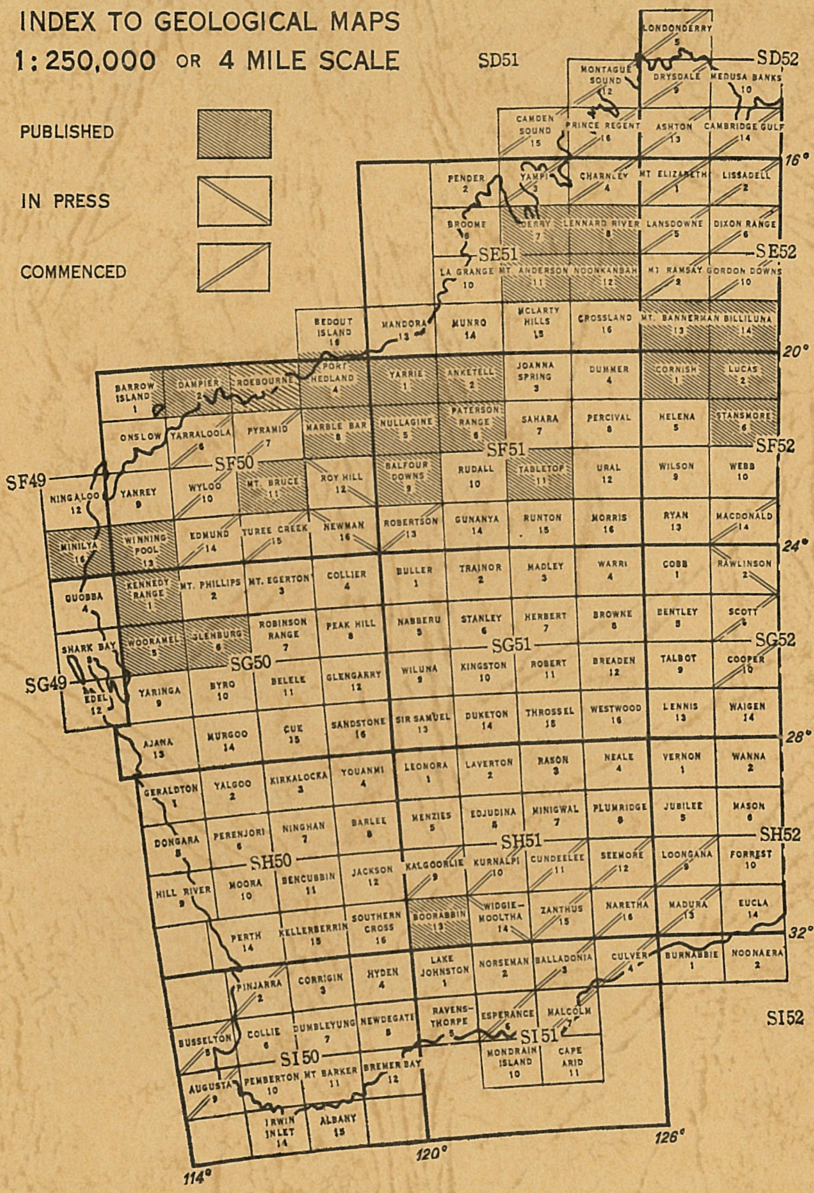
1 : 250,000
GEOLOGICAL SERIES

EXPLANATORY NOTES

PYRAMID
WESTERN AUSTRALIA

Sheet SF/50–7

WESTERN AUSTRALIA
INDEX TO GEOLOGICAL MAPS
1:250,000 OR 4 MILE SCALE



GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

1 : 250,000 GEOLOGICAL SERIES

EXPLANATORY NOTES

PYRAMID
WESTERN AUSTRALIA

Sheet SF/50-7

Compiled by M. Kriewaldt and G. R. Ryan

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1967

DEPARTMENT OF MINES, WESTERN AUSTRALIA

Minister: THE HON. A. F. GRIFFITH, M.L.C.

Under Secretary: I. R. BERRY

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

Director: J. H. LORD

Explanatory Notes on the Pyramid Geological Sheet

Compiled by M. Kriewaldt and G. R. Ryan

The Pyramid 1:250,000 Sheet (SF/50-7) takes its name from a conspicuous conical hill which is known as The Pyramid, King's Pyramid, Pyramid of Captain King, or simply Pyramid. This hill was named after Lieutenant King, R.N., who surveyed the coast of Australia between 1818 and 1822.

Fifteen miles north of the Sheet area is the small town of Roebourne with its port at Point Samson. The mining town of Wittenoom Gorge is 17 miles south of the area and there is a good road from Wittenoom Gorge to Roebourne. There are tracks around the sheep stations and to the mining centres, although the tracks to the Nunyerry mine are poor.

Splendid scenery at Mt. Herbert (the 'Big Hill') and in the Hamersley Range, and springs and pools at Millstream, are important tourist attractions.

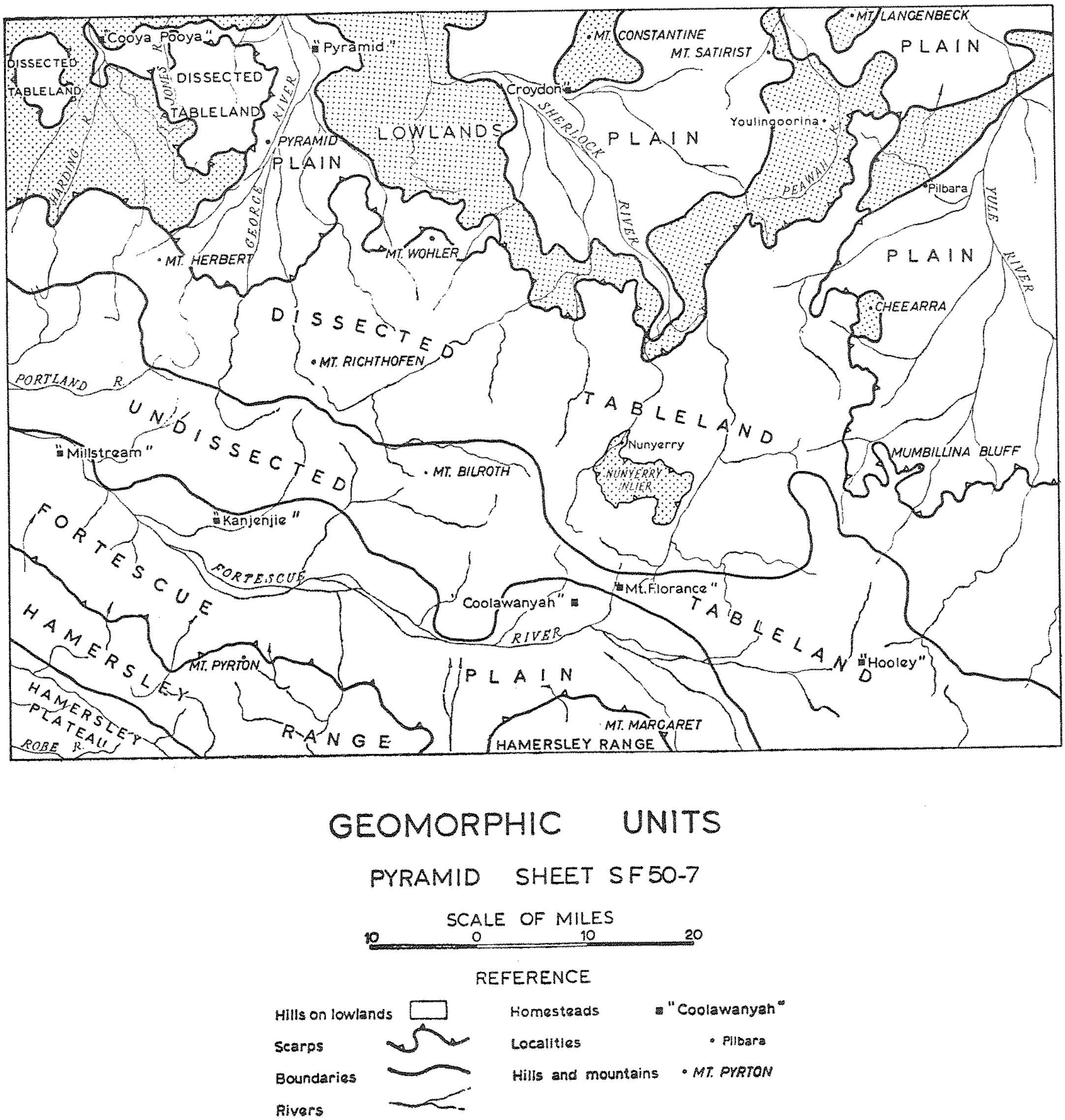
It was not until 1888 that economic minerals were found in the area. Following the discovery of gold and antimony at Mallina and Peawah (just north of the Pyramid area), the alluvial gold fields at Egina and Pilbara were opened up, and in November 1888, the first large nugget found in Western Australia was picked up in Friendly Creek at Pilbara. It weighed 127 ounces. Further finds of reef and alluvial gold and other minerals were made before the turn of the century, and subsequently copper, reef gold, stream tin, and chrysotile have been produced. In 1966 there was no mining in the area although iron deposits and crocidolite in the Hamersley Range, and chrysotile at Nunyerry, were being investigated.

PHYSIOGRAPHY

The main land forms in the area are the Hamersley Range, the broad plain of the Fortescue River, a tableland, and the lowlands of plains and hills north of the escarpment of the tableland (see Figure 1).

The drainage is mainly to the north, although the Fortescue River and tributaries of the Robe River flow to the west. The rivers are usually dry and run only after heavy rains; they have many permanent waterholes charged

Figure 1

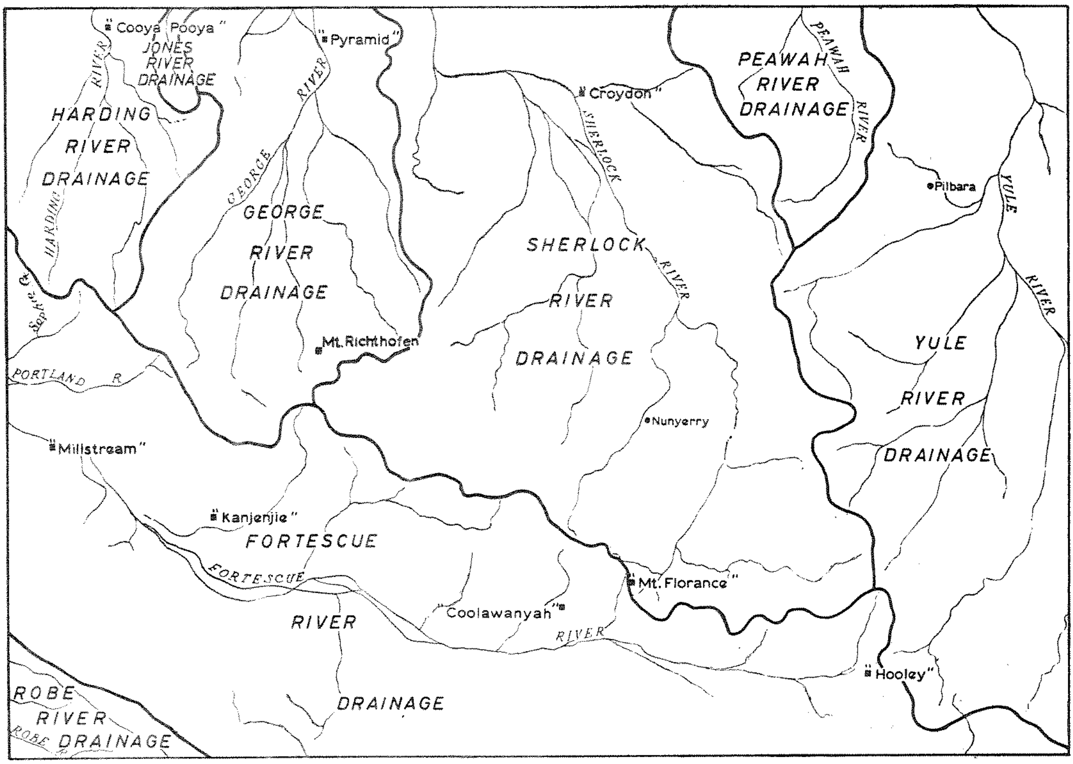


by subsurface flow which continues throughout the year. The catchment areas are shown in Figure 2. Rainfall is erratic, with an average annual total of about 12 inches.

GEOLOGICAL INVESTIGATIONS

These notes and accompanying map are based largely on a geological survey of the area in 1963 by G. R. Ryan and M. Kriewaldt. Petrological and palaeontological examinations were made by A. F. Trendall and H. S.

Figure 2



DRAINAGE CATCHMENTS

PYRAMID SHEET SF 50-7

SCALE OF MILES

10 0 10 20

REFERENCE

Drainage catchment divides	
Catchments	SHERLOCK
Rivers	
Homesteads	"Kanjenjie"
Localities	Pilbara

Edgell respectively. Mineral determinations and assays were made at the Government Chemical Laboratories.

Earlier geological investigations commenced with F. T. Gregory in 1862, and an inspection by H. P. Woodward in 1888. The area was traversed by A. G. Maitland and H. W. B. Talbot in 1905 and then mapped in 1909 by H. P. Woodward. The mining centres of the area were inspected by the Aerial, Geological and Geophysical Survey of Northern Australia, during the period from 1937 to 1939.

STRATIGRAPHIC NOMENCLATURE

Previously named stratigraphic units which are used in these notes are listed in Table 1, along with a key to the source of the name.

Stratigraphic units which are used in a sense differing from the original are Kylena Basalt, Maddina Basalt, and Weeli Wolli Formation.

New names, introduced in Appendix I, are Cooya Pooya Dolerite and Pillingini Tuff.

TABLE 1

PREVIOUSLY NAMED STRATIGRAPHIC UNITS

Stratigraphic Unit	Reference
Boolgeeda Iron Formation	MacLeod and others (1963)
Boongal Pillow Lava Member	de la Hunty (1965)
Brockman Iron Formation	MacLeod and others (1963)
Bunjinah Pillow Lava Member (of Mt. Jope Volcanics)	de la Hunty (1965)
Cleaverville Formation	Ryan and Kriewaldt (1964)
Cliff Springs Formation	Williams (in press)
"Duricrust"	Woolnough (1927)
Fortescue Group	MacLeod and others (1963); Kriewaldt (1964)
Gorge Creek Formation	Noldart and Wyatt (1962)
Hamersley Group	MacLeod and others (1963)
Hardey Sandstone..	MacLeod and others (1963)
Jeerinah Formation	MacLeod and others (1963)
Kuruna Siltstone Member (of Mt. Jope Volcanics)	MacLeod and de la Hunty (1966)
Kylena Basalt Member (of Mt. Jope Volcanics)	MacLeod and de la Hunty (1966)
Lyre Creek Agglomerate Member (of Cliff Springs Formation)	Williams (in press)
Maddina Basalt Member (of Mt. Jope Volcanics)	MacLeod and de la Hunty (1966)
Marra Mamba Iron Formation	MacLeod and others (1963)
Mt. Bruce Supergroup	Halligan and Daniels (1964)
Mt. Jope Basalt	MacLeod and others (1963)
Mt. Jope Volcanics	de la Hunty (1965)
Mt. McRae Shale	MacLeod and others (1963)
Mt. Roe Basalt	Kriewaldt (1964)
Mt. Sylvia Formation	MacLeod and others (1963)
Nullagine Series	Maitland (1908)
Nymerina Basalt Member (of Mt. Jope Volcanics)	MacLeod and de la Hunty (1966)

TABLE 1—*continued*

Stratigraphic Unit	Reference
Pilbara System	Noldart and Wyatt (1962); Ryan (1964)
Poondana Formation	McWhae and others (1958) quoting Lindner and Drew (unpublished)
Pyradie Pyroclastic Member (of Mt. Jope Volcanics)	de la Hunty (1965)
Regal Formation	Ryan and Kriewaldt (1964)
Robe Pisolite	de la Hunty (1965)
Roebourne Group	Ryan (1964)
Roy Hill Shale Member (of Jeerinah Formation)	MacLeod and de la Hunty (1966)
Tumbiana Pisolite	Noldart and Wyatt (1962)
Tumbiana Pisolite Member (of Mt. Jope Volcanics)	MacLeod and de la Hunty (1966)
Warrawoona Succession	Noldart and Wyatt (1962)
Warrie Member (of Jeerinah Formation) ..	MacLeod and de la Hunty (1966)
Weeli Wolli Formation	MacLeod and others (1963)
Wittenoom Dolomite	MacLeod and others (1963)
Woodiana Sandstone Member (of Jeerinah Formation)	MacLeod and de la Hunty (1966)
Woongarra Dacite	MacLeod and others (1963)
Woongarra Volcanics	de la Hunty (1965)

ARCHAEAN

LITHOLOGY

Archaean rocks are exposed in the northeastern part of the Pyramid Sheet area from Croydon to Pilbara and south to Mumbillina Bluff; and also in small inliers at Nunyerry and southwest of Cooya Pooya homestead. They include metamorphosed shale, greywacke, and chert with acid igneous rocks; basic and ultrabasic rocks; granite; and dolerite dykes. Cleaved shale and greywacke predominate in the layered succession which is at least 40,000 feet thick, and has been named the Roebourne Group (Ryan, 1964). The bottom is not known. For descriptive purposes the Pilbara System has been divided into seventeen units which are shown on the map and briefly described in Table 2, with the following supplementary detail:

1. Preconsolidation structures, which are common in the sedimentary rocks of the succession, have been described by Ryan (1965). They include chert boudins and false pebbles, chert breccias, and clastic dykes.

2. No pillow lavas were seen in the basic volcanic rocks, although such structures are common in the succession in adjoining Sheet areas.

3. The ultramafic rock bodies include olivine pyroxenite, olivine hornblendite ('cortlandite'), serpentinized rocks, rocks with chrysotile seams, and rocks rich with magnetite. Smaller bodies of ultramafic rock which occur within the basic volcanic rocks are not shown on the Sheet.

4. A rock curiosity from west of Friendly Creek, on the track from Pilbara to Hong Kong, is considered to have been an acid lava. It is a white, 'cherty' rock with tubular vesicles or pipe amygdales. (Compare with Shrock, 1948, p. 352-356).

5. In many parts of the succession there are small concordant bodies of porphyry that have not been shown on the Sheet.

6. The amphibolites which are shown at three levels in the 'Reference' on the map are considered to have been sills of gabbro.

7. Detrital feldspars in greywacke in the succession are similar to those in the associated porphyries (Trendall, 1964).

8. The succession has been metamorphosed, mostly within the greenschist facies. Locally there are mineral assemblages indicative of the amphibolite facies and of the granulite facies. Many of the basic lavas have been carbonatized and silicified.

9. Granitic rocks of two types intrude the succession. The most common type is deficient in dark minerals, and, although mostly massive, it is commonly gneissic at its margins. This type include a porphyritic granite that has large phenocrysts of potash feldspar. The second type is darker and contains basic xenoliths. It has a high proportion of plagioclase and ranges petrographically from granite to tonalite. The relationship between the two types is not known, but they could well be closely related as the first type also has tonalitic variants, and contains large enclaves of basic schist at Nunyerry and at Pilbara.

10. Small pegmatites, which are not shown on the Sheet, intrude the granite. Also not shown on the Sheet are the many small quartz blows which intrude all parts of the succession. Several dolerite dykes intrude granite to the north of the Mungaroona Range.

Table 2

PILBARA SYSTEM: SUMMARY DESCRIPTION OF ROCK UNITS

Rock Unit	Thickness (feet)	Map Symbol	Lithology	Field Relationships	Land Forms	Economic Geology	Remarks
Dolerite	—	Ad	Altered dolerite	Narrow, discontinuous dykes. Intrusive into granite. Not known to intrude Fortescue Group	Dykes in zig-zag pattern		Correlated with dykes in Yarraloola, Nullagine, and Marble Bar Sheet areas
Melanocratic granite ..	—	Agh	Massive, medium-grained, equigranular, melanocratic, hornblende granite; and tonalite; with basic xenoliths	Intrudes Roebourne Group	Bold bare monoliths projecting through eluvial and alluvial plains		
Porphyritic granite ..	—	Agp	Medium-grained to coarse-grained leucocratic granite with potash-feldspar phenocrysts	Intrudes Roebourne Group. Intimately associated with non-porphyritic granite	Monoliths and low outcrop		
Granite, gneiss ..	—	Ag	Medium-grained, equigranular, leucocratic granite, with granitic gneiss	Massive bodies surrounded by rocks of Roebourne Group with marginal gneisses and metamorphic rocks	Large areas of low outcrop partly covered with eluvium. Some bold outcrops	Beryl-bearing pegmatites near Mumbillina Bluff are intruded into this granite	Possibly includes basement to Roebourne Group
Metamorphic rocks ..	Variable	Am	Metamorphic rocks of various grades: (*a*) banded and schistose, grey to green, generally soft rocks, (*b*) amphibole schist, (*c*) massive, gneissic and granulitic rocks	The schists are marginal to granite		Auriferous quartz reefs at Pilbara are in schists near granite	
Quartzite, shale, chert and jaspilite	3,000	Aw	Quartzite, shale, chert and jaspilite with thin intercalations of amphibolite. Some of the cherts are brecciated	Highest unit known in sequence. Conformable on underlying units. Possibly intruded by granite	Bold flat-topped range cut through by Yule River	Auriferous quartz at Womerina is in rocks immediately beneath this unit	Correlated with Gorge Creek Formation and Cleaverville Formation
Basic volcanic rocks ..	10,000	Ae Ah	Altered grey, green and black basic lavas (Ae) locally with variolitic texture. Intercalations of acid volcanic rocks. Small concordant bodies of porphyry. Includes a marker of blue and white banded chert (Ah) with altered dolomitic rocks	Top contact conformable. Includes Regal Formation at Cooya Pooya and Coonanarrina Pool. Interfingers laterally with shale			The marker chert is not the same bed as in the Dampier and Roebourne Sheet areas
Granular siliceous rocks	500	Ab	Orange-weathering, green, aphanitic and granular siliceous rock with spheroidal bodies; associated porphyry	Part of conformable sequence. Lenses out into shale		The Egina copper mine is in this rock and adjacent slates	Correlated with similar rock at Mt. Brown in Roebourne Sheet area
Slate	Up to 30,000	Ar	Cleaved shale and siltstone with subordinate greywacke; some jaspilite, ferruginous and siliceous shale and chert; small concordant bodies of porphyry	Conformable on underlying unit. Interfingers with higher units. Contains large concordant bodies of course-grained amphibolite which are probably sills (Aa)	Mainly low hills	The coarse-grained amphibolite at Station Peak contains auriferous quartz reefs	Auto-intrusion and auto-brecciation in shale
Ultramafic rocks ..	1,000	Al	Amphibole-serpentine-magnetite rock. Also, graded quartz greywacke and shales, chert, associated porphyry	The ultramafic rock bodies are possibly sills intruded penecontemporaneously during sedimentation	Ridges		Load casts, cross bedding and graded bedding in greywacke
Greywacke and shale ..		Ars	Cleaved quartz greywacke and shale, locally metasomatised; with concordant body of altered basic rock (Aa)	Conformably overlain by cleaved shale. Lowest unit known in area. Locally metamorphosed to schist and intruded by granite		Croydon (Evelyn) copper mine is in this unit. Also auriferous quartz reef at Croydon Top Camp	

AGE, CORRELATION, AND NOMENCLATURE

The rocks described in this section are considered to be part of the Pilbara System, and to be Archaean. The layered succession is part of the Roebourne Group (Ryan, 1964). Nomenclature and correlations are discussed by Ryan (1964; 1965), and by Ryan and Kriewaldt (1964). Suggested correlations are given in Table 2.

Age determinations from rocks of the Pilbara System are discussed by Leggo and others (1965) and a maximum age of 3,040 million years is suggested for the granite 1 mile northeast of Moorambinar Pool.

STRUCTURE

Points of interest in the structural interpretation of Figure 3 are:

1. The anticline at Mt. Constantine. This fold, clearly outlined by steeply dipping beds, has a large lefthand drag on the east limb plunging 40° to the north.

2. The spectacular folding of the bodies of coarse-grained amphibolite: for instance, near the Sisters, at Station Peak, and near Powereena Pool.

3. The structures outlined by the horizon passing through Mt. Satirist, Mt. Langenbeck, Millindinna, and northeast from Millindinna.

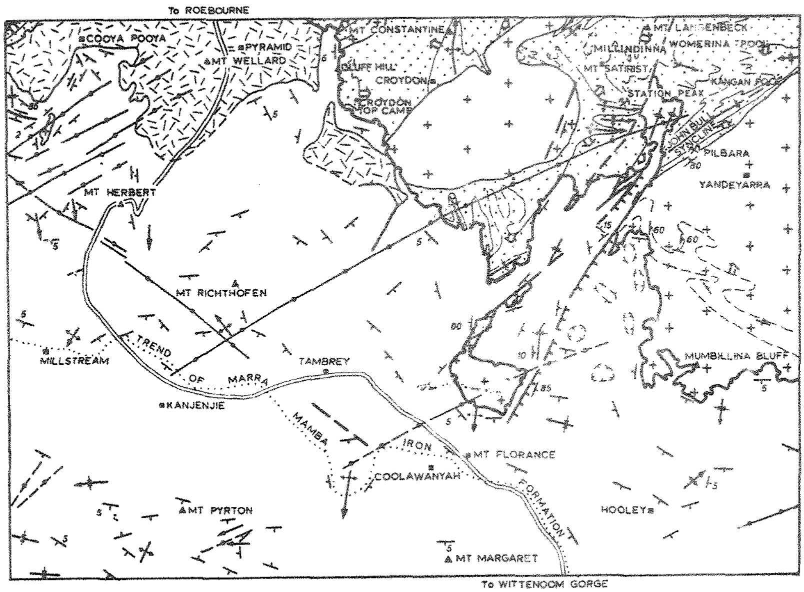
4. The syncline to the north of Pilbara—the John Bull Syncline. The northwest limb of this syncline has about 30,000 feet of section, whereas only the top 10,000 feet of the sequence is readily recognizable in the southeast limb, the lower part being occupied by metamorphic and igneous rocks. The ultramafic rocks and high-grade metamorphic rocks near Cheearra are thought to be part of the southeast limb.

5. There is no outcrop along the interpreted western closure of the structure between Womerina Pool and Kangan Pool.

6. The east-facing limb at Croydon Top Camp. This is interpreted as being the east limb of a north-plunging anticline, the concealed western limb passing through Bluff Hill.

7. Several faults through granite are recognized as Archaean although they are not distinguished from younger faults on Figure 3.

Figure 3



STRUCTURAL SKETCH MAP
PYRAMID SHEET SF50-7

SCALE OF MILES
10 0 10 20 30

REFERENCE

- Cooya Pooya Dolerite
- Mt Bruce Supergroup
- Granite, gneiss, metamorphic rocks.
- Roebourne Group
- Dolerite dyke
- *Unconformity*
- Fault, downthrow block indicated.
- Fault, inferred
- Geological boundary
- " " ,inferred
- Dip and strike of strata
- Syncline
- Anticline
- Dome
- Basin
- Structure lines
- " " ,inferred.
- Facing
- Dip and strike of foliation
- Vertical foliation
- Plunge of folds
- Major road
- Homestead, mining centre, trig.

TABLE 4

FORTESCUE AND HAMERSLEY GROUPS: SUMMARY DESCRIPTION OF ROCK UNITS

Rock Unit	Thickness (feet)	Map Symbol	Lithology	Relationship to Underlying Unit	Physiographic Expression	Photo-pattern	Economic Geology	Remarks
Poolgeeda Iron Formation	50	Pho	Flaggy jaspilite, siltstone and shale	Conformable; contact disturbed by preconsolidation movement	Low broken hills		Hematite bodies south of Sheet area	Small outliers
Woongarra Volcanics ..	500–1,000	Phw	Green to dark-coloured porphyritic and aphanitic dacite and rhyolite lavas with pyroclastic rocks	Conformable; extrusive contact	Low gentle slopes with tors and rubble	Light-toned, massive		Dated at 2,100 m.y. (Leggo and others 1965). Petrology described by Trendall (1963)
Weeli Wolli Formation ..	500–1,000	Phj	Jaspilite and shale	Conformable; little change in lithology	Subdued cuestas	Grey-toned, ridge-forming		Distinguished from Brockman Iron Formation by dolerite sill and position immediately beneath Woongarra Volcanics
Brockman Iron Formation	2,000	Phb	Thinly bedded jaspilite, chert and shale, with beds of black shale, yellow dolomitic shale and dolomite	Conformable	Prominent rounded hills and cliffs	Dark grey-toned, massive, scarp-forming	Hematite bodies and crocidolite seams (mainly in lower part)	Forms Hamersley Range
Mt. McRae Shale ..	250–350	Phr	Pale-coloured fissile shale and dolomitic shale with beds of dark chert, yellow and blue dolomite and dolomite breccia	Conformable	Concave slopes with poor outcrop, broken by benches and cliffs of chert and dolomite	White-toned, cliff-forming		Contains iron-oxide nodules after pyrite. Thickens to east
Mt. Sylvia Formation ..	370	Phs	Pale-coloured fissile shale and dolomitic shale, with beds of jaspilite and dolomite	Conformable	Concave slopes with poor outcrops; prominent bench formed by uppermost jaspilite (Bruno's Band)	White-toned, cliff-forming		Contains iron-oxide nodules after pyrite
Wittenoom Dolomite ..	500+	Phd	Grey crystalline calcitic dolomite, with thin beds of chert and dolomitic shale in the upper part	Conformable	Very little outcrop. Upper part is exposed at foot of Hamersley Scarp in places	White-toned, and bedded	Possible aquifer	Underlies Fortescue Plain
Marra Mamba Iron Formation	20–50	Phm	Ferruginous chert with prominent pinch and swell structure; jaspilite and ferruginous shale	Conformable	Low cuestas and hills covered with ferruginous gravel	Dark-toned, massive, scarp forming	Hematite bodies and crocidolite seams in other areas but none known within Pyramid Sheet area	Roebourne–Wittenoom road follows this formation for over 50 miles

Rock Unit	Thickness (feet)	Map Symbol	Lithology	Relationship to Underlying Unit	Physiographic Expression	Photo-pattern	Economic Geology	Remarks
Jeerinah Formation: Roy Hill Shale Member	100	Pfjo	Fissile, pale-coloured and variegated shale with dolomitic shale in places. Carbonaceous and pyritic where unweathered. Iron-oxide nodules at surface	Conformable	Poor outcrop, gentle valleys with gravel slopes	White-toned, soft, valley-forming		White eucalypts abundant in valleys
Warrie Member ..	200	Pfjw	Laminated chert, fine-grained quartzite, shale and subordinate jaspilite. Pyrite cubes. Iron-oxide nodules at surface	Conformable	Low cuestas and rises with narrow valleys	Grey-toned with white, scarp-forming, bedded		Relief north of Millstream is greater than elsewhere
Woodiana Sandstone Member	50	Pfjd	Silicified mudstone, shale, siltstone, chert, fine-grained quartzite and tuff. Basal grit in places	May be disconformable, probably interdigitated with top of underlying unit	Cuestas, low scarps, and low mesas, capped by siliceous rocks	Grey-toned, massive, scarp-forming		Basal grit of irregular thickness overlies and probably interdigitates with agglomerate at top of underlying formation
Maddina Basalt (upgraded from member)	2,000	Pfm	Altered, amygdaloidal, scoriaceous and massive, basic and intermediate lavas with thin intercalations of tuffaceous siltstone and siliceous mudstone in upper part. Pillow lava at base locally	Generally conformable, but lowermost flows have caused some disturbance of underlying sedimentary rocks. May be interdigitated	Very rough undulating plain of low relief with clay and boulder deposits. Gorges and rough, terraced hills where dissected. Siliceous mudstone intercalations form mesas and scarps	Grey-toned, massive, dissected	Abundant agates. (Small gold and copper deposits in Yarraloola and Mt. Bruce Sheet areas.) Good aquifer	Plains are treeless
Pillingini Tuff (new name)	200–400	Pfp	Bedded tuff with volcanic pisoliths; shale, siltstone and sandstone beds. Small intercalations of lava. Diagenetic calcite common. Locally cross bedded and ripple marked	Conformable	Prominent scarp with cliffs and terraces	Grey-toned, massive, scarp-forming	Possible aquifer	Dolomite beds at Mt. Herbert and elsewhere contain *Collenia* sp. aff. *C. multiflabella*
Kylena Basalt (upgraded from member)	0–700	Pfk	Altered, massive amygdaloidal, and columnar jointed basic and intermediate lavas; locally porphyritic	Conformable	Prominent scarp with cliffs and terraces	Grey-toned, massive, scarp-forming	Possible aquifer	Lavas are carbonated in places and contain pods of carbonate with pyrite. Absent between George River and Pillingini Creek
Cliff Springs Formation ..	0–500	Pfc	Acid tuff, tuffaceous shale, sandstone and greywacke; conglomerate; with agglomerate at top	Conformable on Mt. Roe Basalt; strongly unconformable on Pilbara System	Where bedded, forms terraced hills, cuestas and low mesas	Light-toned, bedded	Sandy beds are possible aquifers	Thickest in the vicinity of the Cooya Pooya Dolerite near Cooya Pooya homestead
Lyre Creek Agglomerate Member	0–300	Pfcl	Bedded to massive agglomerate and tuff, with bombs; indurated in part; with sandstone	Conformable on lower part of Cliff Springs Formation	Irregular low-lying terrain with tors; concave slopes with poor outcrop below cliffs of Kylena Basalt and Cooya Pooya Dolerite	Light-toned, massive (locally bedded)		At top of Cliff Springs Formation
Mt. Roe Basalt ..	0–1,000	Pfr	Altered amygdaloidal, vesicular columnar and massive basic lavas; with distinctive porphyritic flows; and basal sandstone	Strongly unconformable	Dissected uplands; locally terraced with cliffs	Light grey-toned to dark grey-toned, massive, rough textured, scarp-forming		Impersistent, best developed between Nunyerry, Pilbara and Station Peak

UNCONFORMITY

PROTEROZOIC

The Proterozoic succession is outlined in Table 3, and the formations are briefly described in Table 4. This succession is part of the Mt. Bruce Supergroup which includes the Fortescue Group and the overlying Hamersley Group.

TABLE 3

OUTLINE OF PROTEROZOIC SUCCESSION

(Youngest unit on top)

Lithology	Thickness (feet)
4. Acid lavas with banded iron formation at top	1,000
3. Banded iron formation with shale and some dolomite	2,000
2. Shale with banded iron formation near top and bottom and dolomite in middle ..	1,500
1. Flood basalts with pyroclastic and clastic beds in lower part	3,000 to 4,000

FORTESCUE GROUP

The Fortescue Group is dominated by flood basalts. Subordinate to the basalt are beds of pyroclastic and other clastic rocks in the lower part of the group, and non-clastic rocks and fine-grained detrital rocks at the top. The volcanic sequence is commonly up to 4,000 feet thick, and the overlying non-volcanic part of the group is about 350 feet thick. The group lies unconformably on rocks of the Pilbara System with an estimated 2,500 feet of overlap. The top of the group is defined by MacLeod and others (1963) as being at the base of the overlying Marra Mamba Iron Formation. In the Pyramid Sheet area the upper part of the group (the Jeerinah Formation) has more affinities with the overlying Hamersley Group than with the underlying volcanic sequence.

HAMERSLEY GROUP

The Hamersely Group is an evenly stratified succession of banded iron formation, chert, shale, and dolomite, with acid lavas and tuff near the top. The group is characterized by iron formations, and by the extreme persistence of some of the beds. An example of this persistence is a jaspilite bed (18 feet thick) which is recognizable for well over 100 miles. The usefulness of this bed as a marker was first recognized by Dr. B. Campana in 1961, and since that time the bed has been known informally as Bruno's Band.

INTRUSIVES

Dolerite has intruded both the Hamersley Group and the Fortescue Group. One intrusive body in the Fortescue Group is described and given the name Cooya Pooya Dolerite; another sill in the Hamersley Group is described but not named, and a suite of dykes is described also.

Cooya Pooya Dolerite (see Appendix for definition)

Mesas and hills of strikingly black-weathering, tabular, stratified Cooya Pooya Dolerite occupy large tracts of country in the northwest of the Sheet area, but the original shape of the dolerite bodies is not known. The dolerite is intruded into the Cliff Springs Formation, commonly at or near the contact with the overlying Kylena Basalt.

It contains indurated blocks of sandstone and lava, but no definite top contacts have been seen. Small granophyre segregations are present within the dolerite. Also, there is a larger body of granophyre east of Mt. Herbert. At Mt. Wohler, benched mesas of black-weathering dolerite contain isolated amygdales, and the rocks may be extrusive. Although the mapping is inconclusive, the Cooya Pooya Dolerite is considered to consist of a body occupying a feeder neck near Cooya Pooya homestead, a sill intruded into the Cliff Springs Formation, and extrusive lavas near Mt. Wohler.

The Pyramid is capped by a basal remnant of a flat-lying part of the Cooya Pooya Dolerite.

Unnamed dolerite

A sill of altered dolerite lies within the Weeli Wolli Formation. It is broadly concordant, with intrusive contacts, and is displaced by small faults, which were probably contemporaneous with the intrusion.

Dykes

Dolerite dykes occupy vertical and nearly vertical fractures through the Fortescue Group. The fractures are continuous for up to 70 miles. Outcrop is generally poor along these fractures, and it is not known whether the dykes are continuous along the entire length of the fractures. The dominant strike is northeast, although one long dyke strikes northwest.

The age of these dykes is uncertain. They have intruded the Cooya Pooya Dolerite, and outside the Sheet area similar dykes have intruded rocks considered to be Upper Proterozoic. However, no dolerite dykes have been seen in formations above the Marra Mamba Iron Formation within the Sheet area, although there is a very small outcrop of severely weathered dolerite at the foot of the Hamersley Range east of Caliwingina Creek.

AGE, CORRELATION, AND NOMENCLATURE

The sequence of rocks described here under the heading Proterozoic were included (Maitland, 1909; Woodward, 1911) within a large rock unit called the Nullagine Series (Maitland, 1908, 1909) which became generally accepted as a provincial time-rock name for the Upper Proterozoic in Western Australia (David, 1932). However, mapping over the past four years, palaeontological work by H. S. Edgell, and age determinations made at the Australian National University, make placement of the sequence in the Upper Proterozoic unacceptable. (For further information and discussion see Daniels and MacLeod, 1965; Edgell, 1964; MacLeod and others, 1963; Sofoulis, 1962.)

The age of the Fortescue and Hamersley Groups is now considered to be Early Proterozoic, and the rocks to be part of the corresponding Lower Proterozoic time-rock unit (Geological Survey of Western Australia, 1965).

Correlations with units on adjacent Sheet areas are shown in Table 5, which can be compared with Table 2 of Kriewaldt (1964). MacLeod and de la Hunty (1966) have recognized a sequence of five members in the Mt. Jope Volcanics in the Roy Hill Sheet area as against the three members in the Mt. Bruce Sheet area described by de la Hunty (1965), and they remark that correlation of the members is difficult.

TABLE 5

FORTESCUE GROUP: CORRELATIONS

Roy Hill Sheet Area	Pyramid Sheet Area	Mt. Bruce Sheet Area
JEERINAH FORMATION Roy Hill Shale Member Warrie Member Woodiana Sandstone Member	JEERINAH FORMATION Roy Hill Shale Member Warrie Member Woodiana Sandstone Member	JEERINAH FORMATION
MT. JOPE VOLCANICS Maddina Basalt Member	MADDINA BASALT	MT. JOPE VOLCANICS Bunjinah Pillow Lava Member
Kuruna Siltstone Member Nymerina Basalt Member Tumbiana Pisolite Member	PILLINGINI TUFF	Pyradie Pyroclastic Member
Kylena Basalt Member	KYLENA BASALT	Boongal Pillow Lava Member
	CLIFF SPRINGS FORMATION Lyre Creek Agglomerate Member	HARDEY SANDSTONE
	MT. ROE BASALT	

Two members of the Mt. Jope Volcanics in the Roy Hill Sheet area, the Kylena Basalt Member and the Maddina Basalt Member, are continuous with rock units in the Pyramid Sheet area where it is convenient to consider the units as formations rather than as members. They are accordingly upgraded with the names Kylena Basalt and Maddina Basalt, and the Mt. Jope Volcanics is not used as a map unit in the Pyramid Sheet area.

STRUCTURE

The succession dips gently to the south-southwest. The regionally dipping beds form the north limb of a very large syncline with its axis in the Hamersley Plateau to the south. The folding is named Ophthalmian by Halligan and Daniels (1964) and is distinguished by them from their Rocklean folding which has axes trending to the north-northeast. An example of the effect of Rocklean folding in the area is the dome to the west of Coolawanyah homestead. Another example is the anticline north of Mt. Florance homestead.

The simple overall dip is also upset by faulting; the most spectacular instance being the overturned beds on the east side of the normal fault to the east of the Nunyerry inlier. Also, a basinal structure between Nunyerry, Station Peak, and Pilbara with dips generally low, has very steep dips near Hong Kong because of faulting.

Arcuate faults and fold axes outline an arc southwest of Cooya Pooya homestead. They are considered to be related to the intrusion of the Cooya Pooya Dolerite through a fissure or vent centred with respect to the arc, which is continuous into the Yarraloola Sheet area.

The youngest structures are faults of great length and persistence but with very small displacements. They are more in the nature of large joints. Nearly all of them are filled with dilation dykes. The largest throw recorded on these youngest faults (south from Nunyerry) is about 100 feet.

Basal beds in the Cliff Springs Formation have initial and compaction dips up to 5°.

DESCRIPTION OF ROCK UNITS

Mt. Roe Basalt

The bottom unit of the Fortescue Group is the Mt. Roe Basalt of altered basaltic lavas with basal lenses of arkose and tuffaceous sandstone. Some of the lavas are porphyritic. The lavas are considered to be related to contemporaneous subsidence along rejuvenated Archaean faults. Moreover, the thickness of the formation is related to folds in the Archaean rocks, being thicker over synclines and thinner over domes. For instance the formation is well developed between Nunyerry, Pilbara, and Station Peak where it unconformably overlies an Archaean syncline and it is absent over granite at Croydon and East of Nunyerry. The eastern limit appears to be related to the fault which strikes northeastward from the southeast corner of the inlier at Nunyerry to north of Pilbara.

Cliff Springs Formation

Overlying the Mt. Roe Basalt and overlapping onto the basement is the Cliff Springs Formation which is predominantly a pyroclastic unit, although conglomerate and sandstone, with ripple marks and current bedding, are common in the lower part. The conglomerate has pebbles and cobbles of granite, quartz, banded chert, and siltstone. The sandstone is silicified and is eroded to low mesas and cuestas, whereas the pyroclastic rocks are readily eroded to valleys and low-lying terrain.

The upper part of the formation is a massive agglomerate with lava bombs and interbeds of well-bedded tuff. Some of the massive agglomerate is crudely stratified and characteristically exfoliates into flattish pillow-shaped outcrops. In places (for instance, south of Cooya Pooya homestead) the rock type is an indurated massive crystalline breccia with grains of translucent quartz and scattered volcanic pisoliths. This upper pryoclastic unit is named the *Lyre Creek Agglomerate Member*.

The Cliff Springs Formation is thickest in the west near the Cooya Pooya Dolerite, and may be related to a focus of eruption now occupied by that dolerite. It thins to the east, and is absent east of Mumbillina Bluff. Its outcrop is at the foot of the escarpment of the tableland (see Fig. 1), and it is largely covered by scree from the overlying basalts. The formation is equated broadly with the Hardey Sandstone.

Kylena Basalt

Conformably overlying the Cliff Springs Formation in the west and resting unconformably on basement in the east is a variable thickness of lava flows, the Kylena Basalt. The flows have the typical form of flood basalt; a massive base, an amygdaloidal upper part, and a vesicular and scoriaceous top. Agates are common in amygdales in the lavas. Some flows have crude columnar jointing, and are locally porphyritic. Thin beds of tuffaceous siltstone are intercalated between some of the flows. The formation has lensed out and is missing between Mt. Herbert and Pillingini Creek; and because of transgressive overlap onto the basement, it is thin in the east.

The edge of the tableland and the tableland scarp are mostly in this formation.

Pillingini Tuff (see Appendix I)

The Pillingini Tuff conformably overlies the Kylena Basalt, although it overlaps onto the Cliff Springs Formation at Mt. Montagu where the Kylena Basalt is missing. It is about 300 feet thick throughout the Sheet area and is a very useful marker bed having a most characteristic airphoto pattern. The unit includes shale, siltstone, and sandstone. It is characterized by well-bedded tuffs with volcanic pisoliths. Although conspicuous, the pisoliths are not predominant. Diagenetic calcite is common. Trendall (1965) describes the pisoliths and discusses their origin and in particular compares and contrasts them with the accretionary lapilli of Moore and Peck (1961). A crude grading upwards from large to small pisoliths has been noted in some beds. A fossil comparable to *Collenia multiflabella* has been recognized by Edgell (1964) in a specimen from the Pillingini Tuff west of Mt. Herbert. The associated rock is not tuffaceous (J. Daniels, pers. comm.). Current bedding and ripple marks in sandstone at Mt. Herbert indicate a current from the north to northwest.

Lavas are shown on the Sheet as being within the Pillingini Tuff near Hooley homestead. Accepting these lavas as intercalated lenses within the Pillingini Tuff, they can be correlated broadly with Nymerina Basalt Member of the Mt. Jope Volcanics on the Roy Hill Sheet area.

The Pillingini Tuff is considered to be possibly equivalent to the Tumbiana Pisolite of the Nullagine Sheet area.

Maddina Basalt

The final phase of basaltic lava extrusion in the area is represented by the Maddina Basalt. The lavas, which are estimated to be about 2,000 feet thick, are similar to those lower in the Fortescue Group. Amygdales up to 2 feet across are present and some contain agate, calcite, epidote, chlorite, iron oxides, and quartz. There are also vugs with quartz crystals. Scoriaceous tops are common. Thin beds of tuffaceous siltstone separate some of the flows, and near the top there are very thin lenses of chert or silicified mudstone. The lavas are typical flood basalts, but in the headwaters of Pillingini Creek the lowermost flow is a pillow lava, suggesting subaqueous eruption at first. A thin bed of agglomerate lies on the uppermost flow merging with a thin impersistent bed of grit at the base of the overlying formation.

Jeerinah Formation

The Jeerinah Formation overlies the Maddina Basalt. It consists of interbedded clastic and non-clastic rocks, with some pyroclastic detritus towards the base and an impersistent basal grit. The thick concordant dolerite bodies of the type area are missing, and the Jeerinah Formation in the Pyramid Sheet area is as little as 350 feet thick. Iron-oxide balls are common throughout weathered outcrops of the formation and it is probable that most of the white-weathering shale of the formation is carbonaceous and pyritic at depth, as black carbonaceous shale with iron sulphide balls has been struck in several wells.

Three members are recognized in the formation. At the base is the *Woodiana Sandstone Member*. In outcrop this member has a hard quartzitic and cherty appearance, due to silicification of the fine-grained detrital rocks. A silty grit is present locally at the base and tuff is present in places. It caps many of the flat-topped hills on the north side of the Fortescue Plain, and is about 50 feet thick.

A white-weathering shale forms the lowest part of the overlying *Warrie Member*. Banded chert and jaspilite, mudstone, and a green quartzite are interbedded with similar shale in the upper part of the member. Pyrite cubes and pseudomorphs after pyrite are present in some of the chert beds. Black shale with pyrite balls in the spoil of Wilkerson Well (lat. 21° 39′ S. long. 117° 26′ E) which was first recorded by Maitland (1909), comes from the Warrie Member.

The uppermost member, the *Roy Hill Shale Member*, is a white-weathering carbonaceous pyritic shale about 100 feet thick, which is dolomitic in places. It weathers into broad valleys with little outcrop. Iron-oxide balls are plentiful on the surface.

Marra Mamba Iron Formation

In the Pyramid Sheet area the Marra Mamba Iron Formation has strong affinities with the underlying Jeerinah Formation. It is about 50 feet thick as compared with 600 feet in the type area. Besides shale and jaspilite, it contains ferruginous cherts with pinch-and-swell structures similar to those in the type area. The ferruginous cherts and jaspilites crop out as low mesas and hills covered with ferruginous gravel. Carbonaceous shale with pyrite nodules from Bloom Well on Coolawanyah Station (lat. 21° 52′ S, long. 117° 39′ E) has come from beds apparently overlying the ferruginous cherts. If this is so, the shale can be considered to be an upper part of the Marra Mamba Iron Formation. Everywhere in the Sheet area the contact with the overlying Wittenoom Dolomite is obscured by Quaternary deposits of the Fortescue Plain.

Wittenoom Dolomite

The upper part of the Wittenoom Dolomite is well exposed along the scarp of the Hamersley Range, but the lower part is covered. The beds consist of thin-bedded dolomite, shale, and chert. The proportion of shale beds increases towards the top of the unit. Preconsolidation movement has caused many intraformational folds and brecciation in some of the dolomite, for instance near Mt. Margaret. The thickness of the unit is thought to be about 500 feet (as in the type area) but it cannot be measured as the bottom is obscured.

Mt. Sylvia Formation

Overlying the Wittenoom Dolomite are beds of shale and dolomitic shale with thin beds of dolomite and three conspicuous jaspilites. The uppermost jaspilite, Bruno's Band, marks the top of the Mt. Sylvia Formation. The bottom of the formation in the type area is at the base of the lowermost of the three prominent jaspilites.

The thickness in the type area is 110 feet, but near Mt. Pyrton and near Mt. Margaret there is a prominent jaspilite stratigraphically about 370 feet below Bruno's Band. If this is the bottom jaspilite of the formation, then the formation is about 370 feet thick in the Pyramid Sheet area. However, as an increase in thickness from 110 feet to 370 feet is abnormal for units in the Hamersley Group, it appears that there is no conspicuous bottom marker in this area and that the prominent jaspilite is in fact within the Wittenoom Dolomite and not at the boundary between the Mt. Sylvia Formation and the Wittenoom Dolomite. Partly for this reason, the boundary shown on the Sheet between these two formations is not accurately placed.

Hematite balls, presumably after pyrite, were seen in shales of the Mt. Sylvia Formation. Arranged concentrically about some of the nodules are Liesegang rings of iron oxide. Together with the shale the nodules and rings weather out as discus-shaped bodies. Quite probably the shale when unweathered is carbonaceous and pyritic like shales from the Jeerinah Formation. Very fine specks of what appeared to be pyrite were seen in banded cherts from Bruno's Band. These cherts have also many small triangular and rectangular pits which may be after either pyrite or magnetite.

Mt. McRae Shale

Above Bruno's Band, along the northern scarp of the Hamersley Range, there are steep scree-covered slopes eroded into the Mt. McRae Shale. This formation, is mainly poorly-outcropping, fissile, light-coloured shale. It has bench-forming beds of brown and blue dolomite in the middle part, and of dark-coloured chert in the lower. The upper part consists of interbedded chert, jaspilite, and shale. There are fewer dolomite beds in the formation in the west near Mt. Flora than in the east near Mt. Margaret. Also there is a decrease in thickness from an estimated 350 feet near Mt. Margaret to 250 feet near Mt. Flora. The thicknesses are difficult to measure as the top of the formation is nearly everywhere covered with talus from the overlying Brockman Iron Formation. The dolomite beds are best developed in the vicinity of Mt. Margaret. Here, at one locality, there are two beds, each about 5 feet thick, of dolomite breccia with a few fragments of chert. The average size of the breccia fragments is about 1 inch. At the top of the beds there is a sharp gradation, over a few inches, upwards to unbrecciated dolomite. Like those in the Wittenoom Dolomite, these breccias are considered to have been formed by preconsolidation movement. It is suspected that the shale may be carbonaceous where unweathered because of the similarity in outcrop with shale lower in the succession which is known to be carbonaceous at depth.

Brockman Iron Formation

The dominant formation of the Hamersley Group, both stratigraphically and topographically, is the Brockman Iron Formation. The top of the Hamersley Range and many of its spectacular scarps are eroded into this formation which is about 2,000 feet thick (about one third of the thickness of the group). Jaspilites alternate with units of shale and dolomite in the lower part of the formation. A prominent shale unit about 150 feet thick separates this lower part from an upper sequence in which the alternation of shale and jaspilite units is not so distinct.

The units of shale and dolomite have a characteristic succession which is, from top (5) to bottom (1):

5. laminated chert
4. black, blocky-weathering shale
3. fissile dolomitic shale
2. dolomite
1. laminated chert with coarse crystals of carbonate.

However, the complete succession is not present in each unit and may be reversed or partly repeated in different units. Nevertheless, in each particular unit they are, like Bruno's Band, remarkably constant.

The jaspilites form cliffs, with benches at their tops eroded into the less resistant beds of shale and dolomite. Microscopically, the jaspilites have fine laminae of magnetite, chert, carbonate, hematite and stilpnomelane. There are also needles of riebeckite associated with magnetite. Descriptions of the petrology of the Brockman Iron Formation have been given by Trendall (1965). Massive riebeckite with seams of crocidolite is present in the lower part of the formation.

Weeli Wolli Formation

South of Mt. Ulric there is a sill of dolerite in a succession of shale, siltstone, and jaspilite. The presence of stratiform bodies of dolerites in this stratigraphic position was used by MacLeod and others (1963) to define a map unit, the Weeli Wooli Formation. This name is applied to this part of the sedimentary succession in the Pyramid Sheet area, but the sill is not included as part of the formation.

Woongarra Volcanics

In the Pyramid Sheet area the Woongarra Volcanics (previously called Woongarra Dacite) is up to 1,000 feet thick and consists of extrusive dacite and rhyolite with intercalations of acid tuff. These acid volcanic rocks are overlain by isolated cappings of flaggy iron formation up to 100 feet thick. The contact is broadly concordant, although in places it is very disturbed, with fragments of iron formation lying in the acid rock and short tongues of acid rock cutting the iron formation. This intrusive contact is thought to be due to the disturbance of the iron formation and underlying waterlain tuff before consolidation, and not due to igneous intrusion.

Boolgeeda Iron Formation

The cappings of iron formation overlying the Woongarra Volcanics have been mapped as part of the Boolgeeda Iron Formation which has large areas of outcrop south and west of the Sheet area. However, they might lie within the Woongarra Volcanics, as elsewhere this formation is known to contain intercalated jaspilites.

CAINOZOIC

The Cainozoic rock units shown on the Sheet are outlined in Table 6 and described in more detail in Table 7.

The oldest of the deposits (unit 1 of Table 6) are considered to be Tertiary. Units 2, 3 and 4 are assigned to the Pleistocene although the oldest of these (unit 2) could be Tertiary; and units 5 and 6 are taken as Recent.

TABLE 6

CAINOZOIC SUCCESSION

(Youngest unit on top)

6. Alluvium (unconsolidated fluviatile deposits)
5. Colluvium (slope deposits), eolian sand, flood deposits
4. Eluvium (slope deposits, pediment), residual and alluvial deposits (gravel, sandy clay, clay)
3. Alluvium (pebble and cobble deposits)
2. Kunkar and porcelanite, greybilly, kunkar
1. Duricrust, ferruginous pisolite, "colluvium"

A datum for the Cainozoic is provided by the widespread duricrust, a thoroughly indurated crust on an old gently undulating surface. The surface of the crust is in lateral contact with the top of deposits of ferruginous pisolite and of canga (ferruginuous conglomerate), and also in places with the surface of overlying valley-fill deposits (colluvium) shown as map unit 'Czc'. These deposits are restricted largely to the Hamersley Range although there are outliers of duricrust at Mt. Herbert, south of Cooya Pooya, and near Station Peak, and there are small remnants of pisolite in many places. The origin of the pisolite has been discussed by MacLeod and others (1963), Campana and others (1964), and Harms and Morgan (1964).

Two types of kunkar deposits are depicted on the Sheet; incrustations formed on Precambrian rocks, and sheets formed within alluvium and exposed by erosion.

Possibly the kunkar deposits shown on the Sheet were part of a soil profile, subsequently eroded. (For similar instances see Firman, 1964). Other deposits of kunkar that occur in water courses draining calcareous rocks and as sheets within alluvial and residual deposits are not shown. Such kunkar deposits are forming at present by deposition from groundwater rich in calcium and bicarbonate ions.

The greybilly near Powdar Creek is considered to have been formed either by the subsequent thorough silicification of a laterite profile which had been eroded to the pallid zone, or by silicification at the base of the pallid zone during deep weathering (compare with Wright, 1963).

The kunkar with porcelanite at Millstream is thought to rest on the Wittenoom Dolomite, although there is no direct evidence for this. This deposit is continuous to the west on to the Yarraloola Sheet area where valley-fill deposits underlie kunkar with porcelanite (Williams, in press). Similar deposits have been recognized on the adjoining Roy Hill and Mt. Bruce Sheet areas (Talbot, 1920 p. 98, 99; de la Hunty, 1965; MacLeod and de la Hunty, 1966), and these were in part correlated with the Oakover Formation which is a distinctive unit reviewed by Noldart and Wyatt (1962, p. 70, 71). Typically, it is a limestone capped with porcelanite. Similar deposits are described and discussed by Sofoulis and Mabbutt (1963) and also by Mabbutt (1963). It was concluded that the deposits '. . . have been formed since an early stage in the new plateau cycle . . .', that is, that they are younger than the formation of laterite, an opinion provisionally held by Noldart and Wyatt also. It should be noted, however, that the surface cap of the Oakover Formation in the type area may well have been formed some time after the original deposition of the limestone beds, making the rock unit a composite formed at two separate times, and in effect, two formations. Consequently an unqualified correlation of the whole Oakover Formation with the deposits at Millstream, or with any of the kunkar deposits of the Pyramid area is not favoured.

Alluvial deposits of pebbles and cobbles of quartzite and other rocks overlie the kunkar deposits in many places.

Residual and alluvial deposits, which cover large areas and make up the bulk of the Quaternary deposits, rest on a surface younger than the kunkar. They are eroded, as are also the next youngest deposits (unit 5 of Table 6). The youngest deposits shown on the Sheet are confined to present river channels.

GEOMORPHOLOGY

GEOMORPHIC UNITS

The area has been divided into five broad geomorphic units which are shown in Figure 1. The units are described as follows:

Hamersley Range and Hamersley Plateau

The Hamersley Range in the southern part of the Sheet area is formed by dissection of the Hamersley Plateau. It has a notable scarp eroded through resistant duricrust and banded iron formation into weaker shale and dolomite. The scarp is considered to be purely an erosional feature. This is pointed out particularly because it is a widely held opinion that the Hamersley Scarp is related to a fault. The idea goes back to Jutson (1914, p. 121-122) who suggested that the scarp might be a 'fault scarp'.

TABLE 7

CAINOZOIC: SUMMARY DESCRIPTION OF ROCK UNITS

Rock Unit	Thickness (feet)	Map Symbol	Lithology	Field Relationship	Land Forms	Economic Geology	Remarks
Alluvium	0–10	Qr	Unconsolidated fluviatile deposits, mostly sands	Deposits in channels	Dry river beds	Sands for concrete	
Colluvium	0–50	Qg	Unconsolidated to loosely consolidated slope deposits; clay to boulder. Calcareous and ferruginous cements in older parts of unit	Piedmont deposits dissected by present erosion. Base not commonly exposed. Grades upwards into younger deposits not shown on map	Piedmont slopes, fans	Intake areas for underground water	For instance at base of the Pyramid there is a scree of dolerite although there is now practically no dolerite at the top of the Pyramid
Eolian sand	0–30	Qa	Red loamy sand in drifts and fixed seif dunes	Overlies deposits of Yule Surface. In part younger than some of the flood deposits	Fixed sand drifts piled up on the east side of hills. Fixed seif dunes aligned longitudinally. Migration direction was westwards		Loosely consolidated; fixed with vegetation
Flood deposits ..	0–10	Ql	Unconsolidated fluviatile and sheet-flood deposits; loam silt and sand; pebbles near source	Area of outcrop similar to present drainage pattern. Overlies deposits of Yule Surface. Base exposed in creek banks. Dissected	Levees, flood plains and terraces	Aggregate for concrete from coarse material	Many areas of this unit are not shown
Eluvium	0–20	Qpt	Residual, loosely consolidated angular to sub-rounded shale and ironstone fragments; some weak ferruginous cement	Overlies bedrock. Overlain by younger colluvium	(*a*) Surface deposits on gentle dip slopes (*b*) Piedmont deposits and pediment	This deposit, where above the Marra Mamba Iron Formation, is used for road metal. Contains eluvial gold at Egina	Part of deposits of Yule Surface. Similar to younger colluvium but older
Eluvium	0–50	Qpx	Residual deposits of boulders and cobbles in clay	Overlies parent rock—principally gently dipping basalt	Bare stone fields of rock waste. Clay plain with gilgais in swelling clays; rock mantle		Part of deposits of Yule Surface
Eluvium	0–5	Qpr	Residual sand and clay with quartz, feldspar and mica grains. Abundant quartz strew locally	Overlies granite and granulitic rocks	Pediment		Part of deposits of Yule Surface. There are many small outcrops of granite in the area shown as this unit
Alluvium	0–10	Qpg	Unconsolidated gravel and pebble deposits	Merges with other deposits of Yule Surface	Clay plain with gilgais		
Residual and alluvial sandy clay	0–20	Qps	Red sandy clay and loam with sand veneer	Part of deposits of Yule Surface	Pediment		Surface sand reworked into unit Qa
Residual and alluvial clay	0–50	Qpl	Clay and loam with glazed gravel veneer in places. Some sheet kunkar	Overlain by and merges with younger deposits	Pediment. Gilgais common		Part of deposits of Yule Surface

TABLE 7—(*continued*)

Rock Unit	Thickness (feet)	Map Symbol	Lithology	Field Relationship	Land Forms	Economic Geology	Remarks
Alluvial pebbles and cobbles	0–5	Qb	Poorly consolidated pebble and cobble deposits of quartzite and other rocks	Overlies Precambrian rocks and kunkar deposits. Not known to be overlain by younger deposits. Part of deposits of Peawah Surface	Low mesas and dissected plains		Some of the cobbles come from conglomerates in the Cliff Springs Formation. Good tracks
Kunkar with porcelanite	0–10	Qkp	Impure earth limestone with sheets, veins and cavity fillings of white porcelanite	Probably overlies Wittenoom Dolomite at Millstream	Low mesas	Aquifer at Millstream	Some porcelanite has dendrites (oxides of iron and manganese) with iridescence
Kunkar	0–30	Qk	Kunkar—an impure earthy limestone; with some secondary porcelanite	Sheets on and within alluvial deposits and on Precambrian rocks. Locally overlain by unit Qb	Plains and low mesas	Aquifer on Coolawanyah Station	Part of deposits of Peawah Surface
Greybilly	10–20	Qi	Greybilly—a porcelanite	Capping on kaolinized and fresh granite. Part of deposits of Peawah Surface	Small mesas		Isolated occurrences
Colluvium	0–100	Czc	Consolidated ferruginous valley-fill, including hematite-rich conglomerate (canga); some kunkar and siliceous incrustations	Valley-fill, unconformable on Precambrian. Grades laterally to pisolite and to duricrust. Overlain by younger alluvia of same materials (these younger deposits are not shown)		Canga contains iron ore	Part of Hamersley Surface. Probably a good aquifer
Pisolite	0–50	Tp	Pisolitic limonite, goethite and hematite deposits with fossil wood fragments	Unconformable on Precambrian. Grades laterally (in places) to less ferruginized valley-fill detritus. Overlain by fill in Hamersley Range	Low mesas	Elsewhere contains iron ore. No commercial bodies known in Pyramid Sheet area	Correlated with Poondano Formation and Robe Pisolite. Part of Hamersley Surface
Duricrust	0–20	Td	Indurated crust on Precambrian rocks	Forms a prominent, much-dissected, remnant surface			Part of Hamersley Surface

The Hamersley Plateau is a name suggested (Jutson, 1950, p. 60) for that part of the 'Great Plateau of Western Australia' in the Hamersley area. A very small part of this plateau is present in the Sheet area, where it is mainly the top surface of valley-fill deposits with some areas of duricrust and also acid volcanic rocks.

Fortescue Plain

The Fortescue Plain is a broad plain flanked on the south by the scarp of the Hamersley Range, and to the north by low hills. It is drained by the Fortescue River which is fed by numerous small creeks draining from the north and by outwash floods from the Hamersley Range. The plain is not in a rift valley as suggested by Jutson (1914, p. 121; 1950, p. 60-66, 151-2, 157-8) and Talbot (1920, Plates 2 and 13).

Tableland

Gently-dipping basalts and bedded tuffs form a tableland about 1,000 feet above sea level, with a deeply embayed erosion scarp to the north. The southern part includes low hills of sandstone and shale overlying basalt. This tableland is part of the Northern Plateau of Talbot (1920, p. 47) or the Nullagine Plateau of Jutson (1950, p. 64). It is now known as the Tableland (or colloquially as the Tablelands), and the Tableland Shire and the Tableland Statistical District take their names from it.

Dissected Tableland

The northern part of the tableland is dissected by headwaters of several rivers.

Lowlands

Hills and plains form lowlands at the foot of the tableland. The plains include those with eluvium over granitic rocks, and alluvial plains of several rivers.

LAND SURFACES

Surfaces of erosion and deposition are briefly described in Table 8. The oldest of these is the Hamersley Surface named by Campana and others (1964, p. 19-22) and previously recognized by Jutson (1914, p. 76-77, 91, 93). Three surfaces thought to be younger than the Hamersley Surface are here named the Yule, Peawah, and Millstream. The Peawah Surface is considered to be contemporaneous with the Millstream Surface; they are possibly Pleistocene. The Yule Surface is younger than the Peawah Surface and is almost certainly Pleistocene. Overlying the Yule Surface are younger deposits considered to be Recent. These are dissected by present drainage.

TABLE 8

LAND SURFACES

Cycle of Erosion and Deposition	Land Surfaces and Land Forms	Dominant Process	Map Symbol of Associated Rock Units
Present ..	Present drainage	*Fluviatile*	Qr
Recent ..	1. Old drainage terrace 2. Drift sands and sand dunes 3. Piedmont slopes and fans	Fluviatile Eolian Alluvial	Ql Qs, Qa Included in Qg
Pleistocene	*Yule Surface* 1. Loam plains, ± sand or gravel veneers, ± kunkar below surface 2. Surface of deposits on low dip slopes 3. Planed surface on granitic and metamorphic rocks 4. Plains with loam on weathered basalt. Rock-waste fields and gilgais	 Alluvium with soil profile Colluvial Planation Eluvial	 Qpl, Qpg, Qps Qpt Qpr Qpx
?Pleistocene	*Peawah Surface* 1. Low mesas above Yule Surface 2. Low mesas above Yule Surface 3. Small mesas above Yule Surface *Millstream Surface* 1. Dissected plain 2. Little-dissected plain	 Alluvial Eluvial Eluvial Chemical precipitation, eluvial	 Qb Qk, except on Fortescue Plain Qi Qkp Qk on Fortescue Plain
Tertiary ..	*Hamersley Surface* 1. Flat-topped ridges about 200 feet above present plain level; rounded surface of Hamersley Range over 2,000 feet above sea level 2. Small mesas up to 50 feet above plain level 3. Gently-sloping surface of valley-fill deposits in Hamersley Plateau	 Deep weathering followed by hardening, and mechanical erosion Chemical deposition Alluvial	 Td Most Tp Czc

DRAINAGE PATTERN

Closely related to the land forms and the land surfaces is the drainage, both present and past. The present drainage is partly to the west and partly to the north (see Figure 2). The westward draining rivers are the Fortescue and the Robe, and the principal rivers flowing northwards are the Harding, George, Sherlock, Peawah and Yule. Tributaries of the northern rivers have formed deep embayments in the tableland and their headwaters are in narrow gorges. The middle reaches of these rivers have anastomosing channels on wide flood plains. The rivers all flow through one or more water gaps (either in the Sheet area or to the north) due to incision of a superimposed drainage.

Because of headward erosion, tributaries of the north-flowing rivers have captured what were tributaries of the Fortescue. For example, Sophie Creek has been beheaded near Meeringinyia Spring, northwest of Daniels Well homestead, and the original southern flow has been diverted into the Harding River.

Headward erosion by what is now the middle reaches of the Fortescue River into the Fortescue Plain west of Millstream is considered to have taken place, as pointed out by Harms and Morgan (1964). Supporting this contention is the observation that creeks draining southwards on the tableland into the Fortescue have broad valleys except in the Daniels Well area where the Portland River and its tributaries are deeply incised. The deep incision is considered to be due to headward erosion associated with the middle reaches of the Fortescue River into which the Portland River flows.

Further capture of the Fortescue by one of the north-flowing rivers appears to be only a matter of time.

Parts of an old drainage pattern related to the Hamersley Surface are indicated by pisolite deposits. West of Mt. Richthofen their narrow sinuous form suggests an old valley draining to the north, and further to the west their disposition suggests a westward flow, perhaps into an ancestral Robe River.

ECONOMIC GEOLOGY

Gold (20,000 oz.), copper (1,000 tons of ore) and chrysotile (6,000 tons) have been produced from the Pyramid Sheet area, as well as small amounts of several other mineral products. Most of the gold and copper was mined before 1909. Production figures are outlined in Tables 9 and 10. Information on the mining areas is contained in Maitland (1909), Woodward (1911), Wilson (1922), Finucane (1937), Finucane and Telford (1939), Sullivan (1939), Finucane and others (1939), and Ryan (1965).

Brief notes on the economic geology of the various map units are made in Tables 2, 4 and 7.

TABLE 9

PYRAMID 1 : 250,000 SHEET

RECORDED GOLD PRODUCTION TO 31.12.1963

Mining Centre	Alluvial fine oz.	Dollied and Specimen fine oz.	Ore treated tons	Gold therefrom fine oz.	Total gold fine oz.
Croydon	..	..	8.00	5.44	5.44
Hong Kong	21.40	0.02	340.00	445.60	467.02
Pilbara	11.01	134.36	430.00	688.26	833.63
Station Peak ..	178.43	41.37	11,102.50	11,465.41	11,685.20
Other	6,102.62	189.27	103.50	33.93	6,625.80
TOTALS	6,313.46	365.02	11,984.00	12,638.64	19,617.09

TABLE 10

PYRAMID 1 : 250,000 SHEET

RECORDED PRODUCTION OF MINERALS OTHER THAN GOLD TO 31.12.1963

Mineral	Mining Centre	Production (tons)	Value($A)
Chrysotile ..	Nunyerry	6,224.65	596,018
Tremolite ..	Nunyerry	1.00	50
Copper ore ..	Croydon	604.00	14,666
Copper ore ..	Egina	542.00	13,286
Cupreous ore ..	Croydon	102.60	1,960
Cupreous ore ..	Egina	28.59	1,186
Tin concentrate ..	Pilbara Creek	less than 4	..

METALLIC MINERALS

Alluvial Gold

Pilbara, Egina, and Hong Kong are the main centres for alluvial gold in the area. The reported production is around 6,000 ounces, but production has undoubtedly been more than this. Localities from which alluvial gold has been won include Pilbara, Pilbara Top Camp, Upper Friendly Creek, Hong Kong, Womerina, Egina, B14, Croydon Top Camp, Croydon Bottom Camp, and Yareweeree Pool. Alluvial gold near Pilbara is probably derived from nearby quartz reefs; and that at Egina, Hong Kong, Croydon, and B14 may possibly be derived from conglomerates in the Fortescue Group, although these are not known to be auriferous near these localities. At Egina and several other places the gold is in a slate-fragment detritus on top of steeply dipping slates which act as a natural riffle.

Reef Gold

Almost 12,000 ounces of gold are recorded as produced from the Station Peak mines, and a little over 1,200 ounces from other small mines and prospects which are listed in Table 11. The gold is in small quartz reefs.

Antimony

Production of 20 tons containing 50 per cent. antimony is recorded from Prospect shafts at Sherlock Crossing near Coonanarrina Pool. The prospect was not seen during the mapping in 1963.

Beryl

A few hundredweight of beryl have been produced from pegmatities in granite north from Mumbillina Bluff and at Corung Creek.

Copper

Small mines at Croydon (Evelyn) and Egina have produced some 1,000 tons containing over 15 per cent. copper, mainly from carbonates. Other localities in the area with known copper mineralisation are Pilbara, Quamby, Station Peak and Black Gin Point.

Iron

Concentrations of hematite on the Brockman Iron Formation, and hematite conglomerate (canga) derived from this formation are potentially iron ore. The largest deposits are near Mt. Pyrton. No hematite deposits have been found in the Marra Mamba Iron Formation within the Pyramid Sheet area, although such deposits are known elsewhere in this formation. North of the outcrop of the Marra Mamba Iron Formation there are small mesas of ferruginous pisolite similar to the Robe Pisolite.

The bodies of iron minerals in the Pyramid Sheet area are small, and, at best, of secondary commercial interest at present.

Lead

There is a small prospect on a vein of galena in granitic rocks at Flat Rock near Nunyerry, and galena is reported from the Galena Lode at Station Peak.

TABLE 11

REEF GOLD LOCALITIES

Name	Remarks	Recorded Production
Hong Kong ..	Not the same area as the alluvials. Shafts in altered basic volcanic rocks and possible sedimentary rocks	
Foochow	Pit to north of Hong Kong	Over 400 oz. (Hong Kong, Foochow, Empress, Annie Gap)
Empress	Shafts in altered basic volcanic rocks	
Annie Gap ..	Shafts in altered basic volcanic rocks	
East of Annie Gap ..	Small pits in porphyries	Nil
John Bull	Shafts in altered basic volcanic rocks with porphyry	
Teichman	Three prospects in altered basic volcanic rocks	
Pilbara	Several prospects in quartz reefs in schists and gneissic granite	Over 800 oz. (Teichman, Pilbara, Black Prince)
Black Prince ..	Near Pilbara	
Black Gin Point ..	Not located	Nil
Queenslander ..	Not located—near Croydon	5 oz.
Station Peak ..	1 oz./ton from quartz reefs in coarse-grained amphibolite body in slate and greywacke with porphyry	Over 11,000 oz.
Womerina	Weathered basic schists. Prospect	Very small
Croydon Top Camp..	Quartz reef in slates. Adit and shaft	Nil

Tin

Alluvial tin has been produced from creeks and old creek gravels at Pilbara (Sandy Creek, Friendly Creek and Top Camp) and Warden Pool. Production has almost certainly been more than that recorded.

Tungsten

Scheelite is reported from Black Gin Point by Maitland (1919). The occurrence was not seen during the 1963 mapping.

Vanadium, Nickel, Chromium

There is no record of vanadium, nickel or chromium in the area, but there are magnetite-rich rocks in some of the ultramafic rock bodies which might contain these metals.

Zinc

Sulphides of zinc are reported at the water table in the Croydon (Evelyn) copper mine.

INDUSTRIAL MINERALS

Chrysotile

Over 6,000 tons of chrysotile have been mined from serpentinite at Nunyerry, most of the production being after 1950. The mine and plant are now shut down. This deposit has been reported by Wilson (1922) and Adams (1944).

Tremolite

Production of 1 ton of tremolite from Nunyerry is reported.

Crocidolite

Seams of crocidolite occur near the base of the Brockman Iron Formation throughout the Hamersley Range. No economic deposits are known within the Sheet area, although a small quantity of fibre has been won from seams near Mt. Margaret.

SEMI-PRECIOUS STONES

Agate

Small quantities of marketable agate have been picked up from the material weathered from amygdaloidal basalts of the tableland.

Chert

A pale green chert which is in faults through granite southeast of Croydon homestead makes a delicately-coloured tumbling stone. A laminated, variegated chert, or silicified mudstone, from the Jeerinah Formation is also favoured.

Iron Balls

Pseudomorphs after pyrite in the form of many-faceted spheres which weather out of the Roy Hill Shale are a collector's curio.

Tiger-Eye

Poor quality tiger-eye has been found in the Brockman Iron Formation.

Serpentine

Serpentine at Nunyerry would possibly repay investigation for use as a semi-precious stone.

INDUSTRIAL ROCKS

Gravel

Lying on dip slopes of the Marra Mamba Iron Formation are deposits of ironstone and shale detritus which are used for road surfacing.

Building Stone

Flagstones and larger blocks of sandstone have been used in station homesteads and other buildings.

Limestone

The Wittenoom Dolomite contains varying proportions of calcium, magnesium, and iron. One specimen has been assayed as containing 99 per cent. $CaCO_3$, but this is unusual.

OTHER MATERIALS

Carbonaceous Shale

While of no known economic significance at present, the carbonaceous pyritic shale in the Roy Hill Shale is of interest in that 7 per cent. carbon has been assayed from one specimen of this shale. The possibility of the occurrence of economic concentrations of base metal sulphides in this material should be considered.

UNDERGROUND WATER

Underground water of good quality and in good supply is present throughout the area. Springs are common in creeks in the dissected tableland and there are large springs at Millstream. Over 200 wells and 20 bores have been sunk in the area, usually near perennial watercourses, and water is being pumped for stock use from some 180 wells and bores. Water is drawn from alluvium, eluvium, kunkar, kunkar with porcelanite, shale, basalt, slate, sandstone, and weathered granite.

The locations of the wells and bores, with serial numbers, are shown in Figure 5*; and the information on them is briefly summarized in Table 12. Underground water units are shown in Figure 4; and catchment areas on Figure 2.

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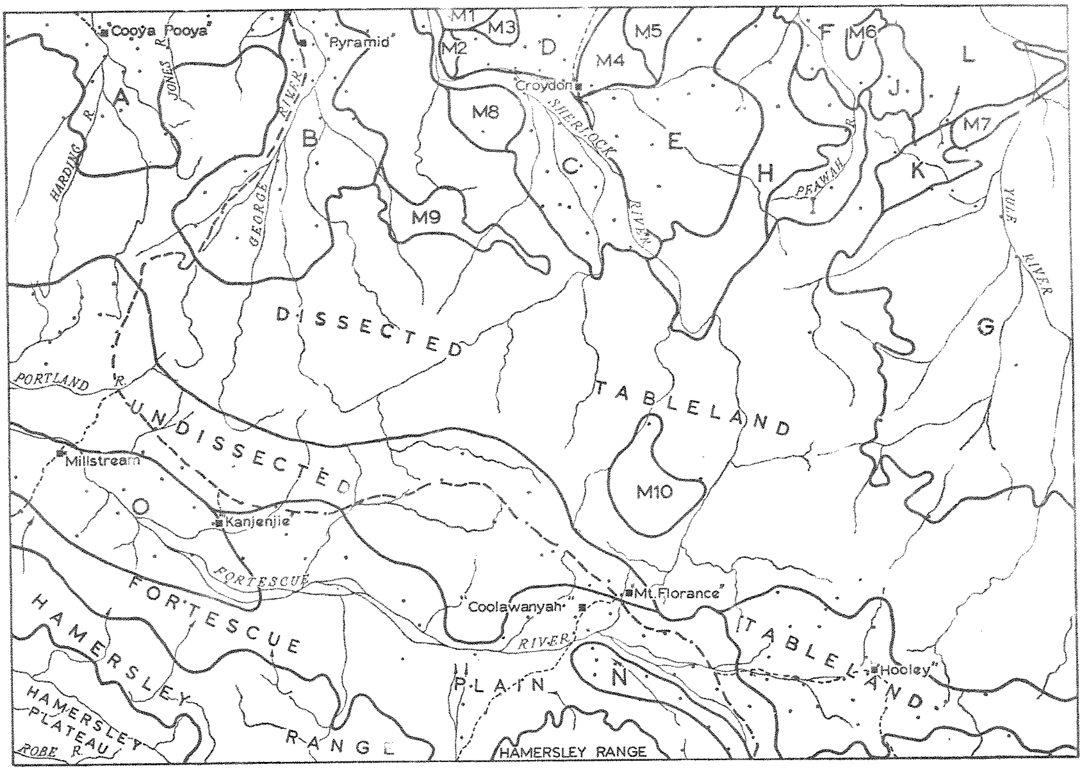
* Details for wells and bores shown on Figure 5 are available at the Geological Survey of Western Australia.

Figure 4



UNDERGROUND WATER UNITS

PYRAMID SHEET SF 50-7

SCALE OF MILES

10 0 10 20

REFERENCE

A	Cooya Pooya hills and plains	I	Peawah hills
B	George alluvial plain	J	Egina hills
C	Sherlock alluvial plain	K	Pilbara hills
D	Croydon alluvial plain	L	Yule plain
E	Croydon granitic plain	M	Miscellaneous (eleven units)
F	Millindinna plain	N	Mt Florance } Fortescue Plain
G	Yandeyarra granitic plain	O	Millstream } Fortescue Plain
H	Satirist hills		

Boundaries of underground water units

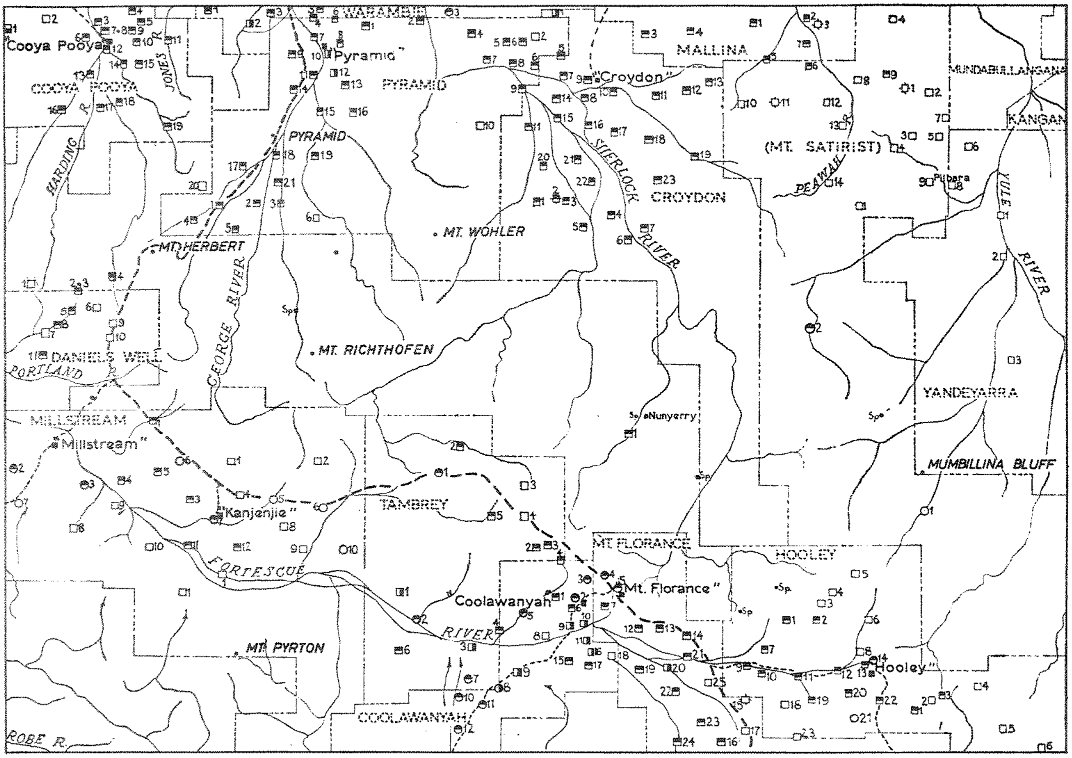
Rivers

Position of bore well or spring

Main roads

Roads and tracks

Figure 5



LOCATION OF BORES WELLS AND SPRINGS

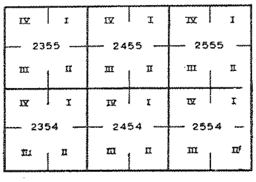
PYRAMID SHEET SF50-7

SCALE OF MILES

10 0 10 20 30

REFERENCE

Main road		Spring		•Sp.
Roads and tracks		Well -	quality fresh	
Homestead	"Coolawanyah"		quality stock	
Pastoral lease boundary			quality unspecified	
Pastoral lease name	COOLAWANYAH		abandoned	
Pastoral "area" name	(MT. SATIRIST)	Bore -	quality fresh	
Hills, mountains	•MT. PYRTON		quality stock	
Localities	•Pilbara		quality unspecified	
Bore and well serial number	14		abandoned	



INDEX TO GRID AREAS

Table 12

PYRAMID 1 : 250,000 SHEET

SUMMARY OF UNDERGROUND WATER INFORMATION

Area	Depth to Water (feet)	Number of Wells and Bores	Average Depth to Water (feet)	Average Depth to Bottom (feet)	Aquifer	Remarks
Lowlands	0–11	12	8	22	Alluvium near creeks and kunkar	
	12–26	80	20	35	Alluvium and weathered granite	
	27–44	16	36	51	Alluvium and weathered granite	
	over 45	4	71	over 95	Slate	Deepest well: over 125 feet
	miscellaneous	7	—	—	Various	
Dissected Tableland	—	—	—	—	Basalt and tuff	Not developed for underground water. Many springs
Tableland . .	0–11	5	11	21	Basalt alongside creeks	
	12–26	17	20	35	Alluvium over basalt	
	27–44	17	37	61	Basalt	
	over 45	9	69	84	Basalt	
Fortescue Plain . .	0–11	11	14	20	Kunkar	Lime-rich water
	12–26	7	40	45	Alluvium and shale	
	27–44	10	44	58	Kunkar with porcelanite	Near Millstream
	over 45	31	97	112	Alluvium and shale	Deepest bore: 230 feet
Hamersley Plateau . .	—	—	—	—	Valley fill	Not developed for underground water

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APPENDIX 1

DEFINITION OF ROCK UNITS

Introduction

The following rock units are proposed and defined:

1. Cooya Pooya Dolerite
2. Pillingini Tuff

Cooya Pooya Dolerite

Proposed name: Cooya Pooya Dolerite

Geographic name from: Cooya Pooya homestead; Lat. 21° 02′ S, Long. 117° 08′ E.

Type of unit: Igneous rock body.

Lithology: Altered dolerite with very subordinate granophyres; locally with amygdales.

Type locality: At Lockyer Gap, 4 miles from Cooya Pooya homestead on the road to Roebourne. (The name Lockyer Gap is not shown on the Pyramid map). Lat. 21° 00′ S, Long. 117° 05′ E.

Description at type locality: Black dolerite intruded into Cliff Springs Formation and containing blocks of that formation.

Distribution: As shown on Pyramid 1 : 250,000 geological map from Cooya Pooya to east of Mt. Wohler. Also on Roebourne and Yarraloola map areas.

Distinguishing features: Very distinctive bold black outcrop and black photo pattern.

Topographic expression: Mesas and tumbled black hills.

Relationships: Intrusive into the Cliff Springs Formation, commonly at contact with the overlying Kylena Basalt. No definite top contacts seen. Possibly occupies a feeder neck near Cooya Pooya. Possibly extrusive offshoots near Mt. Wohler. Elsewhere a sill, up to 300 feet thick.

Correlation: With gabbro-granophyre complex of the Dampier Archipelago.

Age: Younger than Cliff Springs Formation. Possibly penecontemporaneous with Kylena Basalt.

Pillingini Tuff

Proposed name: Pillingini Tuff.

Geographic name from: Pillingini Creek, a tributary of the George River. This creek passes over the Pillingini Tuff at approximately Lat. 21° 23′ S, Long. 117° 24′ E.

Type of unit: Bedded pyroclastic rock unit.

Lithology: Tuff, bedded, green when fresh, weathering brown; with tuffaceous siltstone, shale and sandstone; beds of volcanic pisoliths (Trendall, 1965); diagenetic calcite common, calcareous beds with stromatolites; with lavas, basic to intermediate. Locally cross bedded and ripple marked; load casts. Also banded chert and jaspilite, and agglomerate, in some areas but not at type locality.

Type locality: Mt. Herbert; Lat. 21° 19′ S, Long. 117° 13′ E.

Type section: Not specified or measured.

Thickness: Estimated to range from 150 feet to 500 feet. About 200 feet at type locality.

Top and bottom boundaries: Clear change from an underlying lava to bedded pyroclastic to an overlying lava at type locality. Boundaries are continued by mapping into those areas where there are intercalated lavas.

Distribution: From Cape Preston on the northwest coast, to within the Roy Hill map area and possibly further east.

Shape: A blanket some 300 feet thick, 100 miles wide and 300 miles long (including correlatives).

Recognition: Position in column beneath a thick lava unit (the Maddina Basalt). Photo pattern—light-toned with sinuous stream pattern. Beds of calcite-cemented volcanic pisoliths (although there are similar beds lower in the sequence in the Cliff Springs Formation).

Environment of formation: Shallow water, possibly a shallow saline lake, (Rezak, 1957, p. 145-156). Explosive vulcanism in distributive province.

Topographic expression: Terraced hills in dissected tableland; poor outcrop of low ridges and cuestas in areas of low hills. Characteristic joint-controlled sinuous stream pattern.

Correlations: The Kuruna Siltstone Member, Nymerina Basalt Member, and Tumbiana Pisolite Member of the Mt. Jope Volcanics (MacLeod and de la Hunty, 1966); the Pyradie Pyroclastic Member of the Mt. Jope Volcanics (de la Hunty, 1965); and less certainly the Tumbiana Pisolite of Noldart and Wyatt (1962) and de la Hunty (1064).

Stratigraphic position: Conformably overlies the Kylena Basalt, and conformably underlies the Maddina Basalt of the Fortescue Group.

Fossils—Stromatolites; *Collenia* sp. aff. *C. multiflabella* (Edgell, 1964).

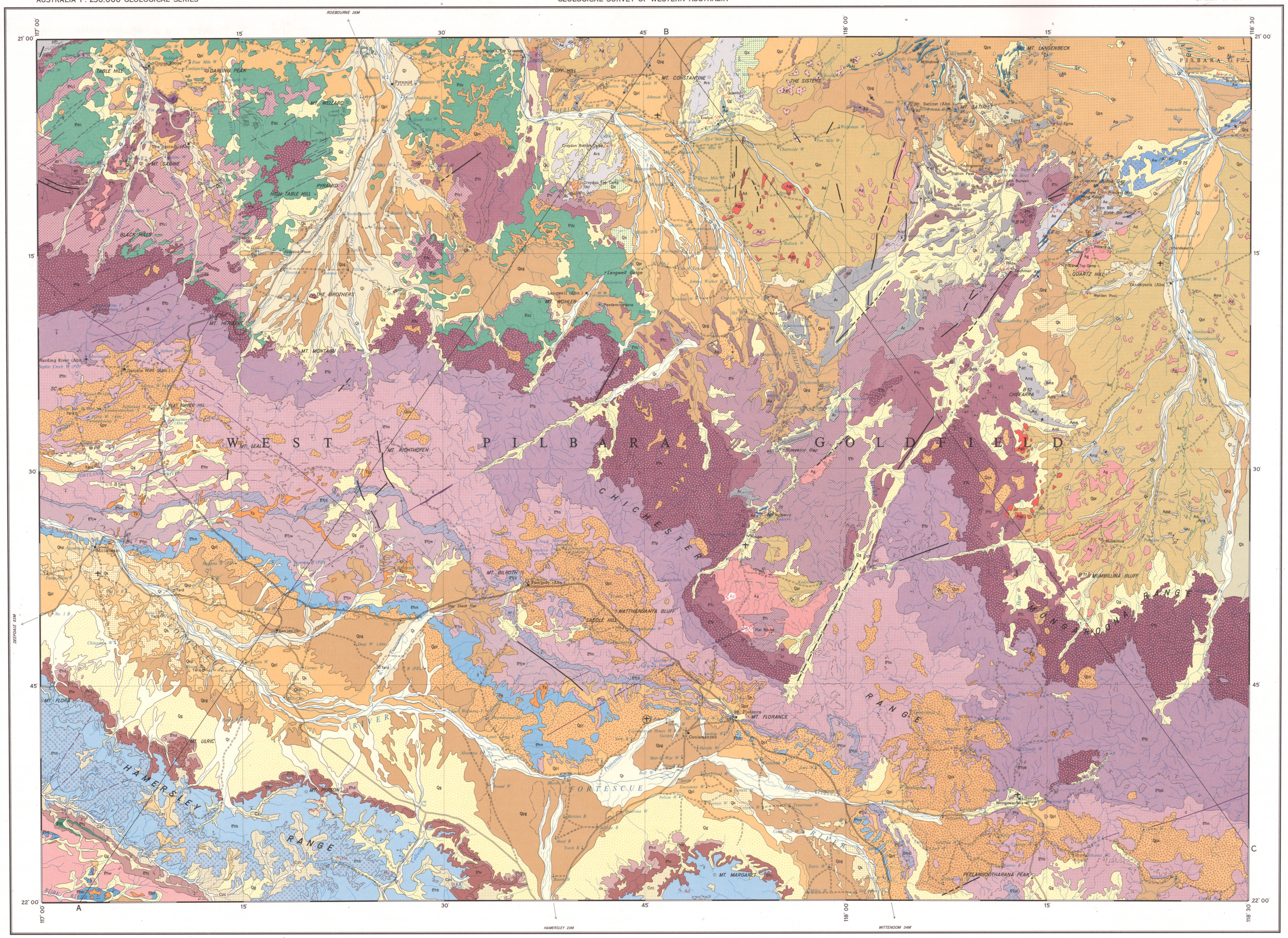
Age: Lower Proterozoic (Geological Survey of Western Australia, 1965).

T. J. HUGHES, Government Printer, Tasmania.

OS. 3055

PYRAMID

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA



SYMBOLS

- Geological boundary
- Fault definite
- Fault inferred
- Fault concealed
- Strike and dip of strata
- Strike of vertical strata
- Strike and dip of overturned strata
- Horizontal strata
- Strike and dip of strata from air photos
  - dip less than 15°
  - dip 15° to 45°
- Top of bed
- Trend line
- Minor anticline
- Drag fold
- Strike and dip of foliation
- Strike of vertical foliation
- Strike and dip of platy flow
- Strike of vertical platy flow
- Joint pattern
- Macrofossil occurrences

- Goldfield boundary
- Highway
- Formed road
- Track
- Airfield
- Landing ground
- Homestead
- Locality • Peedancoordana
- Minor trigonometrical station

- Watercourse (non perennial)
- Pool
- Well or bore with windpump
- Well • W
- Bore • B
- Spring • S
- Position doubtful (PD)
- Abandoned (Abn.)

- Mining area
- Prospect
- Alluvial workings
- Mineral occurrences
  - Antimony Sb
  - Beryllium Be
  - Chrysotile Ac
  - Crocidolite Ad
  - Copper Cu
  - Gold Au
  - Hematite He
  - Lead Pb
  - Tin Sn

REFERENCE

CAINOZOIC — QUATERNARY — RECENT

Qr	Alluvium. Unconsolidated fluviatile deposits, mostly sands
Qg	Colluvium. Unconsolidated to loosely consolidated slope deposits; calcareous and ferruginous cement in older parts of unit
Qa	Aeolian sand. Red loamy sand in drifts and fixed seif dunes
Ql	Flood deposits. Unconsolidated fluviatile and sheet-flood deposits in levees and river terraces

PLEISTOCENE

Qpt	Eluvium. Residual, lightly cemented, low-slope deposits; angular to sub-rounded shale and ironstone fragments
Qpx	Eluvium. Residual deposits of boulders and cobbles in clay; gilgais
Qpr	Eluvium. Residual sand and clay with quartz, feldspar, and mica grains; pediment
Qpg	Alluvium. Unconsolidated gravel and pebble deposits of clay plain; gilgais
Qps	Residual and alluvial sandy clay. Sandy part of clay-plain deposits; pediment
Qpl	Residual and alluvial clay. Clay-plain deposits with glazed gravel veneer in places; some sheet kunkar; gilgais; pediment
Qb	Alluvial pebbles and cobbles. Poorly consolidated gravel deposits
Qkp	Kunkar and porcelanite. Thin layers of white porcelanite in kunkar
Qk	Kunkar. Impure earthy limestone as sheets and incrustations; some secondary porcelanite
Qi	Greybilly. Siliceous capping overlying kaolinised and fresh granite; a porcelanite

TERTIARY

Czc	Colluvium. Consolidated ferruginous valley-fill, including hematite-rich conglomerate (canga) which contains *Iron Ore*; some kunkar and siliceous incrustations
Tp	Pisolite. Pisolitic limonite, goethite, and hematite deposits with fossil wood fragments. Correlated with ROBE PISOLITE and POONDANO FORMATION
Td	Duricrust. Indurated crust on Precambrian rocks

PROTEROZOIC — LOWER PROTEROZOIC

d	Dolerite. Altered medium-grained to coarse-grained dolerite and quartz-dolerite
Pdj	Dolerite. Altered medium-grained dolerite sill. Into WEELI WOLLI FORMATION
Pdc	COOYA POOYA DOLERITE. Intrusive massive and layered fine-grained to medium-grained dolerite with local acid segregations; also stratiform bodies which may be flows or sills. Contains disrupted blocks of CLIFF SPRINGS FORMATION

Mt. Bruce Supergroup — Hamersley Group

Pho	BOOLGEEDA IRON FORMATION. Flaggy jaspilite, siltstone, and shale
Phw	WOONGARRA VOLCANICS. Green to dark-coloured porphyritic and aphanitic dacite and rhyolite lavas with pyroclastic rocks
Phj	WEELI WOLLI FORMATION. Jaspilite and shale
Phb	BROCKMAN IRON FORMATION. Thinly bedded jaspilite, chert, and shale, with beds of black shale, yellow dolomitic shale, and dolomite; contains *Crocidolite* and riebeckite, and bodies of hematite *(Iron Ore)*
Phr	MT. McRAE SHALE. Pale-coloured fissile shale and dolomitic shale, with beds of dark chert, yellow and blue dolomite, and dolomite breccia. Contains iron oxide nodules after pyrite
Phs	MT. SYLVIA FORMATION. Pale-coloured fissile shale and dolomitic shale with beds of jaspilite and dolomite. Contains iron oxide nodules after pyrite
Phd	WITTENOOM DOLOMITE. Grey crystalline calcitic dolomite, with thin beds of chert and dolomitic shale in the upper part
Phm	MARRA MAMBA IRON FORMATION. Ferruginous chert with prominent pinch-and-swell structure; jaspilite and ferruginous shale

Mt. Bruce Supergroup — Fortescue Group (JEERINAH FORMATION: Pfjo, Pfjw, Pfjd)

Pfjo	Roy Hill Shale Member. Fissile, pale-coloured and variegated shale with dolomitic shale in places. Carbonaceous and pyritic where unweathered. Iron oxide nodules at surface
Pfjw	Warrie Member. Laminated chert, fine-grained quartzite, shale, and subordinate jaspilite. Pyrite cubes. Iron oxide nodules at surface
Pfjd	Woodiana Sandstone Member. Silicified mudstone, shale, siltstone, chert, fine-grained quartzite and tuff. Basal grit in places
Pfm	MADDINA BASALT. Altered, amygdaloidal, scoriaceous, and massive basic and intermediate lavas with thin intercalations of tuffaceous siltstone, and siliceous mudstone in upper part
Pfp	PILLINGINI TUFF. Bedded tuffs with volcanic pisoliths; shale, siltstone, and sandstone beds; dolomite bed with *Collenia* sp. Small intercalations of lava
Pfpb	Basalt
Pfk	KYLENA BASALT. Altered, massive, amygdaloidal, and columnar jointed basic and intermediate lavas; locally porphyritic
Pfcl	Lyre Creek Agglomerate Member. Bedded to massive agglomerate and tuff, with bombs; indurated in part
Pfc	CLIFF SPRINGS FORMATION. Acid tuff, tuffaceous shale, sandstone and greywacke; conglomerate; with agglomerate at top
Pfr	MT. ROE BASALT. Altered amygdaloidal, vesicular, columnar, and massive basic lavas; with distinctive porphyritic flows. Basal sandstone

ARCHAEAN — Pilbara System

Ad	Dolerite. Narrow, discontinuous, altered dolerite dykes
Agh	Melanocratic granite. Massive, medium-grained, equigranular, horn-blende granite; and tonalite; with basic xenoliths
Agp	Porphyritic granite. Medium-grained to coarse-grained leucocratic granite with potash feldspar phenocrysts
Ag	Granite, gneiss. Medium-grained, equigranular, leucocratic granite; granitic gneiss
	Metamorphic rocks:
Ams	Soft schists
Ama	Amphibole schists
Amg	Massive, gneissic and granulitic rocks

Roebourne Group

Aw	Quartzite, shale, chert and jaspilite. Thin intercalations of amphibolite; some brecciated cherts. Correlated with GORGE CREEK FORMATION and CLEAVERVILLE FORMATION
Ae	Basic volcanic rocks. Altered grey, green, and black basic lavas, locally with variolitic texture; some acid volcanic rocks, and bodies of porphyry. Includes REGAL FORMATION at Cooya Pooya and Coonanarrina Pool
Ah	Banded chert. Blue and white banded chert; altered dolomitic rocks
Ab	Granular siliceous rocks. Orange-weathering, green, aphanitic and granular siliceous rocks with spheroidal bodies; associated porphyry
Ar	Slate. Cleaved shale and siltstone, with greywacke; some jaspilite, ferruginous and siliceous shale, and chert; small bodies of porphyry
Aa	Coarse-grained amphibolite. Concordant bodies of altered basic rock
Al	Ultramafic rocks. Amphibole-serpentine-magnetite rock. Also, quartz-greywacke and shale; chert; associated porphyry
Aa	Coarse-grained amphibolite. Concordant body of altered basic rock; locally talc-chlorite schist. Contains auriferous quartz reefs
Ars	Greywacke and shale. Cleaved quartz-greywacke and shale. Locally metasomatised
Aa	Coarse-grained amphibolite. Concordant body of altered basic rock

Compiled by Geological Survey of Western Australia. Cartography by Geological Drafting Section, Mines Department. Topographic base from compilations by Lands and Surveys Department.
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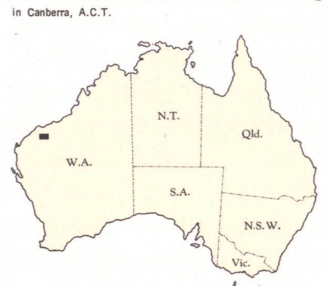
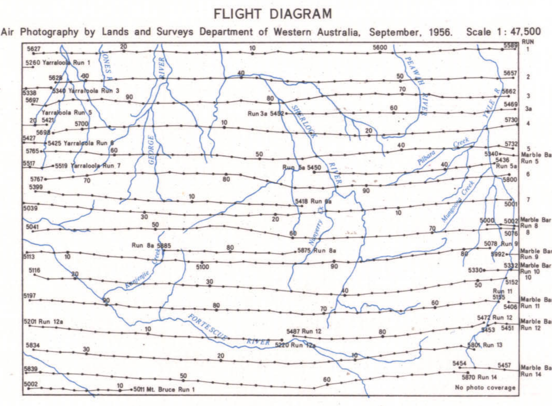
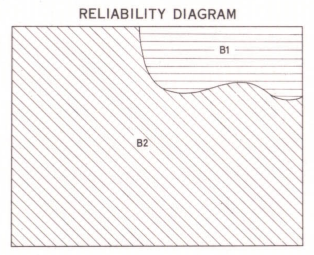


FLIGHT DIAGRAM



RELIABILITY DIAGRAM



B1 Numerous traverses with air photo interpretation
B2 Air photo interpretation with a few traverses

HON. A. F. GRIFFITH, M.L.C.
MINISTER FOR MINES
J. H. LORD, DIRECTOR, GEOLOGICAL SURVEY

SCALE 1 : 250,000

5 0 5 10 15 20 Miles
10,000 0 10,000 20,000 30,000 Yards
5 0 5 10 15 20 25 30 Kilometres

TRANSVERSE MERCATOR PROJECTION
ZONE 1, AUSTRALIA SERIES

INDEX TO ADJOINING SHEETS

DAMPIER SF 50-2	ROEBOURNE SF 50-3	PORT HEDLAND SF 50-4
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Geology by M. Kriewaldt and G.R. Ryan, 1963.
Printed by: Mercury-Walch Pty Ltd., Hobart, Australia

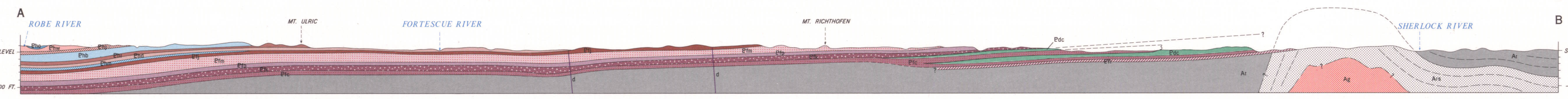
DECLINATION DIAGRAM

Annual change is negligible

DIAGRAMMATIC SECTIONS

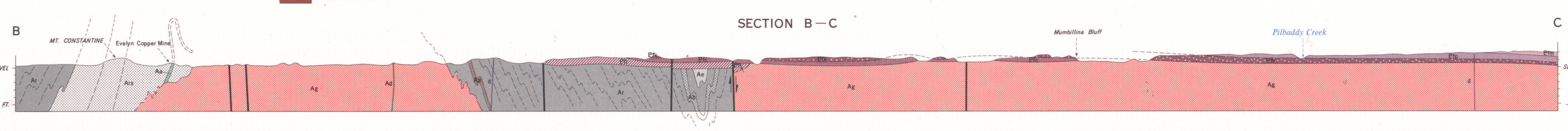
NATURAL SCALE

SECTION A — B

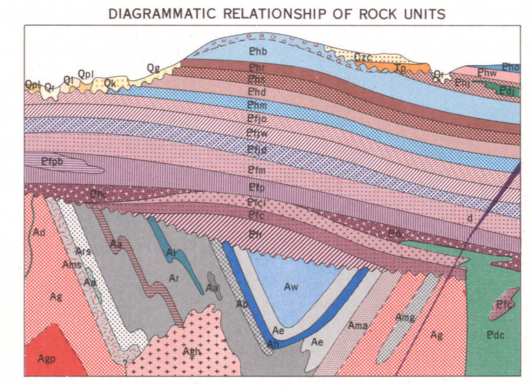


Pfj JEERINAH FORMATION

SECTION B — C



DIAGRAMMATIC RELATIONSHIP OF ROCK UNITS



Unconformity

PYRAMID

SHEET SF 50-7

FIRST EDITION 1966
REPRINT 1971