elsie, MGA 250220E 7611940N).

Metamorphosed pyroxenite (*AWeux*) in the Mount Elsie greenstone belt is typically medium grained, with a variously developed foliation, and commonly associated with metamorphosed peridotite. In places the pyroxenite is coarsely porphyritic, containing pseudomorphs of pyroxene phenocrysts and skeletal (?)ilmenite, replaced by metamorphic actinolite and sphene respectively. The rock appears to be in layers and lenses in metamorphosed melanocratic gabbro.

Sedimentary rocks are a minor component of the Euro Basalt on EASTERN CREEK. Metamorphosed fine-grained clastic sedimentary rocks (*AWesl*) are typically weathered and poorly exposed, except in the extreme northwest of the sheet. The rocks typically contain white mica, with thin cherty layers, and local fuchsitic zones. In less weathered exposures they are pale grey-green, locally laminated, and interbedded with sandstone. Four kilometres west of Mount Elsie (MGA 246090E 7609010N), a weathered exposure of thin-bedded siltstone and medium-grained sandstone has sporadically distributed chert layers up to 200 mm thick. Sandstone beds are characteristically kaolinized, whereas the siltstone layers tend to be partly silicified.

Thin layers of foliated, pale, siliceous metamorphosed felsic (?)volcaniclastic rock (*AWefv*) are exposed in the northwestern corner of EASTERN CREEK. Optical microscopy reveals that the rock consists almost entirely of metamorphic white mica and quartz, with minor chlorite and sphene, suggesting derivation from a felsic protolith.

Metamorphosed layered chert (*AWeccw*) is widespread in the Euro Basalt on EASTERN CREEK, typically forming thin units along specific stratigraphic horizons in association with poorly exposed metasedimentary rocks. The chert typically has black-and-white or grey-and-white layering on a 10 to 150 mm scale, with fine internal laminae in many of the layers. Locally, it contains hydrous Fe-oxides after (?)pyrite. The chert also includes some poorly layered grey to brown or green-grey chert with milky quartz veins. The layered chert is commonly associated with fine-grained, light-grey to pale-brown silicified rocks containing thin chert layers up to 30 mm that may be silicified clastic sedimentary rocks.

Wyman Formation (AWwssz, AWwcc, AWwb, AWwd)

The Wyman Formation (Lipple, 1975; Hickman and Lipple, 1978) is distributed along the southern edge of the Mount Elsie greenstone belt, and in a narrow, north-northwesterly trending corridor west of Mount Elsie. Regionally, the Wyman Formation is generally conformable on the Euro Basalt, although locally unconformable relationships have been reported (Hickman, 1983). On EASTERN CREEK the basal contacts with the Euro Basalt are either strongly faulted or poorly exposed, such that the relationship between the two units is unclear. Relationships with the overlying units range from an apparently conformable contact with a succession of unassigned pillow basalts of the Warrawoona Group (*AW(bk)*), to a faulted contact with the Coondamar Formation, or to unconformable contacts with the Mosquito Creek Formation and rocks of the Fortescue Group. Estimates of the thickness are uncertain due to folding and disruption of the unit; however, a value up to 1 km is probable. The Wyman Formation has not been dated on EASTERN CREEK. A depositional age range of 3325 to 3315 Ma is indicated by a conventional U–Pb zircon date of 3325 ± 3 Ma (Thorpe et al., 1992a), and sensitive high-resolution ion microprobe (SHRIMP) U–Pb zircon dates of 3325 ± 4, 3324 ± 4 (McNaughton et al., 1993), 3318 ± 4 (Nelson, 2002a), and 3315 ± 3 Ma (Nelson, 2002b) from other areas in the East Pilbara Granite–Greenstone Terrane.

On EASTERN CREEK the Wyman Formation consists of silicified clastic sedimentary rock, with subordinate komatiitic basalt and gabbro, and thin bands of chert and very minor amounts of ultramafic rock. Metamorphosed clastic sedimentary rock (*AWwssz*) is the dominant lithotype. Much of the outcrop is weathered, strongly silicified, and cut by chert veins, and includes layers of chert (silicified ?metashale), and minor amounts of strongly silicified basalt. In fresh creek exposures the rocks are thin to medium bedded, commonly well foliated, and include mudstone, sandy siltstone, poorly sorted fine- to coarse-grained sandstone, and pebbly sandstone. The sequence typically contains chert layers up to about 70 mm thick, and has local chertified zones and beds of layered chert. In a creek exposure 8 km west-southwest of Mount Elsie (MGA 242910E 7606180N), fresh outcrops of well-foliated metamorphosed siltstone and fine-grained sandstone are grey to grey-brown in colour. The sandstone typically contains clasts of quartz, plagioclase, and minor tourmaline in a recrystallized, fine-grained foliated matrix of quartz, white mica, chlorite, albite, and opaque minerals. In the pebbly sandstone the clasts are up to 20 mm in size, and are dominated by chert. The mudstone is completely recrystallized to fine-grained quartz, white mica, chlorite, and opaque minerals.

Thin bands of metamorphosed chert (*AWwcc*) are common in some parts of the Wyman Formation. The chert ranges in colour from light brown or grey-brown through to dark grey or green-grey. The rock locally contains crosscutting veins of grey chert or milky quartz, as well as porous zones dominated by Fe-hydroxides (after ?pyrite) and breccia zones with abundant quartz veins. The chert is commonly associated with pale-brown, intensely silicified rock of uncertain origin. In some layers vague pillow-like structures suggest that, locally, the chert may have formed through extreme silicification of basalt. The chert also includes thin bands of layered chert that are too small to be shown separately at map scale.

Basalt in the Wyman Formation (*AWwb*) is variously foliated, grey-green in colour, and has scattered varioles (up to 5 mm), localized vesicular zones, and relict pillow structures. Patchy carbonate alteration is widespread and silicification is common adjacent to chert layers and contacts with clastic sedimentary rocks (*AWwssz*). Small bodies of metamorphosed equigranular gabbro and dolerite (*AWwd*) are common. A typical exposure 6 km southwest of Mount Elsie (MGA 246980E 7604180N) is massive and homogeneous, apart from minor quartz–epidote alteration in thin veins and small patches.

Unassigned Warrawoona Group (AW(bk), AW(cc))

Rocks in the Mount Elsie greenstone belt that could not be confidently assigned to a specific formation include komatiitic basalt (*AW(bk)*) and nonlayered chert and associated silicified rock of uncertain origin (*AW(cc)*). These rocks outcrop in an area about 7 km west-northwest of Eastern Creek Well (MGA 247500E 7601500N), and in a north to northwesterly trending, fault-bound belt close to the northwestern margin of EASTERN CREEK.

Yilgalong Granitic Complex (*AgAm, AgApf*)

The Yilgalong Granitic Complex occupies about 200 km^2 in the central-northern margin of EASTERN CREEK. The complex has a variously deformed intrusive contact with the Euro Basalt, and is overlain nonconformably by rocks of the Fortescue Group in the east. Crystallization of the granites between 3291 and 3274 Ma is indicated by a SHRIMP U–Pb zircon date of 3292 ± 4 Ma (Nelson, 2005e) from EASTERN CREEK, and dates of 3274 ± 5 (Nelson, in prep.), 3277 ± 6 (Nelson, 2005f), 3290 ± 4 (Nelson, 2005g), and 3291 ± 4 Ma (Nelson, 2005h,i) obtained on YILGALONG (Williams, 2005) to the north.

On EASTERN CREEK the majority of the complex consists of strongly deformed, fine- to medium-grained, biotite granodiorite and biotite monzogranite (*AgAm*). Tonalite and granodiorite are dominant along the western margin of the complex near Steel Well. Pegmatite zones are common throughout and some outcrops have thin aplite dykes. A vague layering, defined by variations in grain size and abundance of biotite, is present in areas close to the margin of the granitic complex (e.g. 3.5 km northeast of Mount Elsie, MGA 253260E 7611610N). Local variants include hornblende–biotite monzogranite and a weakly porphyritic monzogranite. Small areas of a fine- to medium-grained, weakly foliated leucocratic granodiorite may be a younger phase. Quartz veins and mafic dykes are common in the Yilgalong Granitic Complex, particularly adjacent to the southeast margin.

An isolated body of microporphyritic biotite granodiorite about 3 km east of Mount Elsie (MGA 253160E 7609530N) is assigned to the Yilgalong Granitic Complex. Outcrop in this area is poor, due to extensive fracturing. The rock is relatively leucocratic, containing about 1–2 vol.% of biotite extensively retrogressed to aggregates of white mica and fine-grained opaque minerals.

Thin dykes and small plugs of feldspar porphyry (*AgApf*) have intruded the greenstone succession to the north and east of Mount Elsie. Most of these dykes are too small to be shown on the map. A dyke 2 km east-northeast of Mount Elsie is grey on fresh surfaces, and contains phenocrysts of plagioclase and quartz up to 3 mm in an aphanitic groundmass. The rock has a SHRIMP U–Pb zircon age of 3279 ± 3 Ma (Nelson, 2005j). Based on their similar age and closeness to the granite–greenstone contact, these dykes are thought to be related to the Yilgalong Granitic Complex.

Structure of the East Pilbara Granite–Greenstone Terrane

Five deformation episodes have been identified in the East Pilbara Granite–Greenstone Terrane on EASTERN CREEK: D_{EP1} to D_{EP5} (Table 1). The three main deformation events (D_{EP1}–D_{EP3}) must have occurred before the development of the Mosquito Creek Basin, which truncates $D_{EP2–3}$ structural trends at the southern end of the Mount Elsie greenstone belt. Most of the deformation events recognized in the Mosquito Creek Basin and Kurrana Terrane have no expression in the greenstone succession, suggesting that the East Pilbara Granite–Greenstone Terrane was stabilized by the time deformation began in the south. Localized crenulations that overprint D_{EP2} and D_{EP3} fabrics are recognized in a few areas, but it is uncertain if they are the result of a deformation prior to the formation of the Mosquito Creek Basin or related to one of the events that have been recognized in the basin. Minor, south-dipping thrust faults in the Yilgalong Granitic Complex (D_{EP5}) are probably related to the D_{MB4} event in the Mosquito Creek Basin (see below).

The large-scale structure of the Mount Elsie greenstone belt is dominated by three features: a partially preserved dome-like structure near Mount Elsie, the flanks of a dome extending onto the western edge of EASTERN CREEK from NULLAGINE, and an intervening, north to northwesterly trending corridor of folding and faulting that runs the length of the belt. The Mount Elsie dome-like structure is outlined by concentric units of chert, mafic schist, ultramafic rock, and sedimentary rock, which young away from the centre of the dome to the northwest, west, and southwest. The dome is truncated along the northern side by granites of the Yilgalong Granitic Complex, and obscured by overlying rocks of the Fortescue Group in the southeast.

D_{EP1} (<3325 Ma)

Structures produced in the first phase of deformation are preserved in parts of the greenstone belt around Mount Elsie. The principal outcrop-scale D_{EP1} structures are a foliation (S_{EP1}, mainly preserved in mafic schist) and a mineral lineation (L_{EP1}). The foliation trends approximately westerly to northwesterly and dips to the south or southwest at 20° to 55°. The mineral lineation is typically down-dip on S_{EP1} and is mainly defined in mafic rocks by the alignment of amphibole. S_{EP1} is crenulated and largely overprinted by S_{EP2} in most areas. Along the contact with the Yilgalong Granitic Complex, due north of Mount Elsie, S_{EP1} is preserved as intrafolial folds of thin leucosomes in a composite $S_{EP1–2}$ fabric. The timing of this event is unknown, but must be post-3325 Ma — the minimum age for the host Euro Basalt.

D_{EP2} (c. 3291–3274 Ma)

The second deformation event resulted in the development of tight folds, a regionally extensive foliation, and a series of arcuate zones of high strain that wrap around the western side of the Mount Elsie dome. D_{EP2} folds are outlined by units of chert and silicified sedimentary rock, and are commonly upright, open to tight, and plunge moderately to the south and southeast. A strong axial-planar foliation (S_{EP2}) is present in most parts of the greenstone belt. In the Mount Elsie area the foliation is broadly parallel to stratigraphy and follows the arcuate trend of the broad-scale structure of the dome. It overprints S_{EP1}, resulting in the development of a pronounced intersection lineation (L_{EP2}), which is parallel to a locally developed mineral lineation.

Constraints on the age of D_{EP2} are provided by relationships with granites in the Yilgalong Granitic Complex. Close to the granite–greenstone contact, 5 km north-northwest of Mount Elsie, the granites have a foliation similar in orientation to S_{EP1-2} and mineral lineation similar to L_{EP2} in the greenstone belt, indicating that some components of the granitic complex pre-date D_{EP2}. Conversely, northeast of Mount Elsie the dome-like structure and S_{EP2} are truncated by younger granites, suggesting that there are also some granites in the complex that post-date D_{EP2}. These relationships suggest that the second deformation event was broadly coeval with intrusion of the Yilgalong Granitic Complex, and is therefore constrained to 3291–3274 Ma. A correlation with the deformation sequence of Van Kranendonk et al. (2002) is problematic because the timing constraints for D_{EP2} place it between their D_2 and D_3. This raises the possibility that D_{EP2} belongs to an as-yet unrecognized deformation event that affected the easternmost part of the Pilbara Craton in the area around the Yilgalong dome of Van Kranendonk et al. (2002).

D_{EP3} (<3274 Ma)

The third deformation event resulted in large-scale shear zones in the centre of the greenstone belt, and along the granite contact west and northwest of Steel Well, and a locally well developed foliation (S_{EP3}). Rocks in the D_{EP3} shear zones have a strong foliation and a well-developed, gently south-plunging mineral–stretching lineation (L_{EP3}). Possible S–C fabrics indicating dextral movement are present in some outcrops. In the shear zones strongly deformed metabasalt locally contains σ-porphyroclasts consisting of aggregates of calc-silicate minerals, such as epidote, sphene, and calcite, after primary pyroxene. The shear zones are assigned to D_{EP3} because they truncate or overprint D_{EP2} structures (e.g. 5 km northwest of Mount Elsie). The third deformation event probably occurred after 3274 Ma (the minimum age for the Yilgalong Granitic Complex) because D_{EP3} structures are well developed in granites along the western edge of the complex.

D_{EP4}

Low-angle normal faults and asymmetric folds in S_{EP2} are developed along the granite–greenstone contact north of Mount Elsie. The faults trend easterly to southeasterly and dip to the south at about 20°. The asymmetric folds are gently plunging, have a weak, west-southwesterly dipping axial-planar cleavage (S_{EP4}), and verge to the west-southwest, consistent with uplift of the granitic complex along shallow-dipping structures. The exact timing of this event relative to D_{EP3} is not clear, and the structures are tentatively assigned to D_{EP4}. Similar structures have not been observed in other parts of the greenstone belt.

D_{EP5}

The Yilgalong Granitic Complex has shallow-dipping thrust faults in an area 4 km east-northeast of Mount Elsie (MGA 253300 7611600). The faults cut an early east-trending, steeply dipping foliation (S_{EP2}), and are associated with north-verging, recumbent asymmetric folds that have a spaced, anastomosing axial-planar cleavage enclosing lenses of less deformed rock with an asymmetry consistent with south-over-north movement. These thrusts have only been observed at this location, and are thought to be equivalent to the late D_{MB4} thrust and reverse faults in the Mosquito Creek Basin succession.

Metamorphism of the East Pilbara Granite–Greenstone Terrane

Greenstones on EASTERN CREEK have mostly been metamorphosed to lower greenschist facies, and basalts and ultramafic rocks commonly display well-preserved primary igneous textures. Amphibolite-facies rocks are restricted to a narrow zone along the contact with the Yilgalong Granitic Complex, from north of Mount Elsie to the northern margin of the sheet. There is no apparent difference in metamorphic grade between the main deformation events in the Mount Elsie greenstone belt (D_{EP1}–D_{EP3}, see **Structure of the East Pilbara Granite–Greenstone Terrane**). In rocks that show both S_{EP1} and S_{EP2}, the foliations are defined by the same metamorphic mineral assemblages.

Mafic rocks are typically replaced by metamorphic assemblages of chlorite–albite–epidote–actinolite (–quartz–sphene), which is diagnostic of greenschist-facies conditions and indicates a metamorphic temperature range of about 280° to 500°C (Bucher and Frey, 1994). In rocks with well-preserved igneous textures, igneous clinopyroxene is commonly replaced by actinolite(–chlorite) and plagioclase by albite(–epidote). Replacement of the primary igneous minerals is typically complete, except in some outcrops of metamorphosed gabbro and pyroxenite, which may contain relict clinopyroxene. Amphibolite-facies metabasalt is strongly foliated with local, thin leucosomes, and is composed of metamorphic assemblages of hornblende–plagioclase(–epidote–sphene–quartz–carbonate minerals).

Metamorphosed peridotite characteristically contains assemblages of a serpentine-group mineral (probably antigorite), magnetite, and various amounts of carbonate, talc, and (?)diopside. Much of the primary igneous textures have been obliterated during serpentinization, but mesocumulate textures are locally preserved. The general absence of tremolite suggests a maximum temperature in the order of 500°C (Bucher and Frey, 1994).

Kurrana Terrane

The Kurrana Terrane is dominated by granite and gneiss (Kurrana Granitic Complex), and greenstones are a very minor constituent. The age of this component of the Pilbara Craton is not well constrained, but recent SHRIMP U–Pb zircon dating (Nelson, 2004h, 2005a,b) indicates an age range of 3.23 to 2.84 Ga.

Kurrana Granitic Complex

The Kurrana Granitic Complex is exposed in the southwestern corner of EASTERN CREEK. In this area the rocks are deeply weathered and information on their petrology is limited. The granites have been assigned to two units using field observations and radiometric data (Fig. 3b) — the Golden Eagle Orthogneiss (*AgKge*), and a weakly porphyritic monzogranite (*AgKbd*) with a high radiometric signature, which is interpreted to be part of the Bonney Downs Granite (Hickman, 1983; Bagas, 2005).

Golden Eagle Orthogneiss (AgKge)

The Golden Eagle Orthogneiss (*AgKge*) is a strongly foliated layered orthogneiss, tectonically juxtaposed against rocks of the Mosquito Creek Basin. The orthogneiss is intruded by the Bonney Downs Granite and unconformably overlain by rocks of the Fortescue Group. SHRIMP U–Pb zircon dating on individual components of the gneiss have given ages of 3225 ± 5 (Nelson, 2005a) and 3178 ± 3 Ma (Nelson, 2004h). Dates of 3283 and 3260 Ma obtained by Sm–Nd whole-rock dating (Tyler et al., 1992), and the presence of a single c. 3379 Ma zircon xenocryst in one sample of orthogneiss (GSWA 178013, Nelson, 2005a), suggest that the orthogneiss may also contain slightly older components.

All exposures of the Golden Eagle Orthogneiss on EASTERN CREEK are extremely weathered, and it is difficult to distinguish the various components of the gneiss in outcrop. In fresh outcrops on NULLAGINE (Bagas et al., 2004a) and NOREENA DOWNS (Farrell and Smithies, 2005), to the west and southwest, the orthogneiss consists mainly of strongly foliated and metamorphosed biotite-bearing monzogranite, granodiorite, and tonalite. Petrographically, the monzogranite is composed of dynamically recrystallized quartz and various proportions of plagioclase and K-feldspar. Small amounts of recrystallized brown biotite are scattered throughout. The orthogneiss is (?tectonically) interleaved with quartz–muscovite schist, amphibolite, and rare pelitic schist and ultramafic schist close to the contact with the Coondamar Formation. Amphibolite is typically in discontinuous layers less than 5 m thick, whereas the ultramafic rocks form narrow lenses. The orthogneiss also contains more extensive areas of weathered chlorite–actinolite schist, quartz–muscovite schist, and amphibolite interleaved with strongly foliated granites (*ADnlbn*).

Bonney Downs Granite (AgKbd)

The Bonney Downs Granite (Hickman, 1983; *AgKbd*) belongs to a group of late- to post-tectonic tin–tantalum–lithium-bearing monzogranites (‘tin granites’ of Blockley, 1980; Split Rock Supersuite of Van Kranendonk et al., 2004) that were emplaced across the East Pilbara Granite–Greenstone Terrane and Kurrana Terrane at 2.89 – 2.83 Ga. The Bonney Downs Granite is deformed and interleaved with the Golden Eagle Orthogneiss and is faulted against the Coondamar Formation along the Coondamar Fault (Fig. 4), which is a zone of late dextral movement (and probable reactivation of the Kurrana Shear Zone (Bagas, 2005) along the edge of the Mosquito Creek Basin (see **Structure of the Mosquito Creek Basin and Kurrana Terrane**).

On EASTERN CREEK the Bonney Downs Granite is a strongly deformed, fine- to medium-grained, weakly porphyritic monzogranite with local pegmatitic zones and sparse aplite veins. It has a distinct radiometric signature (Fig. 3b), characterized by high potassium, thorium, and uranium counts. Petrographic identification of the granite on EASTERN CREEK is uncertain, due to the extreme weathering, but it has been classified as a monzogranite based on the presence of roughly equal proportions of two different types of feldspars (now replaced by clay minerals).

Farther to the west and southwest, on NULLAGINE (Bagas et al., 2004a) and NOREENA DOWNS (Farrell and Smithies, 2005), the granite is largely undeformed and in some areas contains feldspar phenocrysts up to 30 mm in size. A crystallization age of c. 2860 Ma is indicated by a SHRIMP U–Pb zircon date of 2861 ± 4 Ma for two concordant analyses of a single zircon crystal (Nelson, 2005b) from a sample collected on NULLAGINE. A date of 2838 ± 6 Ma for a group of discordant analyses with high $^{208}Pb/^{206}Pb$ values from the same sample gives a minimum estimate of the crystallization age.

Mosquito Creek Basin

The Mosquito Creek Basin is a Mesoarchean, easterly trending structure containing a package of predominantly clastic sedimentary rocks assigned to the De Grey Group. The basin fill consists of two contrasting successions: a lower package of mafic–ultramafic rocks and consanguineous sedimentary rocks (Coondamar Formation, >c. 3.04 Ga), and an upper package of siliciclastic sedimentary rocks (Mosquito Creek Formation, c. 2.93 – 2.90 Ga). The upper package is similar in age and lithology to the Mallina Formation (Smithies et al., 2001) in the Mallina Basin. The appearance of large volumes of clastic sedimentary rocks at c. 2.95 Ga and the paucity of mafic volcanism in this part of the stratigraphic record are indicative of a major change in the tectonics of the Pilbara Craton.

De Grey Group

The De Grey Group (subsequently revised to the De Grey Supergroup, Van Kranendonk et al., 2004) is a succession of sedimentary rocks that was deposited unconformably on the West Pilbara and East Pilbara Granite–Greenstone Terranes at c. 2.97 – 2.92 Ga (Van Kranendonk et al., 2002). Deposition occurred in three major depocentres: the Mallina (Smithies et al., 1999, 2001), Lalla Rookh

(Krapez, 1984, 1989), and Mosquito Creek Basins, as well as in several smaller basins.

On EASTERN CREEK rocks of the De Grey Group outcropping in the Mosquito Creek Basin have been assigned to two formal stratigraphic units: the volcano-sedimentary Coondamar Formation (see Appendix 3) at the base, and the paraconformably overlying siliciclastic Mosquito Creek Formation (Noldart and Wyatt, 1962; Hickman, 1978, 1983). The Coondamar Formation is a subdivision of the Mosquito Creek Formation as defined by Hickman (1978), and is equivalent to the informally named Middle Creek Formation of Blewett et al. (2002).

The stratigraphy of the Mosquito Creek Basin was originally interpreted in terms of a broadly synclinal structure, with the mafic to ultramafic rocks along the margins (now assigned to the Coondamar Formation) at the base, and the siliciclastic rocks (Mosquito Creek Formation) at the top of the sequence in the core of the syncline. The Coondamar Formation has now been separated from the Mosquito Creek Formation based on new geochronological data (Nelson, 2005c) and field data collected in the mapping of EASTERN CREEK (Farrell, 2003, 2005), NULLAGINE (Bagas et al., 2004a), and NOREENA DOWNS (Farrell and Smithies, 2005).

Coondamar Formation (ADncc, ADnb, ADnbk, ADnup, ADnux, ADnur, ADnlb, ADnstb, ADnstbc, ADnss, ADnlbn, ADnu, ADnba, ADnog, ADnsl, ADnst, ADnfv)

The Coondamar Formation outcrops along the southern margin of the Mosquito Creek Basin in the southwest of EASTERN CREEK, and in elongate structural windows close to and along the northern margin of the basin, near the Eastern Creek mining centre. The formation is in faulted basal contact with the East Pilbara Granite–Greenstone Terrane in the north, and with the Kurrana Terrane in the south. The upper boundary is a paraconformity with the Mosquito Creek Formation. The thickness of the Coondamar Formation is uncertain due to the combined effects of strong deformation, tight folding, and faulted basal contacts, but a thickness of up to 2 km is indicated for the type area near Hallcomes Peak (see Appendix 3). The formation has not been directly dated, but must be younger than the 3325–3315 Ma Wyman Formation, the youngest dated unit in the East Pilbara Granite–Greenstone Terrane immediately north of the Mosquito Creek Basin, and older than the overlying Mosquito Creek Formation, which has an interpreted age of c. 2926–2905 (Bagas et al., 2004b). A tentative date of 3035 ± 6 Ma (Nelson 2005c) for a single zircon crystal from a small foliated granodiorite intrusion in the Coondamar Formation on NOREENA DOWNS (Farrell and Smithies, 2005), to the southwest, provides a possible tighter constraint on the minimum age of the formation.

On EASTERN CREEK the Coondamar Formation contains a variety of metamorphosed mafic and sedimentary rocks. It is dominated by chloritic metasedimentary rocks, metagabbro, and amphibolite in the southern area, and basaltic lithic sandstone in the northern exposures. Detailed mapping has also revealed narrow windows of Coondamar Formation along anticlinal axes in the northern half of the basin. Minor components of the formation include metamorphosed chert (*ADncc*), tholeiitic basalt (*ADnb*), komatiitic basalt (*ADnbk*), peridotite (*ADnup*), and pyroxenite (*ADnux*), as well as tremolite–chlorite schist (*ADnur*), and minor talc–chlorite schist and phyllite.

Metamorphosed layered chert (*ADncc*) is restricted to the southern margin of the Mosquito Creek Basin in the southwest of EASTERN CREEK, where it is exposed in the hinge zone of a large upright, northeast-plunging antiform. The chert has layers up to 80 mm thick with fine, regular, and continuous internal laminae up to 2 mm. The rock is typically ferruginous and is associated with poorly exposed amphibole-rich schist (probable metapyroxenite or metagabbro), and outcrops in an area of deeply weathered, poorly exposed, and strongly foliated metamorphic rocks (*ADnlb*).

A recessive unit of metamorphosed, poorly sorted basaltic lithic sandstone and granulestone (*ADnstb*) is exposed close to the northern edge of the Mosquito Creek Basin. Outcrop is poor, but in rare creek exposures it is a green-grey, relatively massive rock with subangular to subrounded mafic lithic clasts. Basaltic lithic sandstone with local carbonate alteration and minor layers of chert (*ADnstbc*) is exposed a few kilometres farther south, along the track to the Eastern Creek mining centre. In this area the rocks are variously deformed and contain abundant small brown spots due to weathering of carbonate porphyroblasts. The rocks are locally rich in carbonates and in places contain carbonate veining. Also present in some locations are layers of pale grey-brown cherty rock with a local boxwork of Fe-hydroxides or quartz.

Narrow windows of well-foliated, metamorphosed chloritic sandstone and siltstone (*ADnss*) outcrop along thrust faults and in the hinge zones of D_3 anticlines in the northern part of the basin. The siltstone is typically metamorphosed to a chlorite phyllite. In the field the sandstone is distinguished by a characteristic pale green-grey to blue-grey colour, a flinty fracture, and a scaly foliation. In some areas sandstone beds have a conglomeratic base with grey or white cherty clasts up to 50 mm in size.

A mixed unit of strongly foliated metamorphic rocks (*ADnlb*) outcrops on the southern margin of the Mosquito Creek Basin along the Coondamar Fault. A wide range of rock types is present, including chlorite–actinolite schist, amphibolite, phyllite, and semipelitic schist. Minor components include biotite schist and andalusite–muscovite schist. A similar rock association, but with interleaved strongly deformed granite (*ADnlbn*), forms rafts within the Kurrana Granitic Complex.

Metamorphosed ultramafic rocks are a distinctive minor component of the Coondamar Formation. On EASTERN CREEK the ultramafic rocks are restricted to the southern part of the basin, and are interleaved with strongly deformed and metamorphosed mafic and sedimentary rocks. Ultramafic rock types recognized in the field include undivided ultramafic rocks (*ADnu*, typically fine-grained rocks with a high magnetic susceptibility), tremolite–chlorite schist (*ADnur*), metamorphosed peridotite (*ADnup*), and metamorphosed pyroxenite (*ADnux*).

Amphibolite (*ADnba*) and metagabbro (*ADnog*) are mainly exposed along the southern margin of the Mosquito Creek Basin in two belts of intercalated mafic and metasedimentary rock. The metagabbro forms large individual bodies up to about 600 m wide and 3 km long, and numerous small lenses or thin layers, too small to show at map scale, interleaved with metasedimentary rocks. Associated with the metagabbro is a unit of metasedimentary rock with thin layers of amphibolite and tremolite–chlorite schist (*ADnsl*). A unit of metasandstone with minor siltstone (*ADnst*) extends along the centre of the northern belt of metagabbro and amphibolite. The metasandstone contains relict quartz clasts enclosed by a foliation defined by white mica, plagioclase, and actinolite. Locally preserved graded bedding indicates that the sequence youngs to the south. A thin discontinuous unit of metamorphosed felsic volcaniclastic sandstone (*ADnfv*) outcrops about 3 km south-southwest of Hallcomes Peak. The rock is partly silicified and contains abundant relict clasts of quartz as well as ?plagioclase.

Mosquito Creek Formation (ADqs, ADqsc, ADqsl, ADqst, ADqss)

The Mosquito Creek Formation is a metamorphosed succession of siliciclastic sedimentary rocks that occupies most of the central part of the Mosquito Creek Basin. The base of the formation is either a paraconformity with the Coondamar Formation or an angular unconformity with rocks of the East Pilbara Granite–Greenstone Terrane. Interpretation of the stratigraphy has been hindered by the effects of complex deformation and the absence of distinctive marker units. Original estimates of the thickness of the formation were greater than 5 km (Hickman, 1978), but mapping of EASTERN CREEK has revealed that much of the formation is tightly folded at wavelengths of 1–2 km, and that there are narrow windows of the Coondamar Formation along anticlinal hinge zones in the northern half of the formation. These observations suggest that, in the north, the preserved thickness of the formation is probably in the order of 1–1.5 km. The age of the Mosquito Creek Formation is not tightly constrained, but recent work on the dating of detrital zircon in sandstones (Nelson, 2004b,c,d,e,f, 2005d) and Pb–Pb dating of galena (Thorpe et al., 1992b; Huston et al., 2002) has shown that it must have been deposited between c. 2926 and 2905 Ma (Bagas et al., 2004b).

The Mosquito Creek Formation has previously been described by Hickman (1975, 1978, 1983) and Eriksson et al. (1994), and the rocks have commonly been interpreted as turbidite deposits. The sedimentology has not been studied in detail, but based on previous work (Eriksson et al., 1994), and additional work carried out in the mapping of EASTERN CREEK (Farrell, 2003, 2005), deposition is thought to have occurred in a submarine fan system. Upper-fan deposits are distributed along the northern margin of the basin, in the area around the Eastern Creek mining centre, and lower- and mid-fan deposits occupy the central and southern parts of the basin.

Much of the Mosquito Creek Formation consists of a monotonous sequence of metamorphosed sandstone, siltstone, and shale (*ADqs*), with well-preserved graded bedding (Fig. 6), and local cross-bedding and sole marks. The rocks are mainly thin bedded (typically 10 to 150 mm), but parts of the succession are more thickly bedded (up to about 1 m) with a greater predominance of sandstone, and scattered pebbly beds. Graded bedding is ubiquitous and, in some locations, there are well developed Bouma sequences (Bouma, 1962) showing a complete gradation from massive coarse-grained sandstone, through parallel-laminated and convolute-laminated siltstones, to shale (A, B, C, and E Bouma divisions). Many beds, however, range from coarse-grained sandstone to fine-grained sandstone or siltstone (B, C and B, C, D Bouma divisions), and the shaly tops are missing. Inverse grading and low-angle cross-lamination can be seen within individual beds in a few locations (e.g. MGA 250880E 7590360N). Tabular beds of sandstone up to 1 or 2 m thick, with a massive or cross-bedded base and a thin silty top may be channel deposits (e.g. MGA 253280E 7592690N). Black to dark-brown ferruginous nodules after (?)pyrite are locally abundant in fine-grained sandstone, siltstone, and shale (Fig. 7). They commonly reach up to 15 mm in size (70 mm in extreme cases) and possibly represent metamorphosed diagenetic pyrite nodules.

Siltstone and shale are typically metamorphosed to slate or phyllite, depending on the metamorphic grade and protolith composition, whereas sandstone is partly recrystallized and foliated. Metashale is commonly dark grey in colour, probably due to the presence of extremely fine graphite after carbonaceous material, and typically contains numerous deformed quartz veins. Optical microscopy, scanning electron microscopy, and X-ray diffraction studies (T. R. Farrell and R. Offler, unpublished data) reveal that the slate and phyllite consist of fine-grained chlorite, illite–white mica, albite, carbonaceous matter (probably graphite), quartz (in most rocks), and accessory monazite and rutile. In the lowest grade rocks the 'chlorite' is probably a mixture of chlorite and mixed-layer chlorite–smectite (Merriman and Peacor, 1999).

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Figure 6. Typical exposure of tabular-bedded turbidites, grading from coarse-grained sandstone to siltstone or shale (dark grey), Mosquito Creek Formation (younging to the right in the photo; MGA 261980E 7589850N)

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Figure 7. Ferruginous nodule in a metasiltstone (phyllite) with well-developed kink bands, Mosquito Creek Formation (MGA 248410E 7587720N)

Many slates contain both K-white mica and Na-white mica (T. R. Farrell and R. Offler, unpublished data).

Sandstone typically contains detrital white mica, quartz, and clasts of grey or black chert, and in many areas is poorly sorted and matrix supported (e.g. MGA 249160E 7581230N). It is locally ferruginous or siliceous. In thin section it contains various proportions of quartz, plagioclase, and chert clasts, plus rare fragments of biotite and granitic rock. Petrographically, the sandstones can be classified as lithic wacke or lithic arenite, but may range through to quartz wacke or subarkosic wacke (classification after Pettijohn et al., 1987).

Discontinuous layers and lenses of pebble conglomerate (*ADqsc*) outcrop in three belts in the north — along the northern edge of the basin and on both flanks of a west-southwesterly trending, doubly plunging anticline that passes through the Eastern Creek mining centre. The conglomerates are associated with coarse-grained sandstone, granulestone, pebbly sandstone, and minor cobble conglomerate, in tabular beds or channel deposits up to about 10 m thick. They contain chert clasts (~90–95 vol.%), some vein quartz, and minor amounts of basalt, granitic rock, sandstone, and kaolinized felsic rock (including quartz porphyry). Along the northern margin of the basin the conglomerates are poorly sorted and matrix supported, with angular to subrounded clasts in a coarse sandy matrix. Farther south, along the anticline near the Eastern Creek mining centre, the conglomerates tend to be more texturally mature and are typically clast supported, with rounded to well-rounded clasts. In some areas the conglomerates are brecciated and silicified (MGA 247850E 7595550N) or ferruginized (MGA 248150E 7600170N), probably due to later faulting and weathering. The conglomerates are interpreted to be upper-fan channel deposits in a submarine fan system.

Interbedded with the pebble conglomerate is an extensive succession of thin-bedded, siliceous fine-grained sandstone, siltstone, and shale (*ADqsl*). The shale is commonly ferruginous, with alternating grey and dark-red laminae. Bed thickness is mostly 20–50 mm, but may attain a maximum of about 100 mm. Locally, the rocks have a convolute or wavy lamination, with some beds having low-angle cross-bedding. There are also rare flute casts and ripple marks. Graded bedding is not common. In a few locations the thin-bedded succession (*ADqsl*) is incised by channel deposits of pebble conglomerate (*ADqsc*). This succession possibly represents a lower, mid-fan lobe deposit.

Also outcropping in the area around the Eastern Creek mining centre is a massive, tabular-bedded sandstone (*ADqst*). The rock is typically medium to coarse grained, with local pebbly zones and sparse beds of pebble conglomerate. Individual beds are about 5–10 m thick. The sandstone grades laterally to thin-bedded, fine-grained sandstone, and is interspersed with thin units of thin-bedded sandstone and siltstone. The lack of grain-size grading and the general absence of other depositional structures suggest rapid deposition, possibly in depositional lobes at the termination of mid-fan channels.

In the area around Eastern Creek Well, and to the west and northwest, is a sandstone–siltstone(–shale) succession (*ADqss*) that shows repeated coarsening-up and thickening-up cycles. Each cycle shows a gradation from a base of thin-bedded (typically 20–50 mm), fine-grained sandstone, siltstone, and minor ferruginous shale to thicker bedded (typically 50–500 mm, but up to 2000 mm), medium- to coarse-grained sandstone with scattered chert granules and local beds of pebbly sandstone and conglomerate. The coarse-grained intervals are commonly graded, and locally ripple marked. Individual cycles are 30–50 m thick. These rocks are tentatively interpreted to represent suprafan lobe deposits in a prograding submarine fan system.

Unassigned felsic igneous rocks (*Agh*)

A suite of felsic dykes are exposed in the northern part of the Mosquito Creek Basin about 7 km west-southwest of the Eastern Creek mining centre. Dykes of hornblende (–plagioclase) porphyry (*Agh*) in this area are commonly conformable, but locally cut across stratigraphy in the host metasedimentary rocks. The dykes are variously foliated and extensively altered (probably during metamorphism). Primary subhedral to euhedral hornblende phenocrysts are pseudomorphed by assemblages of chlorite–Fe oxides (–carbonates–albite), whereas plagioclase phenocrysts are replaced by albite – white mica – carbonates. The groundmass is extensively replaced by fine-grained chlorite, albite, quartz, carbonates, white mica, and opaque minerals. Locally, the dykes contain clots of ferromagnesian minerals and small mafic enclaves up to 30 mm in size. Some dykes have possible amygdales, in the form of irregular 'pools' of coarser grained, radially arranged quartz–carbonate – white mica. The dykes are interpreted to be Archean in age, on the basis of a pronounced foliation in some outcrops, and probably pre-date the D_{MB4} deformation event in the Mosquito Creek Basin.

Structure of the Mosquito Creek Basin and Kurrana Terrane

Up to six phases of deformation ($D_{MB1–6}$) are recognized in the rocks from the eastern part of the Mosquito Creek Basin and the Kurrana Terrane (Table 1). Evidence for the earliest phase of deformation (D_{MB1}) is found only in the Golden Eagle Orthogneiss (c. ?3270–3178 Ma), and possibly in the lowermost parts of the Coondamar Formation (>c. 3035 Ma).

D_{MB1} (<3178 Ma)

The Golden Eagle Orthogneiss has a strongly developed, composite fabric (S_{MB1-2}) with intrafolial, tight to isoclinally folded relics of an early high-grade foliation (S_{MB1}) defined by thin monzogranite leucosomes. A composite fabric, tentatively correlated with S_{MB1-2}, is also present in the Coondamar Formation, where it is preserved in the hinge zone of mesoscale D_{MB4} folds as an anastomosing disjunctive schistosity or cleavage (foliation terminology after Passchier and Trouw, 1996). Chlorite–actinolite schist in the Coondamar Formation locally has a zonal crenulation cleavage (S_{MB2}) with microlithons containing crenulated relics of S_{MB1}.

The tectonic setting and timing of D_{MB1} is not clear due to the effects of later strong deformation, but it must have occurred after c. 3178 Ma, which is the inferred minimum age of the Golden Eagle Orthogneiss. Argon–argon hornblende cooling ages of 3.2 – 3.0 Ga (Wijbrans et al., 2000) for the Kurrana Terrane suggest uplift at this time, possibly related to D_{MB1}. The Kurrana Shear Zone (Bagas, 2005), along the contact between the Kurrana Terrane and the Coondamar Formation, may have formed at this time.

D_{MB2} (2926–2905 Ma)

The second deformation event affected the entire basin. D_{MB2} structures are best developed in the Coondamar Formation and the Golden Eagle Orthogneiss, and are not as prominent in the Mosquito Creek Formation, where they have largely been obliterated during D_{MB4}. The main structures attributed to D_{MB2} are: a strong composite fabric (S_{MB1-2}) in the southern part of the basin, a steep-plunging bedding–cleavage intersection (L_{MB2}), steep-plunging folds (F_{MB2}), and a weak mineral lineation (L_{MB2}).

The most prominent D_{MB2} structure in the southern part of the basin is a strong composite foliation (S_{MB1-2}) subparallel to the basin margin. The foliation trends east to northeasterly, and typically dips to the north or northwest, towards the centre of the basin. In the Golden Eagle Orthogneiss the foliation is a continuous planar schistosity defined mainly by the alignment of thin leucosomes, quartz ribbons, and the lattice-preferred orientation of biotite. The S_{MB2} foliation in the Coondamar Formation is typically a well-developed, continuous schistosity in fine-grained rocks, and a disjunctive schistosity in metasandstone. In contrast, in the Mosquito Creek Formation S_{MB2} is mostly parallel to, and partly overprinted by, S_{MB3}. In a few locations, particularly in the hinge zone of D_{MB4} folds, S_{MB2} is preserved as a spaced cleavage at an angle to S_{MB3} (e.g. 2 km southeast of Eastern Creek Well, MGA 255500E 7597300N). In most areas of the Mosquito Creek Formation S_{MB2} is also parallel to bedding.

A weak mineral lineation defined by the alignment of elongate former (?)carbonate porphyroblasts (L_{MB2}) is tentatively assigned to D_{MB2} (Fig. 8). The porphyroblasts

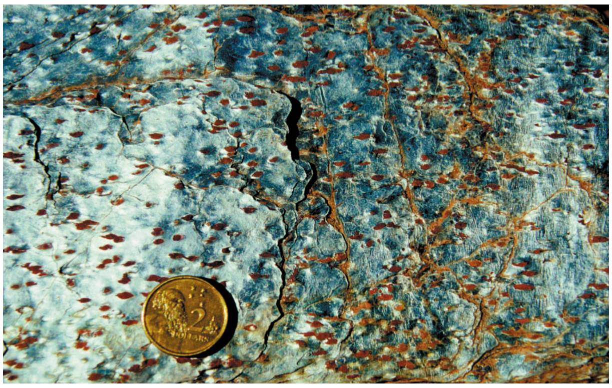

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Figure 8. Mineral lineation in phyllite, Mosquito Creek Formation (MGA 252820E 7578340N). The lineation is defined by the preferred alignment of carbonate rhombs (dark grey), now largely replaced by iron oxides and quartz. Note the later fine crenulation to the right

are now pseudomorphed by fine-grained aggregates of quartz(–chlorite – white mica) or Fe-oxides–quartz. The lineation is typically steep plunging and in some outcrops is overprinted by a crenulation lineation (L_{MB3}).

Mesoscale D_{MB2} folds are typically asymmetric, upright, and open to isoclinal, with steep-plunging axes parallel to a bedding–cleavage intersection lineation (Fig. 9). The folds are locally boudinaged, either during D_{MB2} or in a later event. Macroscale D_{MB2} folds are exposed in a few locations. The folds typically have wavelengths of 100–300 m, and are angular and asymmetric, with an axial-planar foliation subparallel to the long limb and oblique to the short limb. The fold shapes persist along strike (down-profile), resulting in discrete zones, broadly parallel to stratigraphy, where bedding and cleavage are at angles of 10° to 20°.

The tectonic setting during D_{MB2} and the original orientation of D_{MB2} structures are uncertain, but, by

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Figure 9. Dismembered D_{MB2} fold in a sandstone bed, Mosquito Creek Formation (MGA 248400E 7586330N; view from above). The fold is upright and steeply plunging with an axial-planar cleavage

necessity, S_{MB2} must have been shallow-dipping in order for it to be deformed into shallow-plunging upright folds during D_{MB4}. If the D_{MB2} folds are restored to their original orientation by unfolding of F_{MB4}, then they would have been recumbent, with axes plunging gently either north or south.

The absolute age of D_{MB2} is constrained to c. 2926–2905 Ma by the maximum age of the Mosquito Creek Formation, and Pb–Pb galena model ages of 2905 ± 9 Ma for mineralization associated with structures related to D_{MB4} (Bagas, 2005).

D_{MB3}

Rare, reclined, isoclinal folds in the Coondamar Formation and Golden Eagle Orthogneiss on NULLAGINE have been assigned by Bagas (2005) to D_{MB3}. These structures have not been observed on EASTERN CREEK and may be D_{MB2} folds that have not been re-oriented during later deformation.

D_{MB4} (c. 2905 Ma)

The fourth event was an intense pervasive deformation that affected all rocks in the basin, largely overprinting D_{MB2} structures, and resulted in the formation of the predominant east–west to northeast–southwest structural grain. The principal D_{MB4} structures include shallow-plunging, angular, open to isoclinal folds (F_{MB4}), an axial-planar foliation (S_{MB4}), and a shallow-plunging crenulation and mineral lineation (L_{MB4}).

Within the Mosquito Creek Formation, S_{MB4} is a continuous cleavage in metasiltstone, slate, and phyllite, an anastomosing spaced cleavage in metasandstone, and a weakly developed, spaced cleavage in very low grade rocks north of Eastern Creek Well. The foliation trends approximately east–west in the centre of the basin, and northeast–southwest along the northern and southern margins, and is broadly parallel to bedding (S_0), but more steeply dipping near the basin margins. In some outcrops, isoclinally folded beds have an axial-planar continuous crenulation cleavage, suggesting that the foliation seen in outcrop is, in many cases, probably a composite fabric (S_{MB2-4}). Isoclinally folded quartz veinlets, with an axial-planar continuous cleavage are also common (Fig. 10).

In some areas, phyllites have a spaced cleavage and contain small relict porphyroblasts aligned at a low angle to the cleavage (Fig. 11). The porphyroblasts are pseudomorphed by fine-grained aggregates of quartz (–chlorite – white mica) or Fe-oxides–quartz, but preserve inclusion trails that are contiguous with the external foliation (S_{MB2-4}). The inclusion trails typically curve into the external foliation and are finer grained, suggesting that the porphyroblasts have either grown post-D_{MB2} and pre-D_{MB4}, or early syn-D_{MB4}. Porphyroblast growth may have been coeval with the development of the chlorite–mica stacks (Jiang and Peacor, 1994; Li et al., 1994) commonly found in phyllites from the Mosquito Creek Formation. Similar porphyroblast–inclusion trail relationships also occur in the southern part of the basin, where chlorite–actinolite schist and phyllite in the Coondamar Formation typically have a well-developed schistosity, defined by the assemblage chlorite–albite–actinolite, wrapping around relict biotite porphyroblasts with curved inclusion trails (Fig. 12).

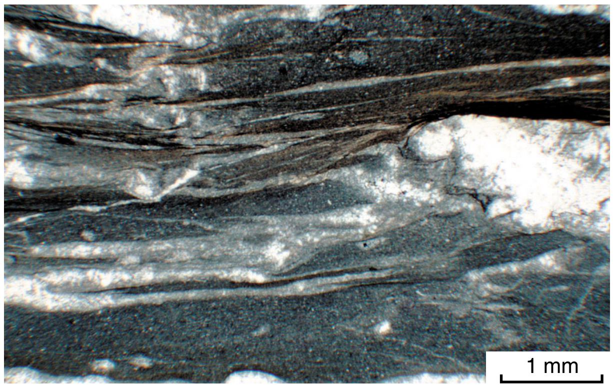

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Figure 10. Composite S_{MB2-3} fabric in a slate with isoclinally folded quartz veins, Mosquito Creek Formation (GSWA 161193, MGA 253530E 7586690N). In most of the rock the fabric is a continuous cleavage, and crenulated relics of S_{MB2} are only preserved adjacent to the quartz veins (plane-polarized light)

Mesoscale D_{MB4} folds are angular, open to very tight, upright to steeply inclined, and typically shallow plunging. The orientation of the fold axes varies across the basin from south to north. Along the southern margin of the basin, the folds are open to tight, and plunge to the east-northeast or northeast. They have an axial-planar disjunctive cleavage (S_{MB4}), and there is a pronounced, combined mineral–crenulation lineation (L_{MB4}) parallel to the fold axes. In the central part of the basin the fold axes plunge gently either east or west, and

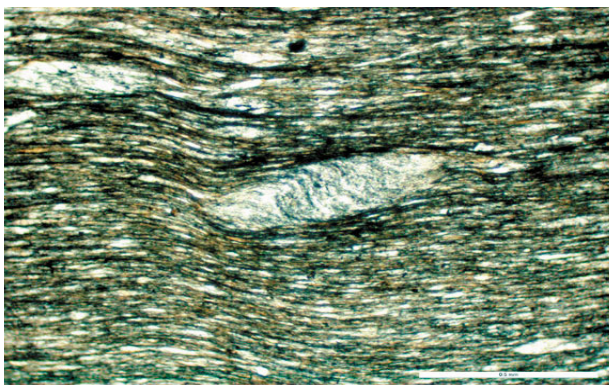

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Figure 11. Pseudomorph of a former (?)carbonate porphyroblast with curved inclusion trails, phyllite, Mosquito Creek Formation (GSWA 161104, MGA 254170E 7586720N). The porphyroblast now consists of extremely fine aggregates of quartz, chlorite, white mica, and carbonaceous material. Note the marked obliquity between the porphyroblast and the external foliation (S_{MB2-3}; plane-polarized light)

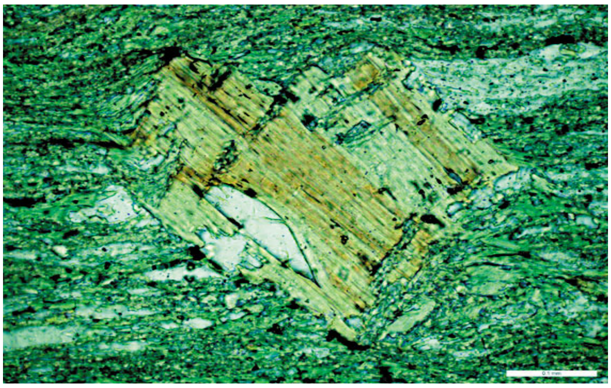

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Figure 12. Biotite porphyroblast with asymmetric chlorite tails, chlorite–actinolite schist, Coondamar Formation (GSWA 174926, MGA 252210E 7574080N). Porphyroblast has an internal fabric defined by the alignment of small grains of graphite (plane-polarized light)

are subparallel to a fine crenulation lineation (L_{MB4}) in metasiltstone and phyllite. In contrast, along the northern margin the D_{MB4} folds typically plunge gently to the west-southwest.

Large-scale D_{MB4} folds are mostly recognized in the field by younging reversals, although there are some well-exposed periclinal folds outlined by resistant conglomerate beds in the northeast part of the basin. Good younging criteria (graded beds, scour-and-fill structures, ripple marks, cross-beds, and channels) are preserved in many outcrops. In the north-central part of the basin, rocks of the Coondamar Formation are exposed in narrow windows through the Mosquito Creek Formation along the anticlinal culminations of major D_{MB4} folds.

Many of the larger D_{MB4} folds in the northern half of the basin are overturned to the north and disrupted by thrust or reverse faults that displace the north-facing limb. The faults appear to have formed in the latter stages of D_{MB4} because they are commonly subparallel to the axial surfaces of D_{MB4} folds. Mesoscale faults typically cut across bedding at a low angle and anastomose around sigmoidal-shaped blocks of less deformed rock (Fig. 13). The fault zones have a variety of localized structures, including quartz slickenfibres (Fig. 14), striations, and fault breccia, as well as tectonic ‘ripples’ or undulations on striated surfaces. Quartz slickenfibres show a spread of plunge directions, but consistently indicate a broadly south-over-north to southeast-over-northwest sense of movement.

D_{MB5} (c. 2860–2775 Ma)

The fifth deformation event involved dextral movement along east- to northeast-trending shear zones (with probable reactivation of late-D_{MB4} faults) and resulted in the development of upright, steep-plunging monoclinal kinks and box folds (F_{MB5}), a locally developed spaced crenulation cleavage (S_{MB5}), and small-scale kink bands and crenulations (L_{MB5}; Fig. 15).

Mesoscale indicators of dextral movement are exposed at various locations in the southern part of the basin, including the Blue Spec Fault zone (Fig. 4), but are best developed along the southern margin of the basin, and appear to affect rocks from both the Golden Eagle Orthogneiss and the Bonney Downs Granite. Dextral shearing is evidenced by S–C mylonites with σ-porphyroclasts in granites, asymmetric pinch-and-swell structures in psammitic layers in thin-bedded metasedimentary rocks, asymmetrically boudinaged quartz veins, and dextral offsets on metre-scale anastomosing shear zones.

Box folds in the central part of the basin have wavelengths of about 0.5 m, amplitudes in the order of 0.1 m, and are in rocks where the main foliation is oriented at 90°–100°, indicating approximately east–west

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Figure 13. Thrust fault (D_{MB4}) in thin-bedded sandstone and siltstone, Mosquito Creek Formation (MGA 250980E 7597820N). The rocks are fractured and variously foliated adjacent to individual fault planes, which anastomose around blocks of relatively undeformed rock. View to the west of a subvertical face

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Figure 14. Quartz slickenfibres on a D_{MB3} thrust fault, Mosquito Creek Formation (MGA 250980E 7597820N). The slickenfibres at this location show a relatively consistent orientation, but in other outcrops there may be up to three sets of fibres in different orientations. View from above looking down onto a shallow-dipping fault surface

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Figure 15. Well-developed kink bands (D_{MB5}) overprinting a fine crenulation (L_{MB3}), phyllite, Mosquito Creek Formation (MGA 261190E 7585870N). The crenulation runs from top right to bottom left

shortening. The S_{MB5} crenulation cleavage is steep dipping, subparallel to the axial surfaces of D_{MB5} folds, and in two principal strike directions (340°–360° and 020°–045°), similar in orientation to the axial-surface traces of the box folds. The kink bands overprint both the L_{MB3} crenulation lineation and the L_{MB2} mineral lineation (Fig. 15).

The timing of D_{MB5} is constrained to after c. 2860 Ma (the maximum crystallization age of the Bonney Downs Granite) and before c. 2775 Ma when deposition of the Fortescue Group commenced. The relative timing of dextral shearing with respect to the kink folding is not entirely clear. The two sets of structures have been assigned to the same event because kink folds in the southern part of the basin are dominantly monoclinic dextral, and kink fold axes are subparallel to the axes of undulations in outcrop-scale anastomosing dextral shear zones.

D_{MB6}

The last major deformation was a ductile–brittle event associated with the formation of late-stage faults that affect all Archean rocks on EASTERN CREEK (see **Structure of the Fortescue Group**). Tight to open folds (F_{MB6a}) are present along north-trending faults associated with small satellite basins of Fortescue Group rocks, and along the Redmond Fault (Fig. 4), which is a younger (D_{MB6b}) west-northwesterly trending oblique slip fault that cuts across both the Mosquito Creek Basin and the Fortescue Group. A sinistral displacement on the Redmond Fault of about 4.6 km is indicated by the offset of a large mafic dyke. An apparent dextral offset by about 2.5 km of the Fortescue unconformity, which dips shallowly to the southeast (about 15°), can be accommodated by a component of north-side-up vertical movement in the order of 1.9 km. Along the northeast side of the Redmond Fault D_{MB6b} folds are upright, open to tight, and typically plunge moderately to steeply to the northwest. Macroscopic S-shaped folds in this area are consistent with flexuring during sinistral north-side-up oblique movement on the fault.

Metamorphism of the Mosquito Creek Basin

Coondamar Formation

Metamorphism of the Coondamar Formation occurred under conditions ranging from subgreenschist facies in the north of the Mosquito Creek Basin to amphibolite facies on the southernmost edge of the basin adjacent to the Kurrana Terrane.

In the northern part of the basin, near Eastern Creek Well, basaltic lithic sandstone is partially recrystallized and replaced by metamorphic assemblages of chlorite–carbonate–quartz(–albite), indicating a metamorphic grade of lower greenschist facies or lower. Farther south, in the central and southern parts of the basin, chlorite–actinolite phyllite and schist consist principally of fine-grained chlorite, actinolite, quartz, and albite, with accessory magnetite, sphene, and apatite. In contrast, in the south near Hallcomes Peak, chlorite–actinolite phyllite locally contains one or both of small porphyroblasts of biotite (commonly <1 mm in width) or aggregates of chlorite(–K-feldspar). The porphyroblasts are partially replaced by chlorite (–K-feldspar–quartz), commonly have chlorite fringes, and contain inclusion trails defined by chlorite, actinolite, and sphene that are oblique to the external foliation. These inclusion trails are interpreted to be relics of S_{MB2} because the porphyroblasts are deformed and enclosed by the matrix foliation (S_{MB2-4}). Biotite is absent from the matrix, indicating that higher grades (mid-greenschist facies or higher) were attained close to the southern boundary of the basin before the development of S_{MB4}.

Amphibolite-facies rocks are restricted to a narrow zone (<500 m wide) close to the boundary with the Kurrana Terrane, where pelitic rocks are metamorphosed to coarse-grained andalusite–muscovite schist, and mafic rocks to amphibolite.

Mosquito Creek Formation

The Mosquito Creek Formation has been metamorphosed under very low to low-grade conditions. Shale and siltstone are typically metamorphosed to slate or phyllite depending on metamorphic grade and bulk composition, and sandstone is partly recrystallized and foliated.

Slate and phyllite typically contain fine-grained chlorite, white mica, albite, graphite, quartz (in most rocks), and small amounts of fine-grained K-feldspar, monazite, rutile, tourmaline, and magnetite. Muscovite and paragonite co-exist in many slates, and some samples also contain intermediate K–Na-white mica. Slate and phyllite locally display small chlorite–mica stacks and retrogressed porphyroblasts (<1.0 mm) enclosed by the main foliation (S_{MB2-4}). The porphyroblasts are pseudomorphed by fine-grained aggregates of quartz(–chlorite–white mica–rutile) or Fe-oxides–quartz, and have inclusion trails defined by concentrations of graphite that are contiguous with the external foliation (S_{MB2-4}). The inclusion trails typically curve into the external foliation and are finer grained, suggesting that the porphyroblasts developed pre- or early syn-D_{MB4}. The original mineralogy of the porphyroblasts is uncertain, but it is possible that they were carbonates.

Chlorite–mica stacks reach up to 0.6 mm in length and are lens or spindle shaped, with long axes parallel to the enclosing foliation (S_{MB2-4}). Mineralogically, they consist of various proportions of chlorite, muscovite, paragonite, intermediate K–Na-mica, and some quartz. The constituent phyllosilicates are typically stacked in bundles at a high angle to the enclosing foliation, and in many cases are kinked or folded, indicating development before D_{MB4}.

Preliminary illite crystallinity (IC = 0.31, s.d. = 0.060, n = 17) and white mica b cell parameter (b = 8.989, s.d. = 0.008, n = 12) studies on slate and phyllite indicate low-pressure/high-temperature-style metamorphism under diagenetic to epizonal (zeolite- to lower greenschist-facies) conditions (Farrell and Offler, 2001).

Neoarchean to Paleoproterozoic Hamersley Basin

The Hamersley Basin (Trendall, 1983) contains a Neoarchean succession of mafic to intermediate volcanic rocks, and subordinate felsic and sedimentary rocks (Fortescue Group), and a conformably overlying package of sedimentary rocks dominated by banded iron-formation, ferruginous shale, and dolomite (Hamersley Group). The basin is interpreted to have developed by rifting of the Pilbara Craton at c. 2.78 Ga, with concomitant extrusion of flood basalts (Tyler and Thorne, 1990; Thorne and Trendall, 2001, and references therein). Subordinate felsic and sedimentary rocks are thought to have been deposited in intracratonic basins. Break-up of the Pilbara Craton is generally considered to have occurred by c. 2.72 Ga, by which time an ocean basin was developed to the south of the present-day craton margin (Tyler and Thorne, 1990; Blake and Barley, 1992). Deposition of the upper part of the Fortescue Group (Jeerinah Formation) and the Hamersley Group is then interpreted to have occurred on a thermally subsiding continental margin (Tyler and Thorne, 1990; Blake and Barley, 1992).

Mount Bruce Supergroup

The Mount Bruce Supergroup (Trendall, 1979; Mount Bruce Megasequence of Blake and Barley, 1992) is a gently dipping supracrustal sequence that lies unconformably on the granite–greenstone basement. The supergroup encompasses all the stratigraphic units that occupy the Hamersley Basin, and comprises a basal volcano-sedimentary succession (Fortescue Group), and an overlying succession of chert–banded iron-formation and dolomite (Hamersley Group).

Fortescue Group

The Fortescue Group (MacLeod et al., 1963; Thorne and Trendall, 2001; the Nullagine and Mount Jope Supersequences of Blake and Barley, 1992; Blake, 1993, 2001) is a thick sequence of Neoarchean mafic and felsic volcanic rocks, and related sedimentary rocks, up to 6.5 km thick that was deposited unconformably on the granite–greenstone basement. Deposition of the Fortescue Group spanned the period from about 2.78 to 2.63 Ga (Arndt et al., 1991; A. F. Trendall, quoted in Nelson et al., 1999), and occurred during rifting of the Pilbara Craton and its evolution into a subsiding, passive continental margin (Tyler and Thorne, 1990; Blake and Barley, 1992; Blake, 1993; Thorne and Trendall, 2001, and references therein).

Rocks assigned to the Fortescue Group cover about two-thirds of EASTERN CREEK, and lie unconformably on rocks of the East Pilbara Granite–Greenstone Terrane, Mosquito Creek Basin, and Kurrana Terrane (Fig. 3). In general, the Fortescue Group succession dips moderately to the east and southeast, and the youngest exposed rocks in the group lie in the southeast corner of the map sheet, close to the Davis River. In the northwest, adjacent to the Yilgalong Granitic Complex, the stratigraphy is complicated by the presence of a shallow basin-like structure, and by post-depositional faulting. In addition, two outliers of the Fortescue Group occupy small, fault-related basins close to the northwest boundary of the sheet. On EASTERN CREEK the Fortescue Group is represented, from base to top, by the Mount Roe Basalt, and the Hardey, Kylena, Tumbiana, Maddina, and Jeerinah Formations.

Mount Roe Basalt (AFr, AFrsc, AFrst, AFrsl)

The Mount Roe Basalt (Kriewaldt, 1964) is a succession, up to 2.5 km thick, of subaerial basaltic lavas, volcaniclastic rocks, and minor subaqueous basaltic lavas (Thorne and Trendall, 2001). Epiclastic sedimentary rocks are a minor component, and are thought to constitute no more than about 1% of the unit (Thorne and Trendall, 2001). On EASTERN CREEK the Mount Roe Basalt is locally at the base of the Fortescue Group, and lies unconformably on rocks of the Mount Elsie greenstone belt, Yilgalong Granitic Complex, and Mosquito Creek Formation in the northwest of the map. A maximum thickness of about 500 m is indicated for an area north of Mount Olive. The unit consists of a basal sandstone and polymictic conglomerate, and an upper succession of basalt and minor gabbro. The sedimentary rocks have been included in the Mount Roe Basalt, although they could also belong to the pre-Mount Roe Basalt package of sedimentary rocks described by Thorne and Trendall (2001). The basalt has not been dated on EASTERN CREEK, but a SHRIMP U–Pb zircon date of 2775 ± 10 Ma (Arndt et al., 1991) indicates a depositional age of c. 2.78 Ga.

Undivided Mount Roe Basalt (*AFr*) outcrops in the northwest corner of EASTERN CREEK, in an area north of the Eastern Creek mining centre, and on the margins of two small outliers of the Fortescue Group close to the western margin of the sheet. The exposure north of the Eastern Creek mining centre is dominated by fine-grained, aphyric, dark green-grey to blue-grey basalt with sparse vesicles up to about 8 mm in diameter. The basalt is mostly homogeneous, apart from a locally developed, vague compositional layering close to the top of some flows. Undivided Mount Roe Basalt (*AFr*) in the outliers near the

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Figure 16. Poorly sorted, polymictic boulder conglomerate at the base of the Mount Roe Basalt, dominated by clasts of vesicular or variolitic basalt derived from the underlying Mount Elsie greenstone belt (MGA 244360E 7604760N)

western edge of the map comprises fine-grained vesicular basalt with local zones of fine- to medium-grained, weakly porphyritic gabbro.

At the base of the Mount Roe Basalt there are local isolated exposures of polymictic pebble and cobble conglomerate (*AFrsc*, Fig. 16). Beds of boulder conglomerate are also present in some areas. The most extensive exposures of this rock type are 1 km northwest of Mount Olive, and along the southern margin of the Yilgalong Granitic Complex. The composition of the conglomerate is directly related to that of the basement rocks nearby. Adjacent to the Mosquito Creek Basin, near Mount Olive, the conglomerate contains clasts of pebble conglomerate and sandstone derived from the Mosquito Creek Formation, as well as basalt from the Mount Elsie greenstone belt. The clasts are set in a coarse-grained sandy matrix. Along the margin of the Yilgalong Granitic Complex the conglomerate is up to about 200 m thick and dips gently to the south at 10° to 20°. It comprises pebble and cobble conglomerate, with interbedded coarse-grained feldspathic sandstone, as well as boulder conglomerate with clasts greater than 1 m in diameter. The conglomerate is locally dominated by granitic clasts, but can contain a wide variety of clasts, including basalt, felsic volcanic rock, layered chert, and vein quartz.

Tuffaceous sandstone (*AFrst*) conformably overlies the basal conglomerate of the Mount Roe Basalt. The sandstone contains angular fragments of quartz, feldspar, and probable mafic rock, as well as (?)devitrified vitric clasts. Also present are local beds containing (?)reworked accretionary lapilli up to about 3 mm in size. The tuffaceous sandstone is interbedded with ripple-marked siliceous siltstone and shale (*AFrsl*), and minor sandstone and pebbly sandstone.

Hardey Formation (AFh)

The Hardey Formation (Thorne et al., 1991) is a succession of clastic sedimentary and volcanic rocks up to 3 km thick that locally includes a quartz–feldspar porphyry, named the Bamboo Creek Member (Thorne and Trendall, 2001; formerly the Bamboo Creek Porphyry, Noldart and Wyatt, 1962). On Eastern Creek the Hardey Formation unconformably overlies the Mount Roe Basalt, and parts of the East Pilbara Granite–Greenstone Terrane and Mosquito Creek Basin. Outcrop is discontinuous and the thickness of the unit varies up to a maximum of about 800 m near the southern boundary of the Yilgalong Granitic Complex. The formation is unconformably overlain by rocks of the Kylena Formation. Uranium–lead zircon dating in other areas of the Pilbara Craton indicates a depositional age range of c. 2768 to 2752 Ma (Pidgeon, 1984; Arndt et al., 1991; Blake et al., 2004).

Undivided Hardey Formation on Eastern Creek (*AFh*) consists of a mixed succession of conglomerate, sandstone, siltstone, and local tuffaceous sandstone. Medium-bedded intervals of polymictic conglomerate, medium- to coarse-grained sandstone, and pebbly sandstone alternate with thin-bedded intervals of fine-grained sandstone and siltstone. The conglomerate contains a wide range of clast types, not all of which are present in each outcrop. Clast types include felsic volcanic rock, granitic rock, vesicular basalt, chert, sandstone, and vein quartz. The clasts are typically rounded to well rounded and up to 200 mm in size. In some areas the Hardey Formation contains a siliceous, dark-grey to green-grey, medium- to coarse-grained tuffaceous sandstone, with local pebbly beds. This rock is distinguished by clasts of accretionary lapilli.

Bamboo Creek Member (AFhb)

On Eastern Creek the Bamboo Creek Member (*AFhb*) overlies and locally intrudes the sedimentary rocks of the Hardey Formation. There are large exposures in the central-northern area, but much of the outcrop is deeply weathered. In fresh outcrops the porphyry is a dark green-grey rock crowded with phenocrysts of pinkish feldspar (?K-feldspar) and quartz in a fine-grained groundmass. The rock is typically massive, and possible columnar jointing is preserved in several locations. In some areas the porphyry is cut by closely spaced joints, and in others it has a crude layering. Contacts with the Hardey Formation are locally discordant, suggesting that the porphyry may be locally intrusive.

Kylena Formation (AFkbk, AFkkl, AFkbi)

The Kylena Formation (Kojan and Hickman, 1998; formerly the Kylena Basalt, MacLeod and de la Hunty, 1966; Hickman, 1983) outcrops in the central and central-northern parts of Eastern Creek. The formation lies unconformably on the Yilgalong Granitic Complex, Mosquito Creek Formation, and Golden Eagle Orthogneiss. For the most part the Kylena Formation is unconformable on the Hardey Formation, although there are locally conformable relationships in the Fortescue Group outlier west of Mount Elsie. Contact with the overlying Tumbiana Formation appears to be conformable. The formation is from about 0.5 to 2.5 km thick. The age of the formation is constrained by a date of 2741 ± 3 Ma for a mafic tuff with a detrital component, interpreted by Blake et al. (2004) as a maximum age, and the c. 2724–2715 Ma age (Arndt et al, 1991; Blake et al., 2004) for the overlying Tumbiana Formation.

The mafic rocks of the Kylena Formation are petrographically similar to the basalts of the Mount Roe Basalt. They have been subdivided using geochemical (Glikson et al., 1986) and radiometric data (Fig. 3b), as has been done in the west Pilbara (Kojan and Hickman, 1998). On EASTERN CREEK the Kylena Formation comprises a lower succession of basalt, local mafic tuff, and probable komatiitic basalt (*AFkbk*), a thin unit of limestone and calcareous shale and siltstone (*AFkkl*), and an upper succession of tholeiitic basalt, basaltic andesite, and andesite (*AFkbi*), with the more differentiated rocks towards the top of the succession.

The lower succession (*AFkbk*) consists mainly of fine-grained, blue-grey, vesicular or amygdaloidal basalt. The vesicles are typically less than about 5 mm in size, but up to 50 mm in some areas, and are concentrated in narrow zones, parallel to layering. Amygdales are filled with the assemblages quartz, quartz–epidote, quartz–carbonate, or quartz–amphibole. Rare zones of brecciation with or without large elongate cavities up to 200 mm long may represent the tops of individual flows. Locally, the basalt is weakly plagioclase-phyric and may have a wispy layering. Some parts of the lower succession contain lapilli tuff with flattened accretionary lapilli, shard-like fragments, and angular to subrounded rock fragments up to 15 mm. Minor rock types not shown separately include massive fine-grained gabbro and laminated siliceous fine ash (?)tuff.

The limestone unit in the middle of the Kylena Formation (*AFkkl*) consists of thin-bedded stromatolitic limestone with interbedded, ripple-marked shale and siltstone. The shale and siltstone commonly have thin interbeds of limestone. Fine-grained sandstone is near the top of the unit in some locations. The maximum thickness of the unit is about 10–15 m. The stromatolites and ripple marks suggest that the unit was deposited in a shallow-water environment.

The upper part of the Kylena Formation (*AFkbi*) consists of a differentiated succession of extrusive rocks ranging in composition from basalt through to andesite (Glikson et al., 1986). This change in composition is reflected in the potassium and thorium concentrations determined from airborne radiometric data. The uppermost part of the succession has a thorium content similar to that of the Bamboo Creek Member (*AFhb*), and a potassium content comparable to parts of the Yilgalong Granitic Complex (*AgAm*). In the field the rocks are very similar to those in the lower succession, and are typically vesicular or amygdaloidal with local zones of brecciation and, in a few locations, possible pillow structures. Minor rock types in this unit include fine-grained laminated clastic sedimentary rock and coarse lapilli tuff.

Tumbiana Formation (AFt)

The Tumbiana Formation (Lipple, 1975; Thorne and Trendall, 2001) conformably overlies the Kylena Formation, and reaches a maximum thickness of about 250 m. In the east Pilbara it consists of a lower unit of fine-grained volcaniclastic rocks with minor carbonate (named the Mingah Tuff Member by Lipple, 1975) and an upper unit of stromatolitic carbonate and calcareous sandstone (named the Meentheena Carbonate Member by Lipple, 1975). An age of 2724–2715 Ma for the Tumbiana Formation is indicated by SHRIMP U–Pb zircon dates of 2715 ± 6 Ma (Arndt et al., 1991) on a tuffaceous sandstone from the middle of the formation, and 2724 ± 5 and 2721 ± 4 Ma (Blake et al., 2004) on felsic tuffs from the base and mid-section of the formation respectively.

On EASTERN CREEK the Tumbiana Formation (*AFt*) outcrops in a northeasterly to east-northeasterly trending belt that extends from Coondamar Creek to a point 20 km northeast of Mount Hays. The main rock types are fine-grained sandstone, siltstone, and a distinctive tuffaceous sandstone or granulestone containing abundant accretionary lapilli. The latter is blue-grey or green-grey and has individual beds, packed with accretionary lapilli, showing weak grain-size grading. Thorne and Trendall (2001) interpreted similar rock types as primary pyroclastic fall deposits. The sandstone is typically basaltic in composition and is locally intercalated with thin basalt flows.

Maddina Formation (AFmbk, AFm, AFmbi, AFmcc, AFmk)

The Maddina Formation (*AFm*; Kojan and Hickman, 1998; Thorne and Trendall, 2001, and references therein) consists mainly of subaerial basaltic lavas and mafic volcaniclastic rocks. The formation conformably overlies the Tumbiana Formation, is up to about 1 km thick, and encompasses the former Nymerina Basalt, Maddina Basalt, and Kuruna Siltstone (MacLeod and de la Hunty, 1966; Hickman, 1983). A SHRIMP U–Pb zircon date of 2717 ± 2 Ma (Nelson, 1998) from near the base of the Maddina Formation shows that it is similar in age to the underlying Tumbiana Formation.

The Maddina Formation covers an extensive area in the east and southeast of EASTERN CREEK. Outcrop in this area is very good, and the unit is clearly defined on radiometric images (Fig. 3b). The formation is dominated by locally vesicular or plagioclase-phyric mafic rocks, and superficially appears to be relatively uniform in composition. However, two major subunits have been distinguished using whole-rock geochemistry (Glikson et al., 1986) and radiometric data. These subunits are, from base to top: komatiitic basalt (*AFmbk)*, and basaltic andesite and andesite, with minor basalt (*AFmbi*). Minor rock units in the Maddina Formation include silicified siltstone and chert (*AFmcc*), and siltstone and tuffaceous siltstone (*AFmk*).

A unit of siltstone and probable tuffaceous siltstone with accretionary lapilli (*AFmk*) is exposed within the Maddina Formation in the northeast corner of EASTERN CREEK, between Boodalyerrie Creek and the eastern boundary of the sheet. On the easternmost edge of EASTERN CREEK, and on PEARANA to the east, the siltstone is underlain and partly intruded by a dolerite sill (*Ad*; Williams and Trendall, 1998).

Jeerinah Formation (AFj)

The Jeerinah Formation (MacLeod et al., 1963; Thorne and Trendall, 2001), formerly the Lewin Shale (de la Hunty, 1964; Hickman, 1983), consists mainly of fine-grained clastic sedimentary rocks with minor chert. It is widely thought to be conformable on the Maddina Formation (Thorne and Trendall, 2001, and references therein) and attains a thickness of up to 1250 m. A depositional age range of 2690 to 2629 Ma is indicated by SHRIMP U–Pb zircon dates of 2690 ± 16, 2684 ± 6 (Arndt et al., 1991), and 2629 ± 5 Ma (A. F. Trendall, quoted in Nelson et al., 1999).

The Jeerinah Formation (*AFj*) forms prominent hills along the western boundary of the Davis River valley, in the southeast corner of EASTERN CREEK. In this area the formation consists of bedded chert, siltstone, shale, and minor medium- to coarse-grained sandstone. The chert is thin to thick bedded and grey to pale green-grey, with a vague lamination, and typically forms a resistant cap over deeply weathered shale and siltstone.

Structure of the Fortescue Group

D_{FG1} (c. 2730 Ma)

A gentle basin-like structure south of the Yilgalong Granitic Complex has affected rocks in the lower part of the Fortescue Group, up to and including the Kylena Formation. The absence of similar structures in the overlying Tumbiana Formation suggests development of the structure before c. 2724 Ma, which is the maximum age of rocks in the Tumbiana Formation (Blake et al., 2004).

D_{FG2} (c. 2690–2629 Ma)

Rocks of the Fortescue Group are cut by numerous faults. North- to northwest-trending dextral faults are interpreted to be structures formed during deposition of the Jeerinah Formation. The faults cut through the Maddina Formation and are locally associated with small basins of Jeerinah Formation that unconformably overlie the lower parts of the Maddina Formation (e.g. 3.5 km southeast of Hallcomes Peak). Subsidiary northeasterly trending faults also probably formed at about the same time.

Hamersley Group

The Hamersley Group lies conformably on the Fortescue Group and is a package of sedimentary rocks, up to 2.5 km thick, characterized by abundant banded iron-formation and iron-rich shale. The lower part of the group consists mainly of banded iron-formation assigned to the Marra Mamba Iron Formation and dolomitic rocks of the Wittenoom Formation (Trendall, 1983). In the northeast part of the Hamersley Basin, which is exposed on EASTERN CREEK, the basal unit is the Carawine Dolomite, which is the easterly correlative of the Wittenoom Formation.

Carawine Dolomite (AHc)

The Carawine Dolomite (*AHc*; Noldart and Wyatt, 1962; Hickman, 1983) is the only unit of the Hamersley Group on EASTERN CREEK. The only exposures of the unit are in the southeast corner of the sheet, south-southeast of the Sunset Hill manganese prospect. More extensive exposures of the dolomite on PEARANA, to the east, have been described by Williams and Trendall (1998, and references therein). The Carawine Dolomite has not been directly dated, but a minimum age of c. 2540 Ma is inferred from a Pb–Pb isochron date of 2541 ± 32 Ma, which is interpreted to be the age of diagenesis of the carbonate sediments (Jahn and Simonson, 1995).

On EASTERN CREEK the dolomite is a grey recrystallized rock with minor amounts of shale and nodular chert. The dolomite is locally variegated due to impurities of iron and manganese, and contains a variety of sedimentary structures suggestive of deposition in a shallow-water, platform setting (Williams and Trendall, 1998).

Minor intrusions of Archean or Proterozoic age

Mafic dykes (*d, Ad*)

Numerous mafic dykes of uncertain age (*d*) cut across rocks of the East Pilbara Granite–Greenstone Terrane, Mosquito Creek Basin, Kurrana Terrane, and Hamersley Basin. Most dyke outcrops are deeply weathered and poorly exposed. Apart from a few exceptions, the majority have a low magnetic susceptibility. In fresh outcrop the dykes are mostly composed of massive, homogeneous dolerite or gabbro. One unusual mafic dyke 9 km southwest of Mount Elsie contains angular and highly irregular fragments of quartz and subordinate chert (Fig. 17). These fragments are thought to be greenstone xenoliths. In many locations mafic dykes are associated with quartz veins that follow the same trend. In a few areas airphoto lineaments are defined by subparallel mafic dykes and quartz veins. A dolerite of inferred Archean age (*Ad*) in the northeast corner of EASTERN CREEK is the continuation of a large dolerite sill on PEARANA (Williams and Trendall, 1998) that has intruded along the contact between the Maddina and Jeerinah Formations.

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Figure 17. Mafic dyke with angular xenoliths of chert, probably derived from metamorphosed chert in the host greenstones, Mount Elsie greenstone belt (MGA 242330E 7605280N)

Hornblende–quartz monzodiorite and diorite (*Agd*)

Mafic plugs up to 250 m wide have intruded the Coondamar Formation about 8 km west-southwest of Eastern Creek Well (MGA 246500E 7595200N and MGA 247300E 7594800N). The intrusions range in composition from hornblende–quartz monzodiorite to hornblende diorite, and are granular and seriate textured with a quartz content locally up to 10%. Small rounded mafic enclaves up to 30 mm are common, and there are rare xenoliths of Mosquito Creek Formation in some outcrops. A crystallization age of c. 2755 Ma is indicated by a SHRIMP U–Pb zircon date of 2755 ± 7 Ma (Nelson, 2004g), suggesting that the intrusions may have been feeders for the Hardey Formation in the Fortescue Group.

Quartz veins (*q*)

Quartz veins (*q*) are abundant in the Mount Elsie greenstone belt, the Coondamar and Mosquito Creek Formations, and the Yilgalong and Kurrana Granitic Complexes. There are several distinct sets of quartz veins of contrasting age. There is an older set of foliation-parallel deformed veins in the Mount Elsie greenstone belt, a later set of foliation-parallel veins in the Coondamar and Mosquito Creek Formations, and a younger set of veins associated with crosscutting mafic dykes (*d*). Most foliation-parallel veins are too small to be shown individually, and hence only the larger quartz veins associated with the mafic dykes are shown on the map.

Neoarchean to Paleoproterozoic Pinjian Chert Breccia (*Ꞓcb*)

The Pinjian Chert Breccia (*Ꞓcb*; Williams and Trendall, 1998) overlies the Carawine Dolomite (*AHc*) along the Davis River in the southeast of EASTERN CREEK. The breccia consists of angular fragments of chert and layered chert in a siliceous matrix. The breccia is locally rich in iron and manganese oxides, giving the rock a black to dark-brown colour and semimetallic lustre. Subeconomic concentrations of manganese occur in the Sunset Hill, Redmond, Snake Hill, and Donkey prospects. The Pinjian Chert Breccia is thought to have formed by deep weathering of the Carawine Dolomite (Williams and Trendall, 1998).

Paleoproterozoic Bridget Suite (*ꞒgBmh*)

A north-northwesterly trending suite of small, post-tectonic monzogranite intrusions (*ꞒgBmh*) lies within the Mosquito Creek Formation close to the western margin of EASTERN CREEK. Many of the intrusions, even though relatively small, have wide, biotite-grade metamorphic aureoles, suggesting that they are the surface exposures of much more extensive igneous bodies. The dominant rock type is a fine- to medium-grained, massive hornblende-bearing granodiorite to monzogranite. The largest exposure, 4 km south-southeast of the Parnell mining centre, is weakly porphyritic and contains scattered, rounded mafic enclaves up to 130 mm, as well as sparse xenoliths of metamorphosed sandstone and vein-quartz. An intrusive age of c. 1800 Ma is indicated by a SHRIMP U–Pb zircon date of 1803 ± 19 Ma (Nelson, 2002c) from an intrusion in the Granite Hills on NULLAGINE (Bagas, 2005), immediately west of EASTERN CREEK.

Phanerozoic Canning Basin

Paterson Formation (*Pa*)

The Paterson Formation (*Pa*) of the Canning Basin is the only Permian–Carboniferous unit on EASTERN CREEK. It is poorly exposed in the northeast corner. More extensive exposures on PEARANA to the east have been described in more detail (Williams and Trendall, 1998). It is interpreted as a fluvioglacial deposit on the basis of a basal diamictite with scattered boulders, and polished grooved pavements on the underlying Pinjian Chert Breccia.

Cenozoic regolith geology

Parts of EASTERN CREEK are mantled by Cenozoic regolith, including residual indurated deposits exposed by erosion, and a range of younger alluvial and eluvial deposits. Individual regolith units have been mapped using field observations in conjunction with airphoto and Landsat-TM image interpretation.

Residual deposits (*Czrf, Czrk, Czrz, Czc, Czoc*)

The oldest regolith units typically form residual deposits on low hills and plateau remnants. They include ferruginous duricrust (*Czrf*), calcrete (*Czrk*), silcrete and siliceous duricrust (*Czrz*), weakly consolidated colluvium (*Czc*), and a unit of limestone and calcareous sandstone (*Czoc*) called the Oakover Formation (Noldart and Wyatt, 1962; Williams and Trendall, 1998).

Ferruginous duricrust (*Czrf*) caps deeply weathered rocks of the Fortescue Group along the Davis River valley, and along Coondamar Creek in the central-southern margin of EASTERN CREEK. Isolated outcrops of ferruginous duricrust are also on the northern edge of the Mosquito Creek Formation, near Mount Olive. These deposits probably represent an ancient weathering surface, possibly related to the 'Hamersley Surface' (Campana et al., 1964).

Calcrete (*Czrk*) forms rubbly deposits on undulating country adjacent to the Davis River, about 2.5 km east of the Redmond manganese prospect. Siliceous duricrust, including silcrete and secondary chert breccia

(*Czrz*), overlies the Pinjian Chert Breccia (*Æcb*) in the southeastern corner of the area. It is thought to be derived from the Pinjian Chert Breccia by deep weathering and secondary silicification (Williams and Trendall, 1998).

Partly consolidated deposits of silt, sand, and gravel (*Czc*) are largely restricted to a few areas in the northeast corner of EASTERN CREEK, and near Coondamar Creek, where they are on low hills above the level of the present-day drainage system. The deposits are partly dissected and eroded, and are interpreted to be the remnants of colluvial deposits that pre-date the present-day erosional regime.

The lower unit of the Oakover Formation (*Czoc*) is only in the northeasternmost corner of EASTERN CREEK, and occupies a paleovalley of the Oakover River (Williams and Trendall, 1998). The formation is estimated to be at least 30–40 m thick, and is considered a lacustrine deposit.

Quaternary colluvium and sheetwash deposits (*Qc, Qcf, Qw, Qwf*)

Proximal slope deposits, comprising unconsolidated rock debris, sand, and silt, lie on steep slopes and in adjacent areas on the valley floor. They have been mapped either as colluvium (*Qc*), or as ferruginous colluvium (*Qcf*) if dominated by ferruginous debris and iron-rich nodules. The latter unit is typically developed in the southeast part of EASTERN CREEK, adjacent to ferruginous duricrust (*Czrf*), and outcrops of the Maddina and Jeerinah Formations.

More distal parts of the regolith, along valley floors, are dominated by sheetwash (*Qw*) and ferruginous sheetwash deposits (*Qwf*). Sheetwash deposits are typically along the major creeks and rivers. They consist of sand, silt with a poorly defined drainage, and are locally gradational into alluvium (*Qaa*) or overbank deposits (*Qao*).

Quaternary alluvial deposits (*Qaa, Qao*)

Recent deposits of unconsolidated to semiconsolidated clay, silt, sand, and gravel (*Qaa*) of probable Quaternary age lie along intermittently active fluvial channels and on adjacent floodplains. These deposits may grade laterally into overbank deposits (*Qao*) or sheetwash (*Qw* and *Qwf*). Broad areas of clay, silt, and sand on floodplains adjacent to major creek systems are mapped as overbank deposits.

Economic geology

Vein and hydrothermal mineralization

Precious metal — gold(–antimony)

Significant historical gold production has come from four mining centres on EASTERN CREEK — Boodalyerrie, Eastern Creek, Elsie, and Mosquito Creek. Additionally, substantial amounts of alluvial gold have been extracted through prospecting activity up to the present time. Most of the hard-rock mining occurred in the early 1900s, although some mines have been worked sporadically since then.

The Boodalyerrie mining centre encompasses a group of small workings within the Yilgalong Granitic Complex (MGA 270750E 7613200N) that were active from 1901 to 1910. Gold was extracted from thin quartz veins in granitic rock with a yellow-green alteration (Finucane, 1939a). Alluvial gold was also produced from the adjacent creeks. Total gold production was 25.992 kg (Ferguson and Ruddock, 2001).

The Elsie mining centre is in the Mount Elsie greenstone belt, close to Mount Elsie. Mining activity occurred mainly between 1899 and 1906, and was focused on quartz veins in foliated metabasalt and mafic schist with carbonate alteration (Finucane, 1939b). Total production up to 1998 was 52.388 kg of gold (Ferguson and Ruddock, 2001).

Larger amounts of gold were found in the Mosquito Creek Formation, which continues to be an area of active gold prospecting. There are two historic mining centres on EASTERN CREEK and several others on NULLAGINE to the west. The Eastern Creek mining centre lies in the northeast corner of the Mosquito Creek Formation, close to Eastern Creek Well. In this area the gold is in quartz veins in slate, and metamorphosed siltstone and sandstone. The mining centre was active mainly between 1908 and 1924 for a total gold production of 308.132 kg, although a few of the shafts have been worked sporadically since then by prospectors. The Mosquito Creek mining centre extends onto the western edge of EASTERN CREEK from NULLAGINE and encompasses the Federal and Parnell mines. These mines lie on the eastern extension of a line of gold and antimony deposits, called the Blue Spec line (Ferguson and Ruddock, 2001). Several other small workings are present along the eastern extension of this line towards the centre of EASTERN CREEK. On NULLAGINE the mineralized lodes contain quartz, stibnite, aurostibite, native gold, pyrite, pyrrhotite, and carbonate, as well as minor amounts of scheelite, arsenopyrite, marcasite, sphalerite, chalcopyrite, magnetite, mackinawite, calvarite, rickardite, and gudmundite (Hickman, 1983; Gifford, 1990).

Stratabound volcanic and sedimentary mineralization

Base metals — copper, lead, zinc

Subeconomic base metal mineralization has been discovered in the Coondamar Formation and the lower part of the Mosquito Creek Formation at several locations near Coondamar Creek, in the southwest corner of EASTERN CREEK. Assays of drillhole chips gave up to 18% Cu, 1.7% Pb, 19.5% Zn, 210 g/t Ag, and 1.75 g/t Au in the Coondamar Horse Creek prospect (Ferguson and Ruddock, 2001). A gossan at the Coondamar Creek Mogul prospect contains malachite, azurite, chrysacolla, cuprite, hydrozincite, smithsonite, and cerussite. At depth the primary mineralization consists of pyrite, chalcopyrite, sphalerite, and galena (Ferguson and Ruddock, 2001).

Regolith-hosted mineralization

Steel industry metal — manganese

Supergene manganese mineralization in the southeast corner of EASTERN CREEK belongs to the Pilbara Manganese Province (de la Hunty, 1963). These occurrences have formed largely by supergene enrichment of manganese-bearing Archean sedimentary rocks of the Hamersley Group. On EASTERN CREEK the manganese deposits are hosted by the Pinjian Chert Breccia (*Ꮭcb*), and form surface sheets and lens-shaped mounds. They are thought to have formed by remobilization and precipitation of manganese during deep weathering of the Carawine Dolomite in the Paleoproterozoic, followed by further surface enrichment during deep weathering in the Cenozoic (Ferguson and Ruddock, 2001). Mineralogical studies have shown that the manganese deposits are dominated by cryptomelane, pyrolusite, and goethite (Ostwald, 1993).

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Appendix 1

Gazetteer of localities on EASTERN CREEK

Place name	*MGA coordinates* *Easting*	*Northing*
Coondamar Horse Creek base metal prospect	259150	7572200
Coondamar Creek Mogul base metal prospect	256745	7576761
Donkey manganese prospect	284935	7575761
Eastern Creek Well	253900	7598600
Federal gold mine (abd)	241815	7583930
Hallcomes Peak	257100	7577030
Mount Elsie	250370	7609100
Mount Hays	270000	7580300
Mount Olive	254600	7599600
Parnell gold mine (abd)	241605	7583961
Redmond manganese prospect	286635	7576161
Snake Hill manganese prospect	293135	7587361
Steel Well (abd)	248100	7617900
Sunset Hill manganese prospect	291235	7581311

NOTE: abd = abandoned

Appendix 2

Correlation of rock codes and stratigraphic names on EASTERN CREEK with rock codes and stratigraphic names used in the GSWA databases

Map code	*Supergroup*	*Old Group/Complex*	*Old Formation: Member*	*New code*	*New Supergroup/Supersuite*	*New Group*	*New Formation: Member*
Qaa				*A1$_c$*			
Qao				*A1$_f$*			
Qw				*W1*			
Qwf				*W1f*			
Qc				*C1*			
Qcf				*C1f*			
Czc				*C2*			
Czrz				*R2$_r$z*			
Czrk				*R2k*			
Czrf				*R3f*			
Czoc			Oakover Formation: Lower unit	Noa-ktpl			Oakover Formation: Lower unit
Pa			Paterson Formation	CPpa-sgpg			Paterson Formation
Ᵽgbmh				P_bg-gmh			
d				AP_op			
q				AP_zqp			
Ᵽcb			Pinjian Chert Breccia	AP_pj-ccx			Pinjian Chert Breccia
Ahc	Mount Bruce Supergroup	Hamersley Group	Carawine Dolomite	Ahac-kds	Mount Bruce Supergroup	Hamersley Group	Carawine Dolomite
Ad				Aodp			
Afj	Mount Bruce Supergroup	Fortescue Group	Jeerinah Formation	Afoj-cl	Mount Bruce Supergroup	Fortescue Group	Jeerinah Formation
Afmbi	Mount Bruce Supergroup	Fortescue Group	Maddina Formation	Afom-bd	Mount Bruce Supergroup	Fortescue Group	Maddina Formation
Afmcc	Mount Bruce Supergroup	Fortescue Group	Maddina Formation	Afom-cc	Mount Bruce Supergroup	Fortescue Group	Maddina Formation
Afm	Mount Bruce Supergroup	Fortescue Group	Maddina Formation	Afom-bng	Mount Bruce Supergroup	Fortescue Group	Maddina Formation
Afmk	Mount Bruce Supergroup	Fortescue Group	Maddina Formation: Kuruna Member	Afomk-bntt	Mount Bruce Supergroup	Fortescue Group	Maddina Formation: Kuruna Member
Afmbk	Mount Bruce Supergroup	Fortescue Group	Maddina Formation	Afom-bk	Mount Bruce Supergroup	Fortescue Group	Maddina Formation
Aft	Mount Bruce Supergroup	Fortescue Group	Tumbiana Formation	Afot-bntt	Mount Bruce Supergroup	Fortescue Group	Tumbiana Formation
Afkbi	Mount Bruce Supergroup	Fortescue Group	Kylena Formation	Afok-bng	Mount Bruce Supergroup	Fortescue Group	Kylena Formation
Afkkl	Mount Bruce Supergroup	Fortescue Group	Kylena Formation	Afokm-kts	Mount Bruce Supergroup	Fortescue Group	Kylena Formation
Afkbk	Mount Bruce Supergroup	Fortescue Group	Kylena Formation	Afok-xbk-bb	Mount Bruce Supergroup	Fortescue Group	Kylena Formation
Afh	Mount Bruce Supergroup	Fortescue Group	Hardey Formation	Afoh-xs-f	Mount Bruce Supergroup	Fortescue Group	Hardey Formation
Afhb	Mount Bruce Supergroup	Fortescue Group	Hardey Formation: Bamboo Creek Member	Afohb-fr	Mount Bruce Supergroup	Fortescue Group	Hardey Formation: Bamboo Creek Member
Agd				Agkhp			
Afr	Mount Bruce Supergroup	Fortescue Group	Mount Roe Basalt	Afor-bbg	Mount Bruce Supergroup	Fortescue Group	Mount Roe Basalt
Afrsc	Mount Bruce Supergroup	Fortescue Group	Mount Roe Basalt	Afor-scp	Mount Bruce Supergroup	Fortescue Group	Mount Roe Basalt
Afrsl	Mount Bruce Supergroup	Fortescue Group	Mount Roe Basalt	Afor-sl	Mount Bruce Supergroup	Fortescue Group	Mount Roe Basalt
Afrst	Mount Bruce Supergroup	Fortescue Group	Mount Roe Basalt	Afor-st	Mount Bruce Supergroup	Fortescue Group	Mount Roe Basalt
Agh				Agnhp			
Agkbd		Kurrana Granitic Complex	Bonney Downs Granite	Asrbo-gm		Split Rock Supersuite	Bonney Downs Granite
Adqs	Pilbara Supergroup	De Grey Group	Mosquito Creek Formation	Anuq-mh	De Grey Supergroup	Nullagine Group	Mosquito Creek Formation
Adqsc	Pilbara Supergroup	De Grey Group	Mosquito Creek Formation	Anuq-mx	De Grey Supergroup	Nullagine Group	Mosquito Creek Formation

Appendix 2 (continued)

Map code	Supergroup	Old Group/Complex	Old Formation: Member	New code	New Supergroup/Supersuite	New Group	New Formation: Member
Adqsl	Pilbara Supergroup	De Grey Group	Mosquito Creek Formation	Anuq-ml	De Grey Supergroup	Nullagine Group	Mosquito Creek Formation
Adqss	Pilbara Supergroup	De Grey Group	Mosquito Creek Formation	Anuq-xml-mt	De Grey Supergroup	Nullagine Group	Mosquito Creek Formation
Adqst	Pilbara Supergroup	De Grey Group	Mosquito Creek Formation	Anuq-mt	De Grey Supergroup	Nullagine Group	Mosquito Creek Formation
Adnlb	Pilbara Supergroup	De Grey Group	Coondamar Formation	Anuc-xmd-mwa	De Grey Supergroup	Nullagine Group	Coondamar Formation
Adnlbn	Pilbara Supergroup	De Grey Group	Coondamar Formation	Anuc-xmd-mgn	De Grey Supergroup	Nullagine Group	Coondamar Formation
Adncc	Pilbara Supergroup	De Grey Group	Coondamar Formation	Anuc-mcj	De Grey Supergroup	Nullagine Group	Coondamar Formation
Adnsl	Pilbara Supergroup	De Grey Group	Coondamar Formation	Anuc-xmh-mwa	De Grey Supergroup	Nullagine Group	Coondamar Formation
Adnss	Pilbara Supergroup	De Grey Group	Coondamar Formation	Anuc-mhc	De Grey Supergroup	Nullagine Group	Coondamar Formation
Adnst	Pilbara Supergroup	De Grey Group	Coondamar Formation	Anuc-mt	De Grey Supergroup	Nullagine Group	Coondamar Formation
Adnstb	Pilbara Supergroup	De Grey Group	Coondamar Formation	Anuc-mtw	De Grey Supergroup	Nullagine Group	Coondamar Formation
Adnstbc	Pilbara Supergroup	De Grey Group	Coondamar Formation	Anuc-mtwk	De Grey Supergroup	Nullagine Group	Coondamar Formation
Adnfv	Pilbara Supergroup	De Grey Group	Coondamar Formation	Anuc-mf	De Grey Supergroup	Nullagine Group	Coondamar Formation
Adnog	Pilbara Supergroup	De Grey Group	Coondamar Formation	Anuc-mog	De Grey Supergroup	Nullagine Group	Coondamar Formation
Adnb	Pilbara Supergroup	De Grey Group	Coondamar Formation	Anuc-mbb	De Grey Supergroup	Nullagine Group	Coondamar Formation
Adnba	Pilbara Supergroup	De Grey Group	Coondamar Formation	Anuc-mws	De Grey Supergroup	Nullagine Group	Coondamar Formation
Adnbk	Pilbara Supergroup	De Grey Group	Coondamar Formation	Anuc-mbm	De Grey Supergroup	Nullagine Group	Coondamar Formation
Adnu	Pilbara Supergroup	De Grey Group	Coondamar Formation	Anuc-ma	De Grey Supergroup	Nullagine Group	Coondamar Formation
Adnup	Pilbara Supergroup	De Grey Group	Coondamar Formation	Anuc-mapt	De Grey Supergroup	Nullagine Group	Coondamar Formation
Adnur	Pilbara Supergroup	De Grey Group	Coondamar Formation	Anuc-mwrc	De Grey Supergroup	Nullagine Group	Coondamar Formation
Adnux	Pilbara Supergroup	De Grey Group	Coondamar Formation	Anuc-max	De Grey Supergroup	Nullagine Group	Coondamar Formation
Agkge		Kurrana Granitic Complex	Golden Eagle Orthogneiss	Ambge-mgtn	Mount Billroth Supersuite		Golden Eagle Orthogneiss
Agam		Yilgalong Granitic Complex		Aemel-mgtss	Emu Pool Supersuite		Elsie Creek Tonalite
Agapf		Yilgalong Granitic Complex		Aemel-mr	Emu Pool Supersuite		Elsie Creek Tonalite
AW(cc)	Pilbara Supergroup	Warrawoona Group		AWa-cc	Pilbara Supergroup	Kelly Group	undivided
AW(bk)	Pilbara Supergroup	Warrawoona Group		AWa-bk	Pilbara Supergroup	Kelly Group	undivided
AWwb	Pilbara Supergroup	Warrawoona Group	Wyman Formation	Akew-bb	Pilbara Supergroup	Kelly Group	Wyman Formation
AWwcc	Pilbara Supergroup	Warrawoona Group	Wyman Formation	Akew-cc	Pilbara Supergroup	Kelly Group	Wyman Formation
AWwssz	Pilbara Supergroup	Warrawoona Group	Wyman Formation	Akew-mdq	Pilbara Supergroup	Kelly Group	Wyman Formation
AWwd	Pilbara Supergroup	Warrawoona Group	Wyman Formation	Akew-o	Pilbara Supergroup	Kelly Group	Wyman Formation
AWeb	Pilbara Supergroup	Warrawoona Group	Euro Basalt	Akee-bbo	Pilbara Supergroup	Kelly Group	Euro Basalt
AWebk	Pilbara Supergroup	Warrawoona Group	Euro Basalt	Akee-bk	Pilbara Supergroup	Kelly Group	Euro Basalt
AWebkc	Pilbara Supergroup	Warrawoona Group	Euro Basalt	Akee-mbmk	Pilbara Supergroup	Kelly Group	Euro Basalt
AWebkz	Pilbara Supergroup	Warrawoona Group	Euro Basalt	Akee-mbmz	Pilbara Supergroup	Kelly Group	Euro Basalt
AWebs	Pilbara Supergroup	Warrawoona Group	Euro Basalt	Akee-xmws-mlv	Pilbara Supergroup	Kelly Group	Euro Basalt
AWebx	Pilbara Supergroup	Warrawoona Group	Euro Basalt	Akee-bbvt	Pilbara Supergroup	Kelly Group	Euro Basalt
AWed	Pilbara Supergroup	Warrawoona Group	Euro Basalt	Akee-o	Pilbara Supergroup	Kelly Group	Euro Basalt
AWeu	Pilbara Supergroup	Warrawoona Group	Euro Basalt	Akee-mu	Pilbara Supergroup	Kelly Group	Euro Basalt
AWeuk	Pilbara Supergroup	Warrawoona Group	Euro Basalt	Akee-muk	Pilbara Supergroup	Kelly Group	Euro Basalt
AWeup	Pilbara Supergroup	Warrawoona Group	Euro Basalt	Akee-mapt	Pilbara Supergroup	Kelly Group	Euro Basalt
AWeux	Pilbara Supergroup	Warrawoona Group	Euro Basalt	Akee-max	Pilbara Supergroup	Kelly Group	Euro Basalt
AWeccw	Pilbara Supergroup	Warrawoona Group	Euro Basalt	Akee-ccb	Pilbara Supergroup	Kelly Group	Euro Basalt
AWesl	Pilbara Supergroup	Warrawoona Group	Euro Basalt	Akee-sl	Pilbara Supergroup	Kelly Group	Euro Basalt
AWefv	Pilbara Supergroup	Warrawoona Group	Euro Basalt	Akee-fnv	Pilbara Supergroup	Kelly Group	Euro Basalt

Appendix 3

Definition of stratigraphic names on EASTERN CREEK

Coondamar Formation

Derivation of name: Coondamar Creek in the southern part of EASTERN CREEK.

Distribution: Southern margin of Mosquito Creek Basin, in the southwest of EASTERN CREEK and southern part of NULLAGINE, and the northern margin of the basin, to the west and south of Eastern Creek Well on EASTERN CREEK. Interpreted to underlie the 1800 km^2 outcrop extent of the Mosquito Creek Basin.

Type area: Southwest of Hallcomes Peak, from MGA 250000E 7569000N to MGA 250000E 7575200N.

Lithology: Metamorphosed and multiply deformed sandstone and siltstone (typically chloritic), with minor chert, basalt, gabbro, ultramafic rock, and felsic rock. Metamorphosed to amphibolite, chlorite–actinolite schist, semipelitic schist, tremolite–actinolite schist, and quartz–muscovite schist in zones of higher metamorphic grade. Estimated thickness 1–2 km.

Relationships: Tectonic contact with the Kurrana Terrane to the south. Tectonized contact with the Wyman Formation in East Pilbara Granite–Greenstone Terrane to the north. Probable faulted unconformity with overlying c. 2926–2905 Ma siliciclastic rocks of the Mosquito Creek Formation.

Age: Between c. 3325 and 3315 Ma, the age of the Wyman Formation (Thorpe et al., 1992; McNaughton et al., 1993; Nelson, 2002a,b), and c. 2926 Ma, the likely maximum age of the Mosquito Creek Formation (Bagas, et al., 2004). A tentative age of c. 3035 Ma (Nelson, 2005a) for a single zircon from a deformed monzogranite intrusion in the Coondamar Formation indicates the possibility of an older minimum age.

Remarks: Previously included in the Mosquito Creek Formation (Hickman, 1978). Synonymy: informally referred to as the Middle Creek Formation (Blewett et al., 2002).

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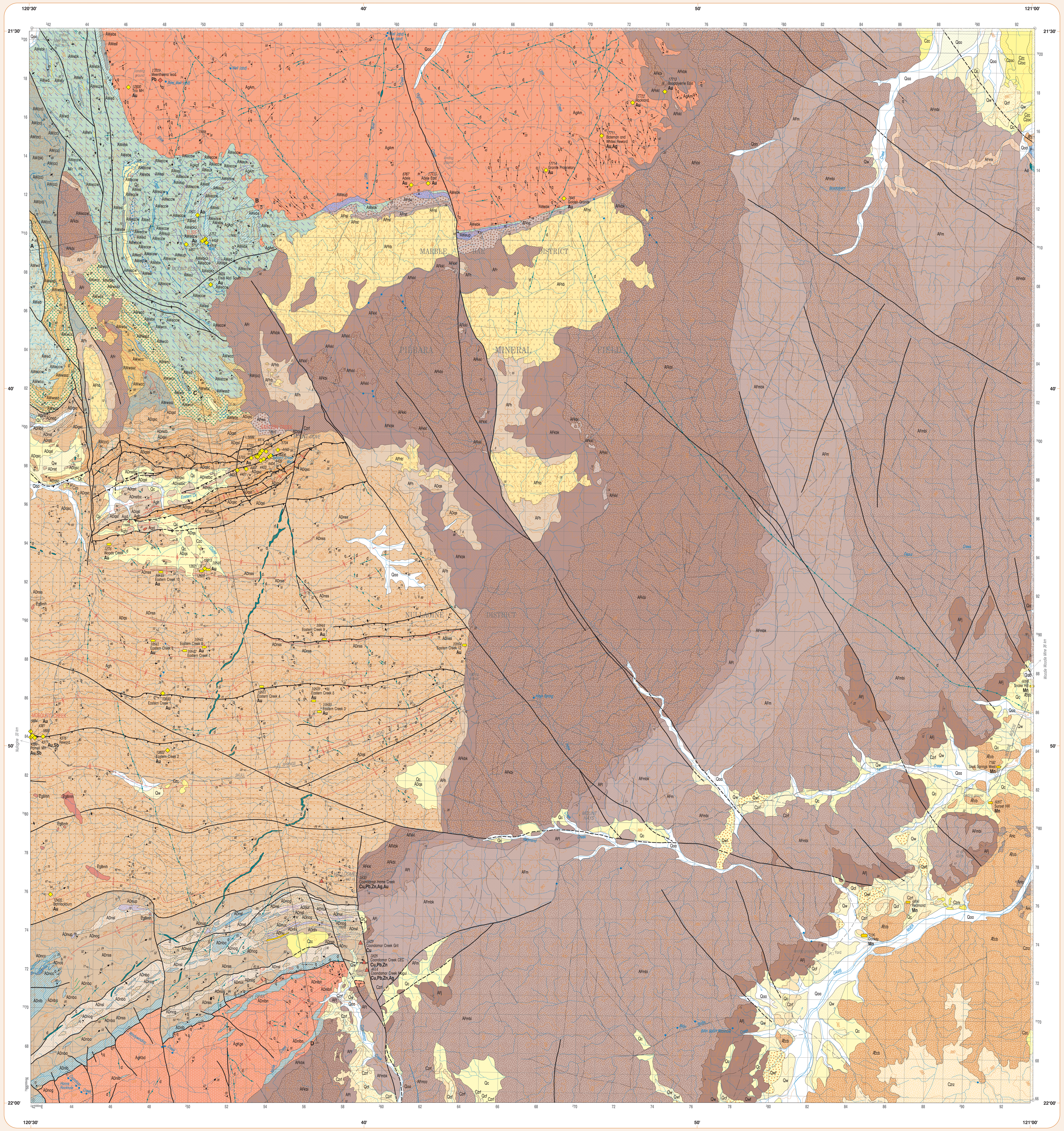
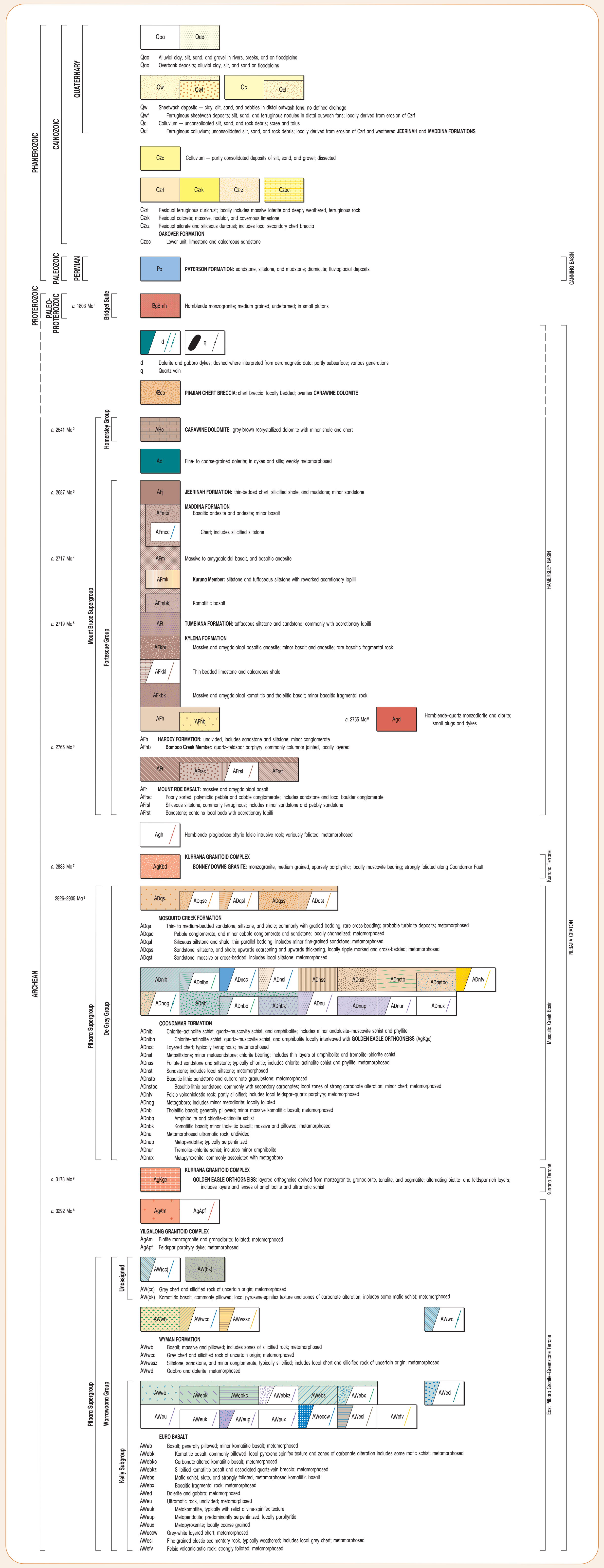
AUSTRALIA 1:100 000 GEOLOGICAL SERIES

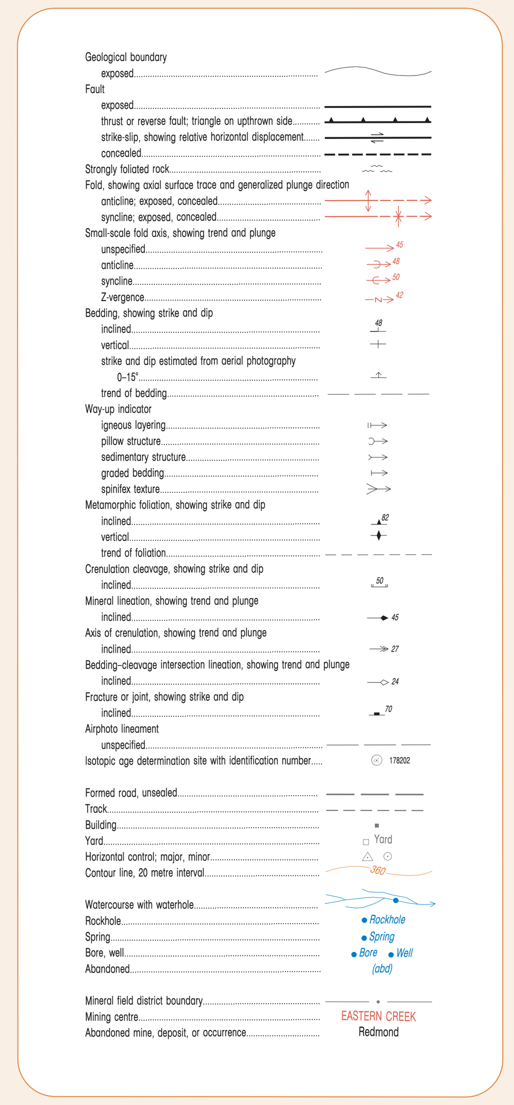
EASTERN CREEK

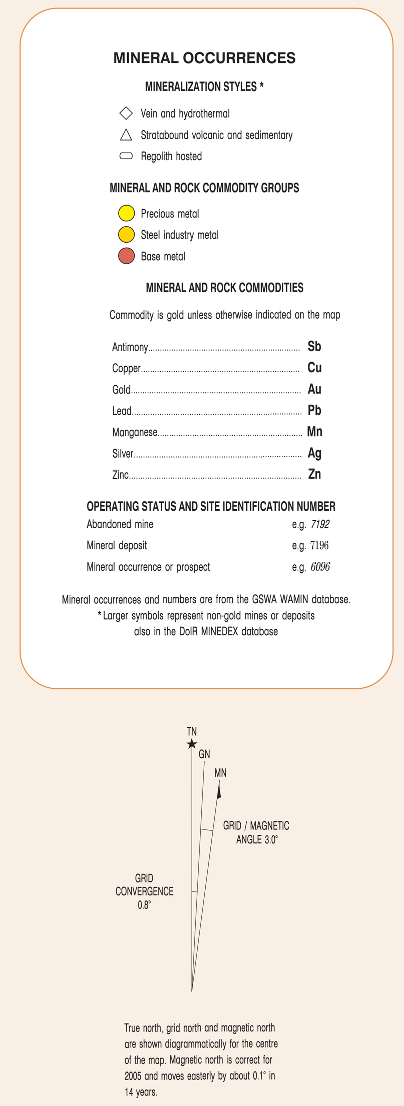
GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

SHEET 3054









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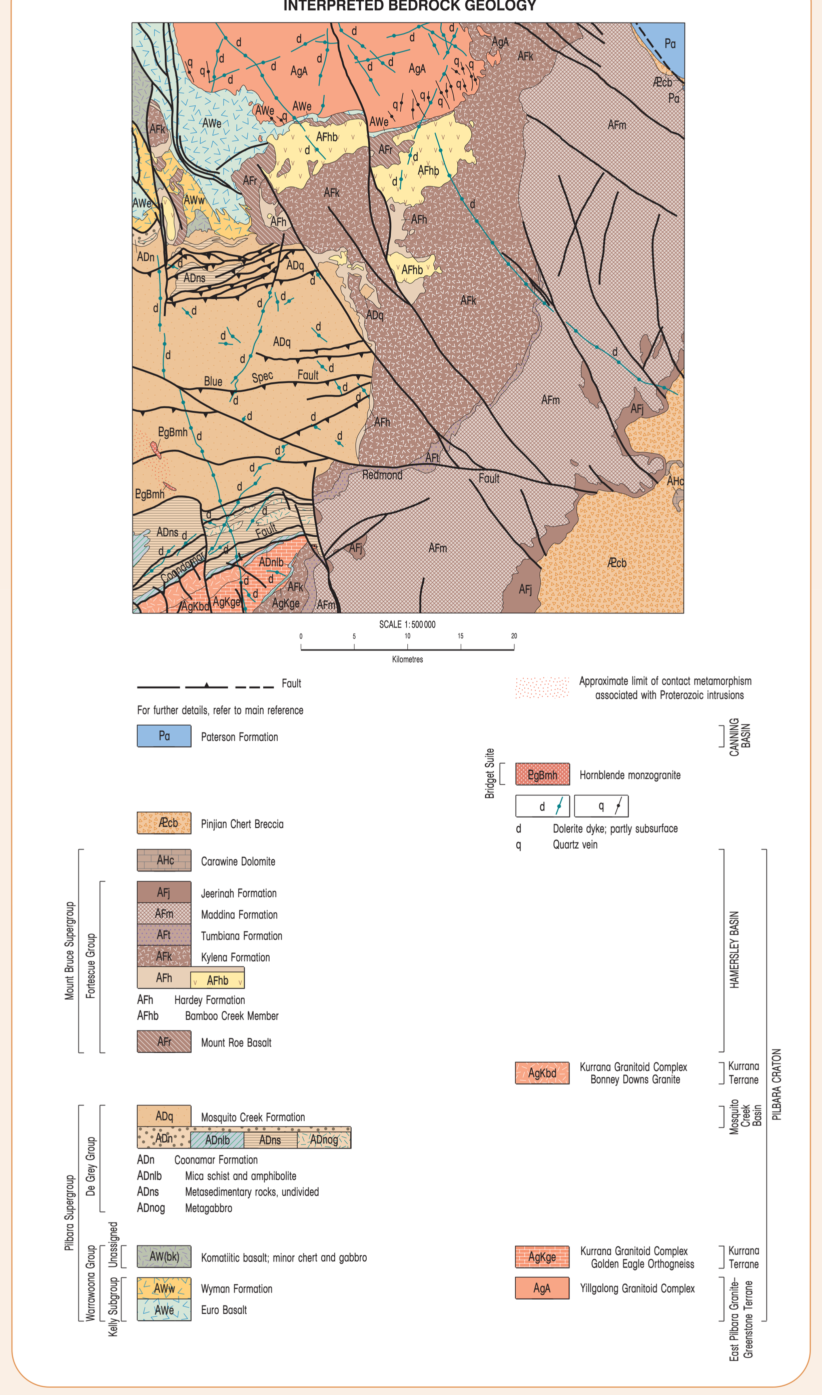

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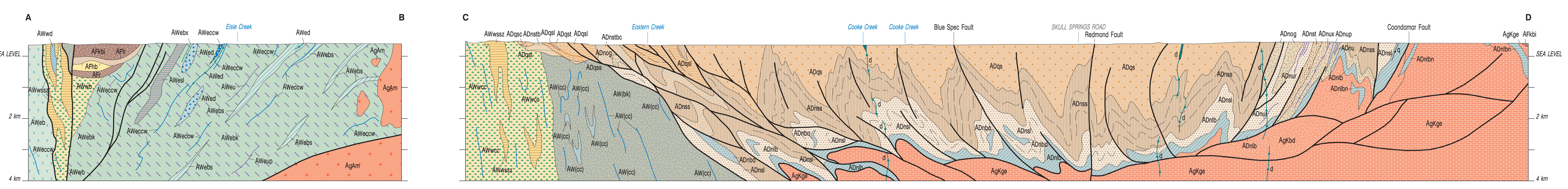

Geology by T. R. Farrell 1999–2001, 2004

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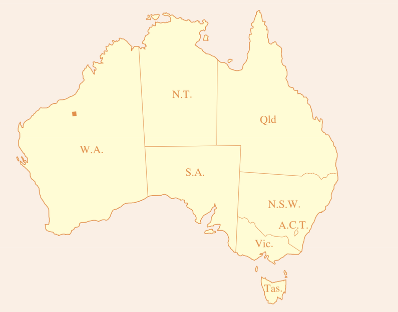

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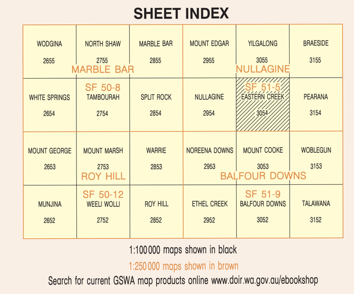

DATA DIRECTORY

Theme	Data Source	Data Currency	Agency
Geology	GSWA	1999–2005	Dept of Industry and Resources
Structural data	WAROX	NOV 2004	Dept of Industry and Resources
Mineral occurrences (non-confidential)	MINEDEX	MAY 2005	Dept of Industry and Resources
	WAMIN	MAY 2005	Dept of Industry and Resources
Cadastre	TENGRAPH	MAY 2003	Dept of Industry and Resources
Horizontal control	GESMAR	MAY 2003	Dept of Land Information
Topographic nomenclature	GEONOMA	MAY 2003	Dept of Land Information
Topography	DLI and GSWA field survey	MAY 2003	Dept of Land Information

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NGA

PRODUCT OF THE NATIONAL GEOSCIENCE AGREEMENT

SCALE 1:100 000

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

UNIVERSAL TRANSVERSE MERCATOR PROJECTION
HORIZONTAL DATUM: GEOCENTRIC DATUM OF AUSTRALIA 1994
VERTICAL DATUM: AUSTRALIAN HEIGHT DATUM

Grid lines indicate 1000 metre interval of the Map Grid Australia Zone 51

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

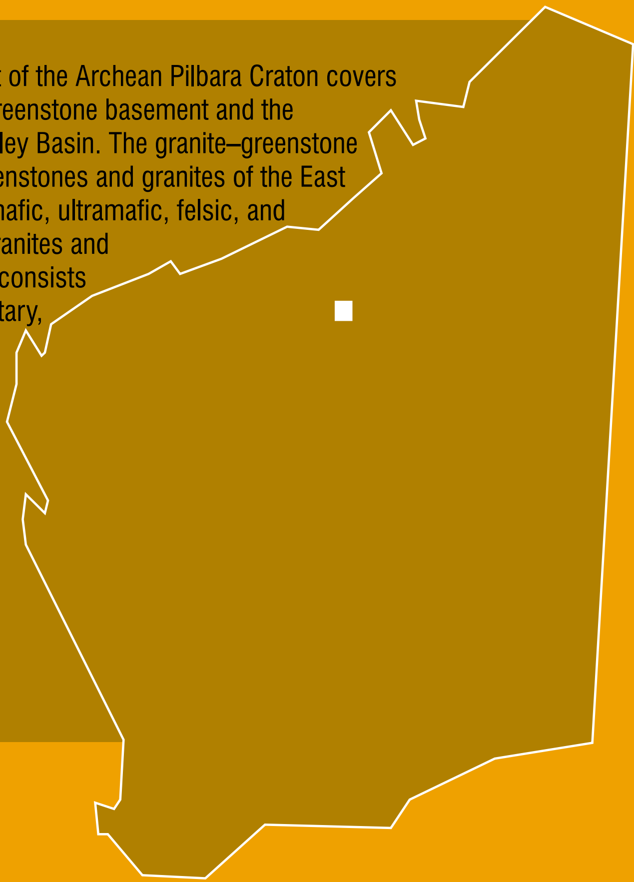
Reference points to align maps based on the previous datum, AGD84, have been placed near the map corners

EASTERN CREEK

SHEET 3054 **FIRST EDITION 2004**

Version 2.0 — September 2005

The Eastern Creek 1:100 000 sheet in the eastern part of the Archean Pilbara Craton covers an area straddling the boundary between the granite–greenstone basement and the unconformably overlying volcano-sedimentary Hamersley Basin. The granite–greenstone basement contains deformed and metamorphosed greenstones and granites of the East Pilbara Granite–Greenstone Terrane, metamorphosed mafic, ultramafic, felsic, and sedimentary rocks of the Mosquito Creek Basin, and granites and gneisses of the Kurrana Terrane. The Hamersley Basin consists mainly of basalt, basaltic andesite, tuffaceous sedimentary, and felsic volcanic rocks of the Fortescue Group, and dolomitic rocks of the Hamersley Group. Gold is deposited in late shear zones along the margin of the Yilgalong Granitic Complex, in greenstones near Mount Elsie, and in metasedimentary rocks of the Mosquito Creek Basin. Base metal mineralization (copper–lead–zinc) near the base of the Mosquito Creek Basin is in the volcano-sedimentary Coondamar Formation. A chert breccia developed over intensely weathered dolomitic rocks of the Hamersley Group contains supergene manganese mineralization.



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FARRELL

Geology of the Eastern Creek 1:100 000 sheet

EXPLANATORY NOTES