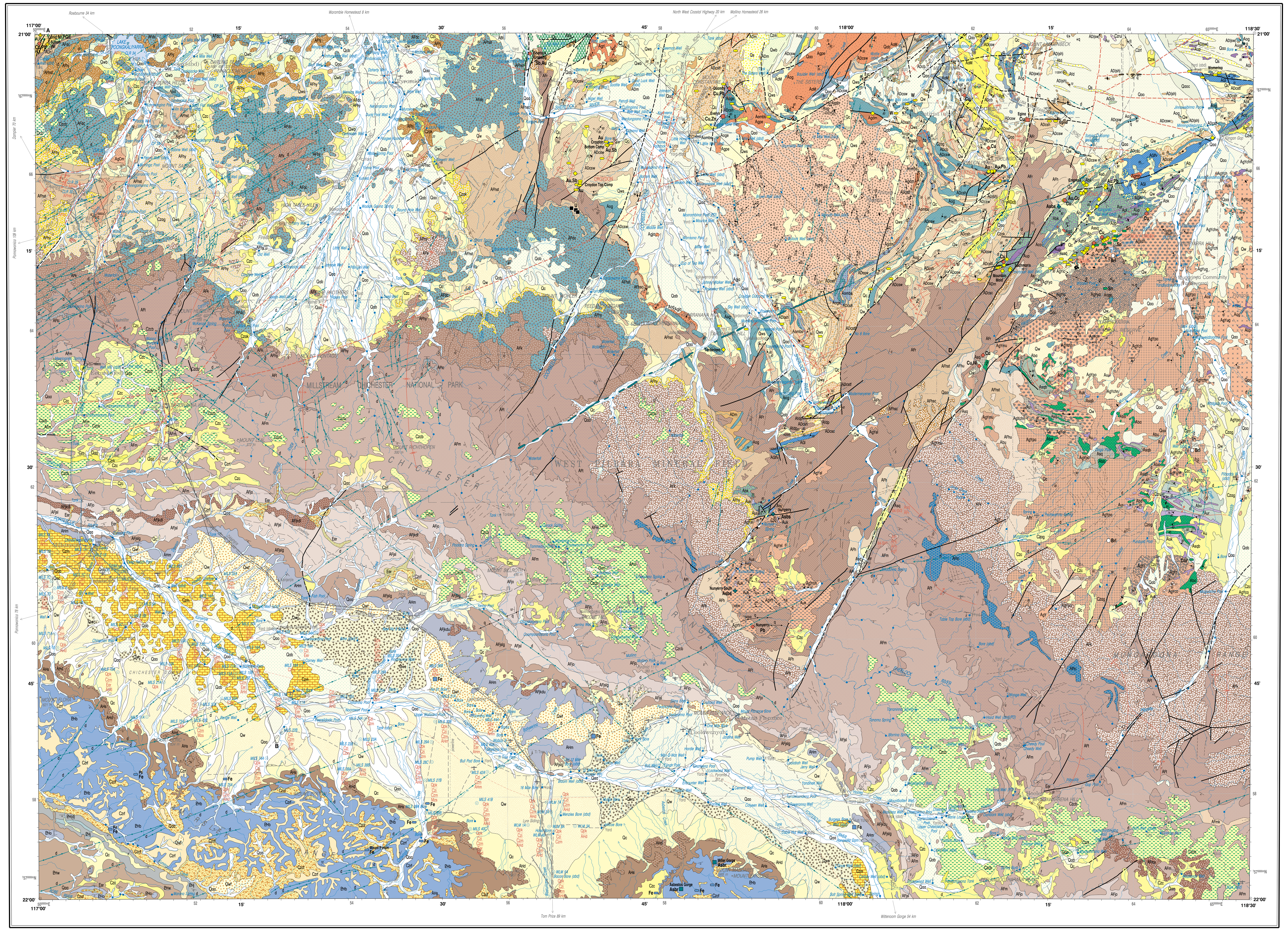
PYRAMID

GEOLOGICAL SERIES OF WESTERN AUSTRALIA



Qaa	Alluvial sand and gravel in rivers and creeks; clay, silt, and sand in channels on floodplains	
Qab	Alluvial sand, silt, and clay in floodplains, with gilgai surface in areas of expansive clay	
Qac	Clay and silt in claypans on floodplains	
Qao	Alluvial sand, silt, and clay in floodplains adjacent to main drainage channels	
Qaoc	Mixed floodplain deposits with numerous small claypans	
Qw	Low-gradient sheetwash deposits — silt, sand, and pebbles on distal outwash fans; no defined drainage	
Qwb	Sheetwash sand, silt, and clay in distal outwash fans, with gilgai in areas of expansive clay	
Qwc	Sheetwash sand, silt, and clay in distal outwash fans, with numerous claypans and minor clay-filled drainages	
Qwf	Ferruginous sheetwash sand, silt, and clay in outwash fans, with clasts of iron formation	
Qws	Sand in distal outwash fans; no defined drainage	
Qc	Colluvium — sand, silt, and gravel in scree and outwash fans	
Qcb	Colluvial clay, silt, and rock fragments derived from mafic rock, with gilgai surface in areas of expansive clay	
Qs	Eolian sand — red-yellow, wind-blown sand; local ridges	

PHANEROZOIC — CAINOZOIC — QUATERNARY

EARLY to MIDDLE PLEISTOCENE

Qck **KUMINA CONGLOMERATE:** alluvial fan deposits; partly cemented (subsurface only)

Cza	Alluvium — sand, silt, and gravel; variably consolidated; dissected by present-day drainage
Czag	Alluvial gravel, variably consolidated; dissected by present-day drainage
Czak	Alluvial calcrete; includes massive, nodular, and cavernous limestone
Czc	Colluvium — dissected consolidated clay, silt, sand, and gravel deposits; derived from adjacent rock outcrop
Czcb	Colluvium, dissected by present-day drainage, with gilgai surface in areas of expansive clay
Czcf	Ferruginous colluvium, derived from adjacent iron formation; includes hematite-rich conglomerate (canga) that contains iron ore
Czrf	Ferricrete; includes ferruginous and pisolitic ironstone; residual origin; locally includes deposits on the Hamersley Surface, dissected by present-day drainage
Czrk	Residual calcrete; massive, nodular, and cavernous limestone; mainly silicified
Czru	Siliceous caprock over ultramafic rock

NEOGENE to QUATERNARY — MIOCENE to PLEISTOCENE

Czi **KANGIANGI CLAY:** alluvial silt and clay; indurated (subsurface only)

Czm **MILLSTREAM FORMATION:** dolomite and calcareous dolomite, with silcrete, clay, and local basal conglomerate

MIDDLE to LATE EOCENE

Eer **ROBE PISOLITE:** pisolitic limonite deposits, developed along palaeodrainage lines; local clay and shale

MESOZOIC

Mzs Conglomerate and clay; clasts of chert, shale, and iron formation; alluvial channel deposits (subsurface only)

d Dolerite dykes; interpreted from aeromagnetic data where dashed

q Quartz vein, commonly along faults

PROTEROZOIC — PALAEOPROTEROZOIC — Hamersley Group (HAMERSLEY BASIN, PILBARA CRATON)

Age	Unit	Description
	PH(d)	Dolerite in sills
	PHo	**BOOLGEEDA IRON FORMATION:** fine-grained, finely laminated banded iron-formation; mudstone, siltstone and chert
c. 2449 Ma [1]	PHw	**WOONGARRA RHYOLITE:** rhyolite, rhyodacite, rhyolitic volcaniclastic breccia, and banded iron-formation
c. 2449 Ma [1]	PHj	**WEELI WOLLI FORMATION:** banded iron-formation (commonly jaspilitic), mudstone, siltstone, and numerous dolerite sills
2479–2454 Ma [2 3]	PHb	**BROCKMAN IRON FORMATION:** banded iron-formation, chert, mudstone, and siltstone
	AHs	**MOUNT McRAE SHALE** and **MOUNT SYLVIA FORMATION:** mudstone, siltstone, chert, banded iron-formation, and dolomite
c. 2561 Ma [4]	AHd	**WITTENOOM FORMATION:** thin- to medium-bedded dolomite, dolomitic mudstone, chert, and volcanic sandstone
c. 2597 Ma [4]	AHm	**MARRA MAMBA IRON FORMATION:** chert, banded iron-formation, mudstone, and siltstone

ARCHAEAN — Mount Bruce Supergroup — Fortescue Group

Age	Unit	Description
2690–2629 Ma [2 5]	AFj	**JEERINAH FORMATION:** shale, siltstone, mudstone, chert, and local dolomite and sandstone (Section only)
	AFjkdu	Dolomite and dolomitic shale; upper unit
	AFjslg	Carbonaceous mudstone and siltstone, chert, and local dolomite beds
	AFjsl	Variegated, light-coloured mudstone and siltstone
	AFjkdl	Dolomite and dolomitic shale; lower unit
	AFjo	**Woodiana Member:** quartz-rich sandstone, chert, chert breccia, and mudstone; locally includes lithic volcaniclastic sandstone
c. 2717 Ma [6]	AFm	**MADDINA FORMATION:** massive, vesicular, and amygdaloidal basalt and basaltic andesite
	AFmx	Basaltic volcaniclastic breccia
	AFmk	**Kuruna Member:** mafic to volcaniclastic sandstone, mudstone, chert, and dolomite
c. 2719 Ma [7]	AFt	**TUMBIANA FORMATION:** mafic to felsic volcaniclastic sandstone, pyroclastic rocks, and fine- to medium-grained clastic sedimentary rock; minor basalt, chert, dolomite, and limestone
	AFtc	**Meentheena Member:** dark grey stromatolitic dolomite and limestone, carbonate-rich pyroclastic rocks, mudstone, and siltstone
c. 2741 Ma [8]	AFk	**KYLENA FORMATION:** massive or amygdaloidal basalt, basaltic andesite, and dacite; local komatiitic basalt and rhyolite
		HARDEY FORMATION
	AFhy	**Lyre Creek Member:** felsic agglomerate and felsic pyroclastic rocks
	AFhj	**Coolajacka Member:** fine-grained ultramafic lava; abundant quartz xenocrysts
	AFhst	Medium- to coarse-grained, poorly sorted sandstone and minor well-laminated siltstone
	AFhu	Felsic pyroclastic rocks, volcaniclastic sandstone, siltstone, and shale; interbedded; local conglomerate
2768–2756 Ma [5 10 11]	AFh	Sandstone, conglomerate, siltstone, shale, and felsic pyroclastic rocks
	AFhsc	Conglomerate; polymictic
c. 2772 Ma [5 12 13]	AFr	**MOUNT ROE BASALT:** massive, vesicular, and glomeroporphyritic basalt
2940–2930 Ma [6]	Agsa	**SATIRIST GRANITE:** metamorphosed biotite(–hornblende) granite (Mallina Basin)

AFdc **COOYA POOYA DOLERITE:** fine- to medium-grained dolerite

c. 2765 Ma [10] Agrl **NERRELY LEUCOGRANITE:** biotite(–tourmaline)-bearing leucogranite; unfoliated

YULE GRANITOID COMPLEX

AgY Granitic rock, undivided; metamorphosed

Age	Unit	Description
c. 2938 Ma [14]	AgYlc	**PILBARA CREEK MONZOGRANITE:** biotite-bearing monzogranite and syenogranite; leucocratic; weakly foliated to massive; metamorphosed
c. 2935 Ma [15]	AgYug	**MUNGARINYA MONZOGRANITE:** biotite-bearing monzogranite and syenogranite; weakly foliated to massive; metamorphosed
c. 3165 Ma [16]	AgYpo	**POWDAR MONZOGRANITE:** biotite-bearing monzogranite and syenogranite; weakly foliated to massive; metamorphosed
	AgYel	**ELLAWARRINA MONZOGRANITE:** biotite-bearing monzogranite; metamorphosed
	AgYya	**YANDEEARRA GRANODIORITE:** biotite-bearing granodiorite, weakly to strongly foliated; metamorphosed
	AgYt	Hornblende–biotite tonalite, undivided; metamorphosed
	AgYmh	Hornblende-bearing monzogranite to granodiorite, undivided; metamorphosed
c. 2945 Ma [15]	AgYmu	**MUNGAROONA GRANODIORITE:** hornblende(–biotite)-bearing granodiorite and monzogranite; greenstone and gneissic rafts and xenoliths; metamorphosed
2937–2933 Ma [15]	AgYch	**CHEEARRA MONZOGRANITE:** monzogranite to granodiorite; massive to strongly foliated and gneissic; metamorphosed
	AgYchn	Monzogranite to granodiorite gneissic granite; metamorphosed
3066–2940 Ma [15]	AgYco	**COCKERAGA LEUCOGRANITE:** leucocratic biotite(–hornblende) tonalite and granodiorite and subordinate monzogranite; well-developed schlieric banding; local abundant greenstone and gneiss xenoliths; metamorphosed

(East Pilbara Granite–Greenstone Terrane)

Age	Unit	Description
2946 Ma [15]	Agd	Diorite; mesocratic to melanocratic; hornblende(–biotite) bearing; weakly foliated to massive
	Agmh	Monzogranite; hornblende(–biotite) bearing
	Agja	**JALLAGNOONINA GRANODIORITE:** tonalite and granodiorite; metamorphosed
c. 2948 Ma [9]	Agpe	**PEAWAH GRANODIORITE:** hornblende–biotite high-Mg diorite, granodiorite, and tonalite; metamorphosed
	Agdm	High-Mg diorite; metamorphosed

(Mallina Basin and East Pilbara Granite–Greenstone Terrane)

Pilbara Supergroup — Unassigned

Age	Unit	Description
	Aod	Metadolerite
	Aog	Metagabbro, medium to coarse grained
	Aoge	Melanogabbro; typically low-Ti tholeiitic; metamorphosed
	Aombs	Fine- to medium-grained actinolite–chlorite(–serpentine–plagioclase) schist; boninitic composition
	AaM	**Millindinna Intrusion:** undivided mafic and ultramafic rocks as layered sills; metamorphosed
2946–2941 Ma [14 15]	Afd	Dacite; locally spherulitic; metamorphosed
	Afdp	Porphyritic dacite; metamorphosed
	Apf	Quartz–feldspar porphyry; metamorphosed

De Grey Group

Age	Unit	Description
	ADm	**MALLINA FORMATION:** interbedded shale, siltstone, and medium- to fine-grained wacke; minor layers of chert; metamorphosed
<2970 Ma [17]	ADc	**CONSTANTINE SANDSTONE:** undivided fine- to coarse-grained clastic rocks; metamorphosed (Section only)
	ADcsh	Laminated shale; locally includes minor beds of poorly sorted subarkose, siltstone, ferruginous siltstone, shale, and iron formation; metamorphosed
	ADcsw	Wacke; locally subarkosic; fine to coarse grained; well-developed graded units; minor pebble beds and shale; turbiditic; metamorphosed
	ADcstf	Poorly sorted subarkose; includes wacke; lesser interbeds of shale; rare graded beds; metamorphosed
	ADcsc	Conglomerate, pebbly sandstone, and coarse-grained lithic sandstone; metamorphosed
	ADcb	Basalt; locally with pyroxene spinifex texture, local hydroclastic breccia; metamorphosed

Bookingarra Group

Age	Unit	Description
c. 2975–2945 Ma [6]	ABe	**LOUDEN VOLCANICS:** undivided basalt, komatiitic basalt, and pyroxene spinifex-textured basalt; interbedded clastic units and chert; metamorphosed
	ABt	**MOUNT NEGRI VOLCANICS:** variolitic and vesicular basalt, undivided; metamorphosed

Unassigned De Grey Group

Unit	Description
AD(sh)	Laminated shale; locally includes siltstone, ferruginous siltstone, shale, and iron formation; includes minor beds of poorly sorted subarkose; metamorphosed
AD(sw)	Wacke; locally subarkosic; fine to coarse grained; well-developed graded units; minor pebble beds and shale; turbiditic; metamorphosed (<2941 Ma)[14]

(Whim Creek and Mallina Basins)

Age	Unit	Description
c. 3000 Ma [7]	AgCm	**CHERRATTA GRANITOID COMPLEX:** syenogranite to granodiorite, locally biotite-rich, foliated; metamorphosed (West Pilbara Granite–Greenstone Terrane)

Gorge Creek Group

Age	Unit	Description
	AGl	**CLEAVERVILLE FORMATION:** banded iron-formation, jaspilite, chert, siltstone, shale, and minor felsic volcaniclastic rock; metamorphosed
< 3016 Ma [6]	AGlfv	Felsic volcaniclastic rock, lithic volcaniclastic sandstone, and siltstone; metamorphosed

(East Pilbara Granite–Greenstone Terrane)

Whundo Group

Age	Unit	Description
c. 3115 Ma [18]	AUb	**BRADLEY BASALT:** pillow basalt, massive basalt, dolerite sills, and minor units of felsic pyroclastic rocks and chert; metamorphosed
c. 3120 Ma [18]	AUt	**TOZER FORMATION:** mafic and felsic lava and pyroclastic units; metamorphosed
c. 3125 Ma [18]	AUn	**NALLANA FORMATION:** basalt, with minor ultramafic, felsic, and sedimentary units; metamorphosed

(West Pilbara Granite–Greenstone Terrane)

Pilbara Supergroup — Unassigned

Unit	Description
As	Sedimentary rock, undivided; metamorphosed
Asb	Mafic volcaniclastic conglomerate, sandstone, and siltstone; metamorphosed
Asc	Conglomerate; metamorphosed
Asq	Quartz–muscovite schist and quartzite
Asqb	Quartz–muscovite schist and quartzite with locally abundant mafic schist and amphibolite
Assq	Fine-grained quartz sandstone and siltstone; minor shale and chert; metamorphosed
Astvf	Felsic volcanic sandstone and volcaniclastic rock; metamorphosed
Acc	Chert; metamorphosed
Ab	Undivided metamorphosed mafic rock
Aba	Amphibolite; fine to medium grained; massive to strongly foliated
Abk	Komatiitic basalt, pyroxene spinifex textured, and olivine basalt; metamorphosed
Abu	Interleaved amphibolite and talc–tremolite–serpentine–chlorite schist
Au	Undivided metamorphosed ultramafic rock
Auk	Serpentine–talc–tremolite rock after komatiite; pseudomorphed olivine spinifex textures
Aup	Metaperidotite; serpentinized
Aur	Tremolite-rich schist; after ultramafic rock
Aus	Serpentinized ultramafic rock
Aux	Metapyroxenite (Section only)

YULE GRANITOID COMPLEX

Age	Unit	Description
c. 3165 Ma [15]	AgYfr	**FLAT ROCKS TONALITE:** biotite-bearing tonalite; strongly foliated; locally interleaved with abundant massive to weakly foliated, K-feldspar porphyritic monzogranite; metamorphosed
c. 3420 Ma [14]	AgYla	**YALLINGARRINTHA TONALITE:** biotite–hornblende-bearing tonalite; moderately to strongly foliated; metamorphosed

(East Pilbara Granite–Greenstone Terrane; PILBARA CRATON)

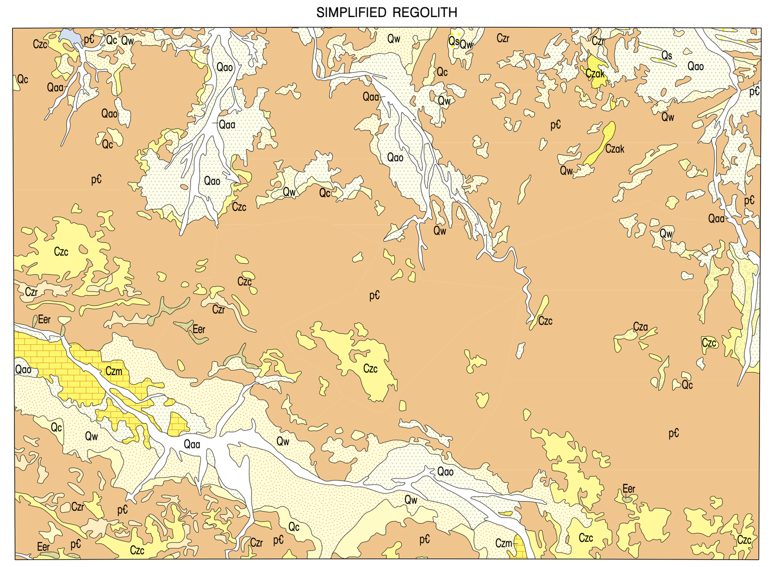
Symbol	
Geological boundary	exposed; concealed
Fault	exposed; concealed; concealed, interpreted from aeromagnetic data; relative displacement
Fold, showing axial trace and generalized plunge direction	anticline; exposed, concealed; syncline; exposed, concealed; overturned anticline; exposed, concealed; overturned syncline; exposed, concealed; antiform; exposed, concealed
Bedding, showing strike and dip	inclined; vertical; horizontal; overturned; strike and dip estimated from aerial photography 5–15°, 15–45°; trend of bedding
Igneous layering, showing strike and dip	inclined
Igneous flow banding, showing strike and dip	inclined
Igneous contact, showing strike and dip	inclined
Way-up indicator	pillow structure; graded bedding; cross-bedding
Metamorphic foliation, showing strike and dip	inclined; vertical
Cleavage, showing strike and dip	inclined; vertical
Crenulation cleavage, showing strike and dip	inclined
Mineral lineation, showing trend and plunge	inclined
Bedding–cleavage intersection lineation, showing trend and plunge	inclined
Airphoto lineament	unspecified
Stromatolite fossil locality	
Isotopic age determination site with identification number	141977
Road, unsealed	
Track	
Railway, with siding	
Powerline	
Landing ground	
Homestead	Pyramid
Locality	Cumberabbera
Aboriginal community	Yandeyarra
Building	
Yard	Yard (abd)
Bridge	
Microwave repeater station	
National park boundary	
Reserve boundary	
Horizontal control; major	
Levee	
Watercourse with ephemeral pool or waterhole and dam	
Pool	P
Waterhole	WH
Waterfall	Waterfall
Spring	Spring
Pipeline	pipeline
Bore, well	Bore, Well
Water exploration bore, showing subsurface data	MILS 12A Czm
Water exploration or monitoring bore	MILS 22B
Windpump	
Dam, tank	Dam, Tank
Abandoned; position doubtful	(abd) (PD)
Mining centre	PILBARA
Mine, abandoned mine, or deposit (names are filtered for clarity)	Empress
Mineral exploration drillhole showing subsurface data	Asq

Bore names

Abbreviated map prefix	Full prefix shown in WIN database
CLR	Cape Lambert Railway
CP	Cooya Pooya
DR	Deep Reach
MILS	Millstream
SAT	Satirist
WLM	Weelumurra

SIMPLIFIED REGOLITH

Qaa	Alluvium in channels
Qao	Floodplain deposits
Qw	Sheetwash deposits
Qc	Colluvium
Qs	Eolian sand
Cza	Alluvium
Czak	Alluvial calcrete
Czc	Consolidated colluvium
Czr	Residual deposits; mainly ferricrete
Czm	Millstream Formation
Eer	Robe Pisolite
p€	Precambrian rock outcrop



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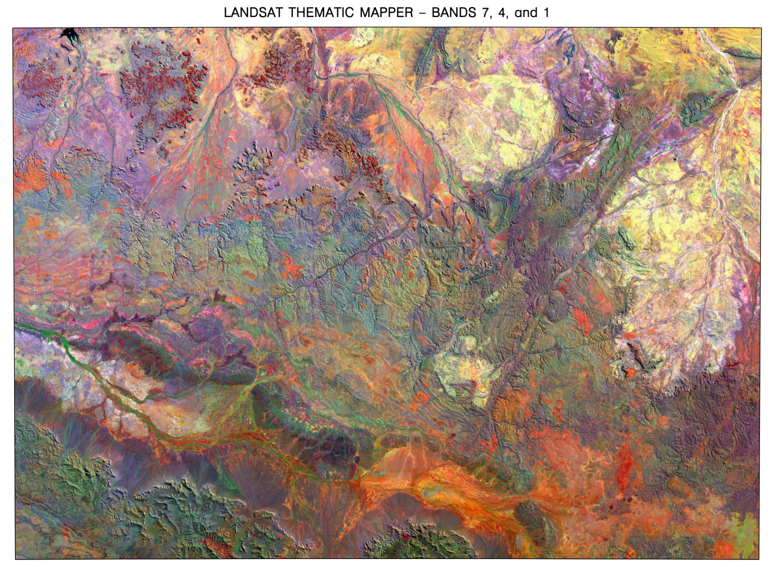
LANDSAT THEMATIC MAPPER – BANDS 7, 4, and 1



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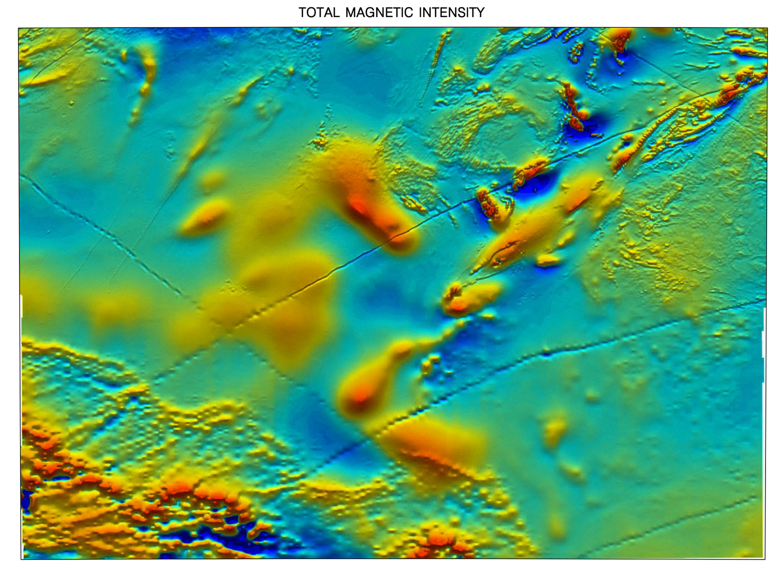
TOTAL MAGNETIC INTENSITY



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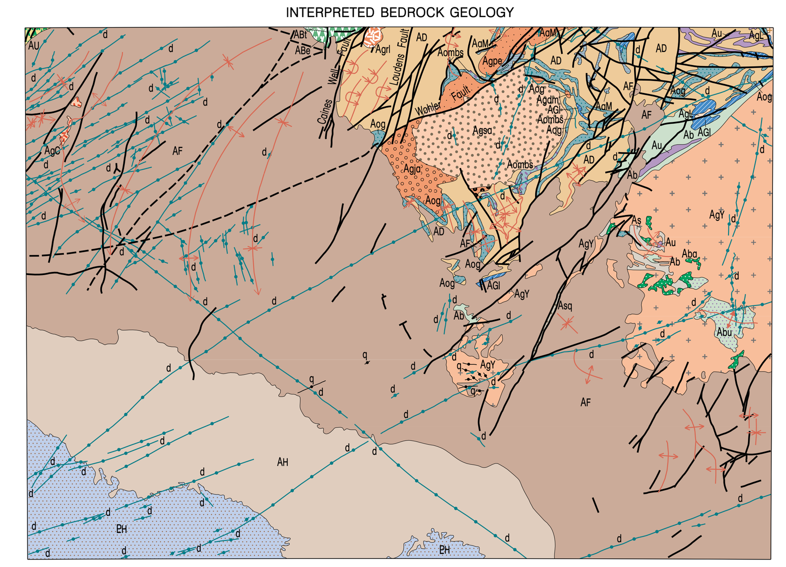
INTERPRETED BEDROCK GEOLOGY



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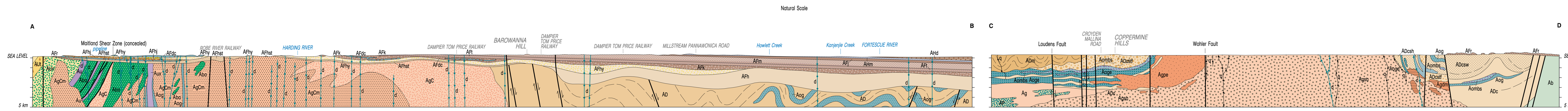
d	Dolerite
PH	Upper Hamersley Group
AH	Lower Hamersley Group
AF	Fortescue Group
Agrl	Nerrely Leucogranite
Agsa	Satirist Granite
AgY	Yule Granitoid Complex
AgL	Carlindie Granitoid Complex
Agja	Jallagnoonina Granodiorite
Agpe	Peawah Granodiorite
Agdm	High-Mg diorite
Aog	Gabbro
Aombs	Actinolite–chlorite schist; boninitic composition
AaM	Millindinna Intrusion
AD	De Grey Group
ABe	Louden Volcanics
ABt	Mount Negri Volcanics
AgC	Cherratta Granitoid Complex
AGl	Gorge Creek Group Cleaverville Formation
AU	Whundo Group
As	Interleaved quartz–muscovite schist, quartzite, amphibolite, and tonalite
Ab	Metabasalt
Aba	Amphibolite
Abu	Metamorphosed mafic to ultramafic rock
Au	Metamorphosed ultramafic rock

Fault — Fold axes — For further details, refer to main reference

DIAGRAMMATIC SECTIONS

Natural Scale



Ag Granitic rock, unassigned — AP Pilbara Supergroup unassigned

DATA DIRECTORY

Theme	Data Source	Data Currency	Agency
Geology	GSWA	2002	Dept of Industry and Resources
Structural data	WAROX	AUG 2003	Dept of Industry and Resources
Mineral occurrences	WAMIN	AUG 2003	Dept of Industry and Resources
LANDSAT	Remote sensing services	NOV 2001	Dept of Land Information
Total Magnetic Intensity	GSWA	OCT 2003	Dept of Industry and Resources
Topographic nomenclature	GEONOMA	2002	Dept of Land Information
Topography	DLI and GSWA field survey	2002	Dept of Land Information
Exploratory water bores	Water Information system (WIN)	OCT 2003	Dept of Environmental Protection

Exploratory water bore and drillhole data from field observations, scientific publications, non-confidential statutory reports, and the AQWA (WRC) database:
W. A. Davidson, 1969, GSWA Record 1969/3.
J. C. Barnett, 1981, GSWA Annual Report, p. 35–42.
CRA Exploration Pty Ltd, 1985, GSWA Statutory mineral exploration report, Item 3189 A16464 (unpublished).
J. C. Barnett and D. P. Commander, 1986, GSWA Record 1986/8.

MINERAL OCCURRENCES

MINERALIZATION STYLES
- Orthomagmatic, mafic, and ultramafic mineralization
- Pegmatite, skarn, greisen, and porphyry mineralization
- Vein and hydrothermal mineralization
- Stratabound sedimentary mineralization
- Mineralization in the regolith

MINERAL AND ROCK COMMODITY GROUPS
- Precious mineral
- Precious metal
- Steel industry metal
- Base metal
- Iron
- Energy mineral
- Industrial mineral

MINERAL AND ROCK COMMODITIES

Commodity is gold unless otherwise indicated on the map

Antimony	Sb
Asbestos-riebeckite (crocidolite)	Asbr
Asbestos-chrysotile	Asbs
Beryl	Brl
Copper	Cu
Corundum	Cor
Iron	Fe
Lead	Pb
Nickel	Ni
Platinum group elements	PGE
Tin (cassiterite)	Sn
Tungsten	W
Uranium	U

Mineral occurrences are from the GSWA WAMIN database.

Compiled by R. H. Smithies and A. H. Hickman 2002
Geology by R. H. Smithies 1996–2002, A. H. Hickman 1999–2002, and T. R. Farrell 1999

Geochronology by:
(1) M. E. Barley et al., 1997, Nature, no. 385, p. 55–58.
(2) D. R. Nelson et al., 1999, Precambrian Research, v. 97, p. 165–189.
(3) A. L. Pickard, 2002, Australian Journal of Earth Sciences, v. 49, p. 491–507.
(4) A. F. Trendall et al., 1998, Australian Journal of Earth Sciences, v. 45, p. 137–142.
(5) N. T. Arndt et al., 1991, Australian Journal of Earth Sciences, v. 38, p. 261–281.
(6) D. R. Nelson, 1998, GSWA Record 1998/2, p. 52–55, 59–65, 133–135.
(7) D. R. Nelson, 2001, GSWA Record 2001/2, p. 167–177.
(8) T. S. Blake, 2001, Precambrian Research, v. 107, p. 139–177.
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(10) R. T. Pidgeon, 1984, Australian Journal of Earth Sciences, v. 31, p. 237–242.
(11) D. R. Nelson, in prep. GSWA Record 2004/2.
(12) J. R. Richards et al., 1997, Mineralium Deposita, v. 16, p. 7–30.
(13) M. T. D. Wingate, 1999, Australian Journal of Earth Sciences, v. 46, p. 493–500.
(14) D. R. Nelson, 1999, GSWA Record 1999/2, p. 97–107, 144–150.
(15) D. R. Nelson, 2000, GSWA Record 2000/2, p. 78–92, 101–112, 203–206.
(16) D. R. Nelson, 2003, GSWA Record, 2002/2, p. 144–150.
(18) D. R. Nelson, 1996, GSWA Record, 1996/5, p. 156–159.
Interpreted geochronology by:
(17) R. H. Smithies et al., 2001, Sedimentary Geology, p. 141–142, 79–94.

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Web www.doir.wa.gov.au Email geological.survey@doir.wa.gov.au
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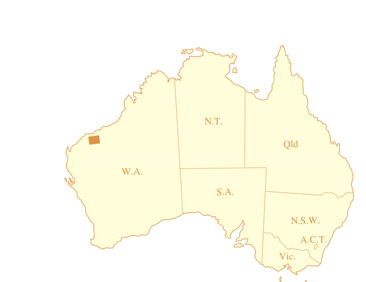
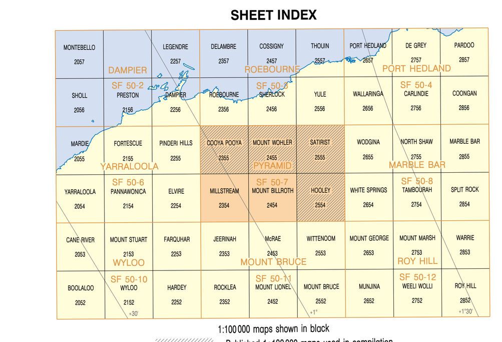
SMITHIES, R. H., and HICKMAN, A. H., 2004, Pyramid, W.A. Sheet SF 50-7: Western Australia Geological Survey, 1:250 000 Geological Series.



SHEET INDEX



1:100 000 maps shown in black
Published 1:100 000 maps used in compilation
1:250 000 maps shown in brown
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The lines indicate magnetic declination, 1995
+ means declination is east and correction must be added to compass bearing to give true bearing
- means declination is west and correction must be subtracted from compass bearing to give true bearing
Annual change is 2' easterly

Department of Industry and Resources — Geological Survey of Western Australia
CLIVE BROWN, M.L.A. MINISTER FOR STATE DEVELOPMENT
JIM LIMERICK DIRECTOR GENERAL
TIM GRIFFIN DIRECTOR
NGA
PRODUCT OF THE NATIONAL GEOSCIENCE AGREEMENT

SCALE 1:250 000

5000 0 5 10 15 20 25 — Metres / Kilometres

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

Grid lines indicate 20 000 metre interval of the Map Grid Australia Zone 50

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

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

PYRAMID

SHEET SF 50-7

SECOND EDITION 2004

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