COMMONWEALTH OF AUSTRALIA.

DEPARTMENT OF NATIONAL DEVELOPMENT.

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS.

NOONKANBAH—4-MILE GEOLOGICAL SERIES.

Sheet E/51-12, Australian National Grid.

EXPLANATORY NOTES No. 10.

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EXPLANATORY NOTE SERIES—

1. Urandangi, 1952.
2. Wollongong, 1954.
3. Canberra (in preparation).
4. Minilya, 1955.
5. Springsure, 1957.
6. Sydney, 1957.
7. Jerilderie, 1957.
8. Derby, 1958.
9. Mt. Anderson, 1958.
10. Noonkanbah, 1958.
11. Lennard River (in press).
12. Anketell, 1957.

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DEPARTMENT OF NATIONAL DEVELOPMENT.

Minister : SENATOR THE HON. W. H. SPOONER, M.M.

Secretary : H. G. RAGGATT, C.B.E.

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS.

Director : P. B. NYE, O.B.E.

Deputy Director : J. M. RAYNER.

These notes were prepared in the Geological Section.

Chief Geologist : N. H. FISHER.

Explanatory Notes on the Noonkanbah 4-Mile Geological Sheet.

Compiled by

G. A. Thomas.

INTRODUCTION.

The Noonkanbah 4-mile Sheet covers part of the Fitzroy Basin, which is the northern part of the Canning (Desert) Basin. The Fitzroy Basin is defined as the area bounded by Precambrian rocks in the north and the Fenton Fault in the south. The small south-eastern portion of the map south of the Fenton Fault is therefore not part of the Fitzroy Basin. The major areas of Precambrian rock lie to the north of this Sheet area.

Outcrops of Precambrian, Ordovician, Devonian, Carboniferous, Permian, Triassic, Jurassic and possible Tertiary rocks crop out in the area.

The following maps and aerial photographs cover the Noonkanbah Sheet:—

Four miles to 1 inch Military Map, prepared by Australian Army Survey Corps;

Aerial photographs flown by the R.A.A.F. at a scale of 1 to 50,000;

One mile photomap series of Department of Lands and Survey, Perth.

The area forms part of the 10 mile to an inch topographical series, Sheet 17—Halls Creek, by Department of Lands and Survey, Perth.

OUTLINE OF PREVIOUS INVESTIGATIONS.

Hardman (1884, 1885) in the course of a regional survey of the Fitzroy Valley pioneered geological work on the Noonkanbah Sheet area. Jack traversed the area in 1906. Very little more was then done prior to the work of Blatchford and Talbot from 1921 to 1929, and of Wade (1924, 1935). In this period detailed mapping was done at Mt. Wynne, Pool Range, and in the Prices Creek area. Drilling was undertaken at Prices Creek and the Poole Range; the first shallow holes at Prices Creek were begun in 1919 and showed traces of oil. Woolnough in 1933 pioneered the aerial reconnaissance of the area; Caltex geologists Bremner (1940) and Kraus (1941) continued the regional reconnaissance work. The more intensive recent work began with that of Reeves (1949), and was continued by the field parties of the Bureau of Mineral Resources, Geology and Geophysics, from 1948 to 1952 (Guppy, Lindner, Rattigan and Casey, 1958). Since 1953 work has been continued by Bureau geologists and by geologists of West Australian Petroleum Pty. Ltd. Henderson (1956a, b) has described the cores of the B.M.R. bores No. 2 and 3, at Laurel Downs and Prices Creek.

Palaeontological studies have accompanied the field mapping and understanding of the Systems represented has gradually been built up. Ordovician rocks at Prices Creek were first reported by Guppy and Öpik (1951). The Ordovician cephalopods have been described by Teichert and Glenister (1952, 1954). Hardman (1883) referred rocks, now known as Devonian and Permian, to the Carboniferous Period. Pioneer work on his collections by Nicholson (1890), Hinde (1890), Foord (1890) revealed that both Devonian and Permo-Carboniferous rocks were present. Etheridge (1918) described forms collected by Jack and later by Basedow. The widespread extent of Middle and Upper Devonian rocks was confirmed by the studies of Hosking (1933), Prendergast (1935) and Delepine (1935), Hill (1936), and Ripper (1937).

The studies of C. Teichert from 1939 to 1949 (summarized by Teichert in 1949) have put the understanding of the biostratigraphy of the Devonian on a firm basis. Specialist studies by Coleman (1951), Howell (1952), Hill (1954), Veevers (in press) and Glenister (1958) have advanced this knowledge. The presence of Lower Carboniferous outcrops with a rich marine fauna was indicated by Thomas (1955, 1957, 1958b). Jones (1957) has identified ostracods and Balme (1956) has recorded spores from the Laurel Downs Bore (B.M.R. No. 2).

Understanding of the Permian faunal succession and stratigraphy has also developed gradually. Pioneer fossil descriptions from localities not on this sheet are found in Etheridge (1890, 1914, 1918), and Bretnall (1926). More recently, Miller (1936) and Teichert (1942) described the Nura Nura ammonoids. Bryozoa have been described by Crockford (1944, 1957), Productacea by Coleman (1957), Orthotetacea by Thomas (1958), corals by Hill (1937, 1943) and the crinoid *Calceolispongia* by Teichert (1949). Edwards (1942) described some plant fossils from the Poole Range. Thomas and Dickins (1954) reviewed the Permian correlations and announced the presence of Upper Permian marine faunas. Permian foraminifera have been described by Crespin (1958).

The Mesozoic rocks, represented mainly by the Blina Shale on this sheet, were reviewed by Brunnschweiler (1954). The numerous occurrences of leucite lamproite of assumed Mesozoic age were described by Wade and Prider (1940).

PHYSIOGRAPHY.

The area can be conveniently divided into four topographical groups: (*a*) the limestone ranges in the north-east corner, (*b*) the Fitzroy Valley, (*c*) the sandstone ranges south of the Fitzroy Valley, (*d*) part of the sandy Canning Desert in the south-west corner.

(*a*) The limestone ranges extend across the north-east part of the area as a number of disconnected plateaux and wide ridges. The Pillara and Emanuel Ranges extend south-east, and the Oscar Range and the Geikie Range north-west, of Fitzroy Crossing. The limestone ranges, mainly composed of

Devonian limestone, generally form very rough dissected plateaux, often almost impenetrable. They constitute an advanced karst topography. The elevation is generally not more than several hundred feet above plain level.

These ranges are part of a long line of limestone ranges extending to the north-west and south-east. Individual ranges are crossed in places by wind or water gaps. The valley of the Margaret River, a tributary of the Fitzroy River, forms a wide gap. The Geikie Gorge of the Fitzroy River and the Brooking Gorge are picturesque steep-walled water gaps with extensive permanent pools. The valleys are probably superimposed features. The Margaret Valley contains no known outcrops of Grant Formation, which suggests that this valley at least was not cut before Permian times.

Isolated limestone hills occur, east of the main ranges, in the broad alluvial plains of the Margaret Valley. Residual black soils are developed near the limestone ranges and hills.

(*b*) Downstream from the Geikie Gorge the Fitzroy River crosses the Sheet area in a westerly direction. East of Fitzroy Crossing, it is joined by a large tributary, the Margaret River. Christmas Creek, another important tributary, flows from the south and joins the Fitzroy River near Cherrabun Homestead.

The Fitzroy and Margaret Rivers rise in the Leopold Ranges to the north-east, where heavy run-off occurs in the rainy monsoonal season. These streams are degrading in the higher reaches but are heavily aggrading in the broad valleys which occupy much of the Noonkanbah Sheet area.

Jutson (1934) suggested that the major streams of the Fitzroy Region, notably the Fitzroy and Lennard Rivers, were originally consequent streams flowing south-west and had sufficient fall to maintain their initial courses across the hard limestone ranges until broken by capture by longitudinal (in part subsequent) streams. Present evidence suggests that the valleys through the limestone ranges may be superimposed. Sufficient covering could have been supplied by a mantle of Grant Formation, of which remnants survive on the Oscar Range. The Devonian Fairfield Beds and Carboniferous Laurel Beds* may also have been more extensive than at the present day.

The broad flood plains of the Fitzroy Valley farther downstream and of Christmas Creek are adjusted to the regional geological structures. The Fitzroy River falls from 355 feet near the hospital at Fitzroy Crossing to 264 feet near the Aerodrome at Noonkanbah Homestead. The broad alluvial plains have a few billabongs and the Fitzroy River has a large anabranch east of Fitzroy Crossing. The banks are commonly steep and the river appears to be cutting into the alluvium.

The alluvial flood plain of the Fitzroy River gives way north and south to slightly more elevated sandy plains on which irregular short seif dunes have developed. Small isolated hills north of the Fitzroy Valley are formed by outcrops of Permian sandstones and by the Fitzroy Lamproite. Outcrops of Carboniferous and Permian rocks form low ridges on the plains in places.

* Recently (1958) re-named "Formation".

(*c*) To the south of the Fitzroy Valley and west of Christmas Creek are sandstone ranges. The largest is the St. George Range, about 30 by 12 miles in area and trending roughly north of west. This is a dissected plateau formed by a dome in the resistant sandstones of the Grant Formation and Poole Sandstone. The maximum height at Mt. Tuckfield is 1,016 feet, about 500 feet above the surrounding plain. Mt. Hutton and its neighbours and the Poole Range are hills of similar type, i.e. dissected plateaux and mesas. The Shore Range comprises linear east-west ridges of resistant Liveringa sandstone. The Barbwire Range is also formed of Liveringa sandstone capped by Jurassic rock.

(*d*) The south-west corner of the area is part of the sand plain of the Canning Desert. Long seif dunes trend at about 280° across the area; they have an average elevation of about 50 feet. A few mesas of Jurassic rock form a low relief.

The following information is extracted from the Atlas of Australian Resources, prepared by the Division of Regional Development, Department of National Development, Canberra:—

The normal mean temperature for the summer months November to February is 90-95° Fahr., and for the winter months: May 70-75° F., June 65-70° F., July 65-70° F., and August 70-75° F. The normal mean annual range of temperatures is 40-50° F. Less than five days of frost are experienced annually. The annual average rainfall is 20-25 inches with a variability of about 30 per cent. Most rain falls from November to March. The monthly averages are: November 1-3 inches, December 3-5 inches, January 5-7 inches, February 4-5 inches, March 3-4 inches.

STRATIGRAPHY AND PALAEONTOLOGY.

The formations exposed on the Noonkanbah Sheet area are summarized in Table 1 and Figure 1. Brief notes on the fossils are included.

STRUCTURE.

The Pinnacle and Fenton Fault lines are the dominant structural features of the area. For a review of the structure, the Sheet area can be divided into three parts: (*a*) the area north-east of the Pinnacle Fault, (*b*) the area between the Pinnacle and Fenton Faults, (*c*) the area south-west of the Fenton Fault.

(*a*) The rocks exposed north-east of the Pinnacle Fault line consist of Precambrian basement with overlying Ordovician, Devonian and Carboniferous sediments, and minor outcrops of Permian Grant Formation.

The Ordovician and Devonian rocks of the Emanuel Range and the Devonian rocks of the Pillara Range strike mainly north-westerly. Normal strike-faulting, parallel to the Fenton line, is present in the Pillara Ranges and Virgin Hills. The Middle Devonian (partly biostromal) Pillara Formation in the Geikie Range has gentle dips of varying strike, possibly mainly initial. Here the Upper Devonian rocks dip away from the Pillara Formation with steep dips—probably initial—in places.

TABLE I.—STRATIGRAPHY OF NOONKANBAH SHEET.

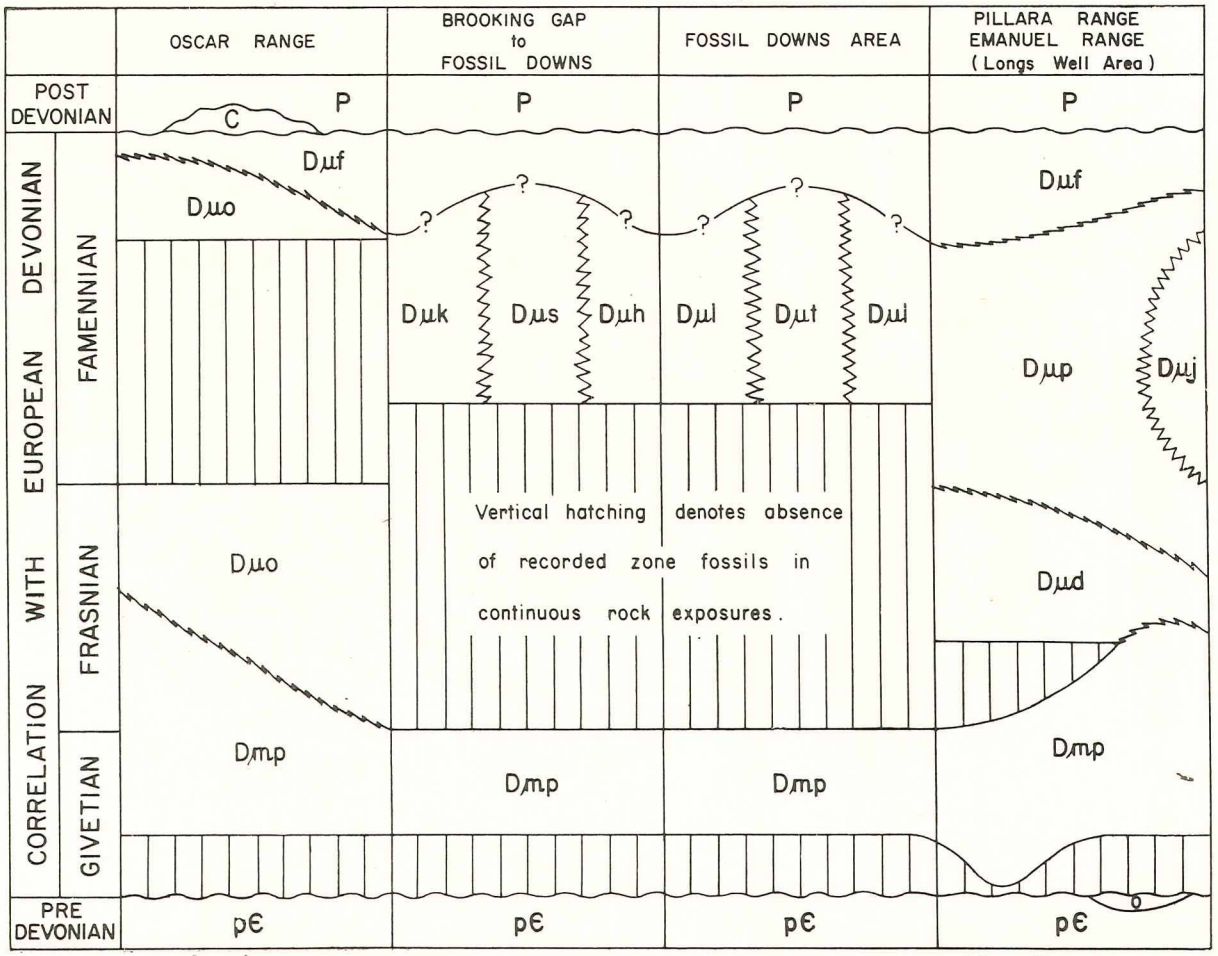
Period.	Age.	Rock Unit and Map Letter Symbol.	Thickness.	Lithology.	Distribution.	Structure.	Topography.	Palaeontology and Age.	Stratigraphic Relationship.	Economic Geology.	Principal References.	Remarks.
QUARTERNARY		Residual black soil .. .. (Qrb)	Superficial ..	Heavy clayey soil, forming shrinkage cracks when dry	North-east parts of area adjacent to limestone outcrops, two small outcrops in south-west		Plains, with regularly arranged shrinkage cracks				Guppy et al. 1958	Commonly developed over calcareous formations
		Other residual soils .. .. (Qrr)	Superficial ..	Variable sandy and clayey soils	Several large areas in western part of sheet		Grassy plains				Guppy et al. 1958	Mainly above Blina Shale and Liveringa Fmn.
		Alluvium .. .. .. (Qra)	0–100 feet	Light textured, usually sandy	Along valleys of Fitzroy River, Margaret River, Christmas Creek and smaller creeks		Flood plains, river banks, terraces; gullying common			Good shallow water in normal seasons	Guppy et al. 1958	
		Travertine, tufa, caliche .. (Qrc)	Superficial ..		Fringing limestone ranges, e.g., Oscar Range, Oscar Plateau, Emanuel and Pillara Ranges		Platforms and low ridges				Guppy et al. 1958	
		Sand dunes.. .. .. (Qs)	0–100 feet	Well rounded quartz sand in part iron-stained	Extensive areas in north-central part of sheet; east of St. George Range and in south-east corner		Plains with ridges (seif dunes)				Guppy et al. 1958	
TERTIARY	?	Pisolitic ironstone	Superficial ..	Ferruginous pisolites and nodules with rock fragments, cemented in sandy ferruginous matrix	Small patch in north-west part of area	Thin capping	Low hills			Road metal	Guppy et al. 1958	
	?	Warrimbah Conglomerate .. (Tw)	50+ feet	Unconsolidated accumulation of pebbles and boulders, rounded and water worn	Scattered areas in west part of sheet, north of the Fitzroy River	Probably old river deposits	Low ridges with exposed boulders	No fossils known, Tertiary possibly			Guppy et al. 1958	
JURASSIC	Lower Portlandian, or Kimmeridgian	Alexander Formation .. (Jua)	Less than 180 feet	Fine to coarse-grained impure quartz sandstones with interbedded siltstones. Sandstone is friable, brown and red. Siltstone pink or purple with mica flakes, sandy lenses	Small mesa in south-west corner ..	Sub-horizontal	Small mesa	Fossils found in Edgar Ranges; ammonites and pelecypods of Lower Portlandian or Kimmeridgian age	Top eroded, unconformable on Permian ..		Brunnschweiler 1954	More extensive outcrops to the west
	Lower Portlandian, or Kimmeridgian	James Sandstone .. .. (Juj)	Less than 80 feet	Medium-grained to conglomeratic sandstone, strongly cross-bedded and ferruginized	Small outcrops in south-west corner ..	Sub-horizontal	Capping low hills ..	No fossils known; correlated with base of Alexander Formation by lithology	Top eroded, unconformable on Permian ..		Brunnschweiler 1954	More extensive outcrops to the west
	Lower Portlandian, or Kimmeridgian ?	Barbwire Sandstone .. (Jub)	70 feet+	Interbedded, red and white siltstone, sandstone with conglomerate lenses	Small outcrops in Barbwire Range in south part of area	Sub-horizontal	Capping on dissected mesas	No fossils; possibly correlated with James Sandstone	Unconformably above Liveringa Formation		Guppy et al. 1958	The Barbwire Range extends southwards
? POST TRIASSIC		Fitzroy Lamproite .. .. (fv)	..	Massive leucite lamproite, volcanic agglomerate with chalcedony coating, volcanic ash	Mount Abbot, Mount Cedric, Machells Pyramid, Mount Gytha, Fishery Hill, Mamilu Hill, Hills' Cone, Wolgidee Hills, Mount Ibis, Kalyeeda Hills, "P" Hill, White Rocks, Brutens Hill, Oscar Plug	Mostly eroded volcanic necks	Mostly more or less rounded hills. Some plugs		Volcanic intrusions into Permian Rocks and into Blina Shale at White Rocks		Wade and Prider, 1940	
TRIASSIC		Blina Shale.. .. .. (Rb)	100 feet+	Grey and brown siltstone, shale and sandy shale, ferruginized conglomeratic sandstone	Scattered outcrops north of Mount Cedric, north of Wolgidee Hills and north-west of Rose's Hill	In synclinal structure above Liveringa Formation	Clay-soil plains with low outcrops	Fossils in area to west of Sheet include bone fragments, *Lingula* and estheriids, some spores. Possibly Upper Triassic	Top eroded, unconformable ? above Liveringa Formation	Poor aquifers, possibly source rock for petroleum	Guppy et al. 1958 Brunnschweiler 1954	
PERMIAN	Upper Permian (probably Tartarian) Late Artinskian to Kungurian	Liveringa Formation .. (Pl)	1,500+–3,000+ feet	Hardman Member quartz greywacke and fine micaceous yellow and olive-green quartz sandstone, partly calcareous, rich marine fauna Intermediate member, thin-bedded ripple-marked sandstones and conglomeratic sandstones, plant fossils. Lightjack Member, similar to Hardman Member, marine fossils	Extensive outcrops in west of area; in Shore Range and south of the Pinnacle Fault line	Folded, some faulting ..	Mainly plains with low ridges; some linear ranges, e.g. Shore Range; some hills, e.g. Mount Hardman	Hardman Member rich in brachiopods, some molluscs and bryozoa (Upper Permian, probably Tartarian). Plants in intermediate beds, including spores. Lightjack Member rich in pelecypods and gastropods, some brachiopods, bryozoa and foraminifera rare ammonoids. Brachiopods common in Shore Range. (Late Artinskian to Kungurian)	Conformably overlies Noonkanbah Formation and unconformably? overlain by Blina Shale	Good aquifers especially in middle member	Guppy et al. 1958 Thomas and Dickins 1954	Disconformities in sequence possible
	Artinskian	Noonkanbah Formation .. (Pn)	1,200+ feet	Shale, calcareous siltstone, limestone, sandstone, intraformational conglomerate, marine fossils	Widespread outcrops in western and southern parts of Sheet	Folded into anticlinal and synclinal folds, some faulting	Plains with low ridges formed by calcareous beds	Numerous brachiopods, bryozoa, crinoids, some corals and molluscs, foraminifera, rare trilobites (Artinskian)	Disconformably overlies Poole Sandstone and is conformably overlain by Liveringa Formation	Possible source rocks for petroleum. Some aquifers	Guppy et al. 1958	
	Artinskian	Poole Sandstone .. .. (Pl). (Nura Nura Member at base)		Thin-bedded, white, fine micaceous quartz sandstone with plant fossils, current-bedded and ripple-marked. Nura Nura Member ferruginous silty quartz sandstone and calcareous sandstone	Flanking Mount Wynne, domal structure in north-west corner and the St. George Range and Poole Range structures	Folded, exposed in domal structures	Hills and dip slopes ..	Plant fossils in higher beds. Marine fauna at base includes brachiopods, molluscs. Some bryozoa, crinoids, and ammonites (Early Artinskian)	Disconformably overlies Grant Formation and overlain probably disconformably by Noonkanbah Formation	Good aquifers	Guppy et al. 1958	
	Sakmarian	Grant Formation .. .. (Pg)		Sandstone, conglomerate, tillite, siltstone, some varves. Intraformational contortions and cross-bedding, some boulders	In core of St. George Range domal structure and Poole Range and Mount Hutton structures. Scattered outcrops in north-eastern area	In cores of domal structures and overlying Ordovician, Devonian and Carboniferous rocks in the north-east	Hills and dip slopes. Rugged mesas in the larger domal structures	Rare wood fragments only. Probably mainly of Sakmarian age	Unconformably overlies Laurel Beds and disconformably overlain by Poole Sandstone	Good aquifers, possible reservoir rock for petroleum	Guppy et al. 1958	Correlated with Lyons Group of Carnarvon Basin
CARBONIFEROUS	Dinantian	Laurel Beds .. .. (Cll)	1,400 feet+	Grey sandy calcarenite, some sandstone at base, inter-bedded grey siltstone and shelly yellow-brown calcarenite in higher beds	South-west of Oscar Range ..	Folded and faulted ..	Mainly plains with low ridges, outcrops commonly flaggy	Rich in brachiopods, some pelecypods and gastrapods, corals, nautiloids, crinoids, shark's teeth, ostracods and conodonts (Dinantian)	Overlies, probably unconformably, Fairfield Beds; unconformably overlain by Grant Formation	Some aquifers in lower beds. Several successful bores	Thomas— 1957 1958b	
DEVONIAN	Famennian	Fairfield Beds .. .. (Duf)	200 feet+	Inter-bedded grey brown and yellow brown fine limestone breccia, calcarenite, sandy and silty limestone, marl and well-sorted sandstone	Needle-eye Rocks, Oscar Hill, area north of "Old Fossil" Homestead, south of Oscar Hill, Virgin Hills	Occupying syncline in Needle-eye area, possibly folded near Oscar Hill	Low hills and ridges ..	Rich in brachiopods, corals, bryozoa, nautiloids (Famennian)	Overlies probably conformably Oscar Formation and Mount Pierre Group; unconformably (probably) overlain by Laurel Beds	No water bores on this Sheet. Good springs	Guppy et al. 1958 Teichert, 1949 Veevers 1958	Fauna corresponds to *Peoductella Zone* (Teichert 1949)
	Famennian	Geikie Formation .. .. (Dus)	1,300 feet maximum	Bedded grey calcarenite, fine limestone breccia, oolitic limestone and some sandy limestone. Small bioherms and massive beds of organic and clastic limestone	Eastern and southern flanks of ranges bordering the Geikie Gorge, west of Brooking Gap	Dips primarily depositional, some compaction possibly over buried ridges	Rugged and in places cavernous. Karst topography	Correlated with Oscar Formation and in part at least with Brooking and Copley Formations. Fossils usually rare and poorly preserved, include brachiopods	Overlies unconformably Pillara Formation, and passes laterally into Copley and Brooking Formations	No water bores attempted. Terrain difficult	Guppy et al. 1958	
	Famennian	Oscar Formation .. .. (Duo)	1,500–2,300 feet	Clastic and organic limestone, contains calcarenite and limestone breccia. Usually thin-bedded; in places massive and reefy	Oscar Range, south-west flank ..	Homoclinal dip of 25°–30°, thought to be primarily depositional	Rugged and broken limestone range. Karst topography	Correlated with Geikie Formation and in part at least with Brooking, Copley and Napier Formations, Fossils, few and poorly preserved, include stromatopoids sponges, rare brachiopods, crinoid stems	Overlies unconformably Pillara Formation and Precambrian and conformably overlain by Fairfield Formation and probably unconformably by Laurel Beds; passes laterally into Brooking Formation	No water bores attempted. Terrain difficult	Guppy et al. 1958	
	Famennian	Brooking Formation .. (Duk)	3,150 feet	Inter-bedded red, grey and mottled clastic limestone, sandy and silty limestone, oolitic limestone, sandstone. Beds lensing and cross-bedded in upper part, scattered bioherms	Brooking Gap area, south-east Oscar Range	Gently folded, dips mainly depositional	Flat or gently undulating surface with flaggy outcrops	Upper beds, at least, correlated with Geikie and Oscar Formations. Fossils few and poorly preserved	Overlies unconformably Pillara Formation and is overlain conformably by Fairfield Formation, north of this area	Possibly some aquifers ..	Guppy et al. 1958	
	Famennian	Copley Formation .. .. (Duh)	2,650 feet	Inter-bedded grey, red, mottled clastic limestone, oolitic limestone, sandy and silty limestone, limestone breccia	Area north of Geikie Gorgie ..	Gently folded, dips mainly depositional	Flat or gently undulating surface with flaggy outcrops	Upper beds correlated with Geikie Formation, sparse brachiopods, gastropods, stromatoporoids and algae	Unconformably overlies Pillara Formation ..	No water bores attempted	Guppy et al. 1958	
	Famennian	Fossil Downs Formation .. (Dul)	1,500–1,700 feet	Calcarenite, clastic limestone, biohermal limestone, limestone, sandy and silty limestone	Area north of Fossil Downs Homestead	Gently folded; dips variable, steep dips primarily depositional	Ranges, hills and plains with scattered outcrop	Correlated with Mount Pierre Group, Oscar Formation. Fossils sparse, include brachiopods, gastropods, stromatoporoids algae, corals and crinoid stems	Unconformably overlies Pillara Formation and Precambrian. Overlain by Fairfield Beds	Some aquifers known ..	Guppy et al. 1958	
	Famennian	Stony Creek Conglomerate .. (Dut)	?	Boulder to pebble conglomerate, greywacke and sandstone. Torrential fanglomerate	North and south of Baobab Creek ..	Unknown	Low rounded hills ..	No fossils. Marginal to marine lithofacies of Fossil Downs Formation	Unconformably overlies Pillara Formation, north of this area	Probably good aquifers. One successful bore	Guppy et al. 1958	
	Famennian and Frasnian	Mount Pierre Group (Dup): Virgin Hills Formation	1,400 feet	Red brown, grey and mottled silty limestone and calcareous siltstone, shale, small bioherms, sandy and conglomeratic facies	Virgin Hills, Mount Pierre, Needle-eye Rocks	Gently folded to sub-horizontal	Mainly grassy plains with shrinkage cracks	Corals, goniatites (Frasnian to Famennian Stufe I.–III.)	Conformably overlies Gogo Formation and unconformably overlies Pillara Formation. Is overlain by Fairfield Beds	Some possible aquifers in sandy and conglomerate facies	Guppy et al. 1958	
	Frasnian	Gogo Formation	1,050 feet	Grey brown bedded limestone, siltstone and shale with concretions	Northern flank of Pillara and Emanuel Ranges	Sub-horizontal	Grassy plains, outcrops rare	Pelecypods, nautiloids, ostracods, coccostean and crustacean fossils (Probably Frasnian)	Conformably overlies Sadler Formation. Overlain conformably by Virgin Hills Formation	Poor for aquifers		
	Famennian	Sparke Conglomerate .. (Duj)	1,000 feet	Boulder to pebble conglomerate, calcareous sandstone, cross-bedded sandstone. Torrential fanglomerate	Virgin Hills	Usually sub-horizontal but irregular	Rounded hills with radial dendritic drainage pattern	No fossils. Marginal lithofacies of Mt. Pierre Group and about same age as conglomerate facies elsewhere in region	Unconformably overlies Pillara Formation and Precambrian and interfingers with marine faunas of Mount Pierre Group. Conformably overlain by Mount Pierre Group	Probably good aquifers ..	Guppy et al. 1958	
	Frasnian	Sadler Formation .. .. (Dud)	700–1,200 feet	Clastic limestone, bioherms and massive reefs, sandy and silty limestone, siltstone. Rich in fossils, many silicified	Northern scarp of Pillara and Emanuel Ranges	Gently folded, some faults. Dips low	Low ridges and gentle hills, flaggy outcrops	Brachiopods, corals, bryozoa, stromatoporoids, molluscs, goniatites (Frasnian)	Unconformably overlies Pillara. Conformably overlain by Mount Pierre Group	Possibly some aquifers ..	Guppy et al. 1958 Veevers 1958	
	Givetian	Pillara Formation .. .. (Dmp)	1,850 feet	Biostromal limestone, bedded limestone, calcareous sandstone, siltstone, marl; marine fossils	Emanuel Range, Home Range, Pillara Range, Geikie Range, Oscar Range, area near Geikie Gorge	Pronounced north-westerly dips in ranges south of Margaret River; elsewhere dips are low	Rugged deeply dissected hills, karst topography. Epi-Permian surface exposed	Abundant biostromal massive and branching stromatoporoids, corals, some brachiopods, bryozoa (Givetian mainly, Frasnian in part)	Unconformably overlies Prices Creek Group and Precambrian. Overlain unconformably by Saddler Formation, Oscar, Geikie, Brooking and Fossil Downs Formations	Probably no aquifers. Terrain difficult for drilling	Guppy et al. 1958	
ORDOVICIAN	Tremadocian to Llandeilian	Gap Creek Formation .. (Og)	630 feet+	Dolomite, silty dolomitic limestone, sandy bands common. Marine fossils	Emanuel Creek to Prices Creek ..	Low north-easterly dip ..	Low strike ridges ..	Brachiopods, trilobites	Conformably overlies Emanuel Formation and unconformably overlain by Pillara Formation	Possibly good aquifers ..	Guppy and Opik 1950 Guppy et al. 1958	
		Emanuel Formation .. (Oe)	1,950 feet	Limestone and shale	Emanuel Creek to Prices Creek ..	Low north-east dip ..	Plains with low strike ridges. Outcrops in Emanuel Creek and nearby	Trilobites, brachiopods, nautiloids, gastropods, graptolites	Overlies either Precambrian or buried older Palaeozoic rocks. Conformably overlain by Gap Creek Formation	Doubtful for aquifers. Possible petroleum source	Guppy and Opik 1950 Guppy et al. 1958	
PRE-CAMBRIAN		Lamboo Complex .. .. (pCl)		Schists, gneiss, slate, phyllite, granite and granitized sediments	Between Virgin Hills and Pillara Range	Complex system, faulted .	Low rounded hills ..		Basement complex	Not known for aquifers ..	Guppy et al. 1958	More exposed north of this area

[*To face page* 6.]

FIG. 1. CORRELATION OF DEVONIAN FORMATIONS

(Adapted from Veevers, J.J., 1958; based on distribution of zone fossils.)

Letter symbols as in Table 1. ~~~ *Unconformity* *Interfingered formational boundary*



WA 3E-51 F.J.R.

South of the Margaret River the Upper Devonian beds dip gently off the Pillara Formation without marked unconformity and near Mt. Pierre form a gentle synclinal basin. Minor north-south faulting occurs in places.

The Carboniferous rocks contain numerous small folds and north-west-trending faults.

(*b*) The Pinnacle Fault has a trend of about 310°, roughly parallel to the structural trends in the Proterozoic rocks farther north. The Pinnacle structure is best exposed south of the Emanuel Range but is believed to extend to the north-west. The Pinnacle structure line marks the southern limit of outcrop of Ordovician, Devonian and Carboniferous rocks. The only Permian rocks exposed are small outcrops of Grant Formation. It is thought that the area north of the fault was a shelf in Devonian times and was only slightly transgressed by Permian seas. Seismic traverses across the Pinnacle Fault, near Prices Creek, indicate about 20,000 feet of sediments below the Talbot syncline south of the fault, and about 1,600 feet of sediments north of the fault (Smith, 1955). Basement rocks of the Lamboo Complex were reached at 672 feet in B.M.R. No. 3 bore at Prices Creek (Henderson, 1956c). Guppy et al. (1958) consider that the Pinnacle line is a fault along which movement occurred after the deposition of the Grant Formation and which continued during the deposition of the later Permian beds. Casey and Condon (in Appendix V. to Guppy et al.) have put forward an alternative interpretation of the Pinnacle and Fenton Faults. They state that "although faulting has been established along these structures, it may be not the dominant structure but a secondary feature representing the surface trace of an underlying unconformity or subsurface 'high'". The section A-B-C of the map shows Condon's interpretation of the subsurface geology at the Pinnacle structure, in terms of a high-angled unconformity with a subsurface ridge to the north. The Pinnacle structure is not exposed north-west of the Prices Creek area and no geophysical or bore information is available.

The Fenton Fault is roughly parallel to the Pinnacle Fault. Exposures near Mt. Fenton show faulting with a north-easterly hade. Seismic and gravity data are not available for this part of the area but in the west at Mt. James, and farther north-west, gravity surveys suggest a rapid thickening of sediments to the north of the Fenton Fault. At Mt. James the estimated "downthrow" to the north is 12,000 feet (Wiebenga and van den Linden, 1953). The Fenton Structure is considered by Guppy et al. to be essentially a fault with downthrow to the north and with variable displacement. The section line D-E shows Condon's interpretation of the subsurface structure at Mt. Fenton.

The Permian and possibly the Triassic sediments between Pinnacle and Fenton Faults are folded and faulted. A major anticlinal axis extends across the area obliquely to the dominant structural lines. This axis is a continuation of the southern anticlinal axis of the Fitzroy Basin (Guppy et al. 1958). South of it is the McLarty Syncline adjacent to the Fenton Fault, and north of it is a synclinal axis with Triassic rocks exposed in the north-west of the Sheet area. Farther east the synclinal axis becomes obscure except near the Pinnacles,

where the Talbot Syncline is exposed adjacent to the Pinnacle Fault. The anticlinal axis has two domal culminations, the St. George Range and the Mt. Hutton-Poole Range Structures. The Grant Range has a core of exposed Grant Formation flanked by Poole Sandstone and Noonkanbah Formation. The dips at the surface on the northern flank reach 5°, and on the southern, where a secondary dome is present, 3-14°.

The Poole Range-Mt. Hutton Structure is generally similar, with surface flank dips of 3 to 5 degrees. Seismic surveys indicate that this structure persists in depth on the north and east flanks at least. Unconformities were indicated at 8,000 and 13,000 feet on the north-east flank towards the Talbot Syncline (Smith, 1955; Williams, 1956). Reflections continued to about 20,000 feet.

Both the Poole Range-Mt. Hutton and the St. George Range Structures are affected by roughly north-south faults, which are high-angled, apparently normal, faults of varying throw. It is not certain whether the Blina Shale is conformable or unconformable on the Liveringa Formation, and hence the age of the major folding of the Permian is uncertain. Some folding may have been taking place in Permian times.

(*c*) The Jurassic rocks exposed south of the Fenton Line are nearly horizontal; downwarping, perhaps with some faulting, may have occurred in this part of the area in Jurassic times. Outcrops of Jurassic rocks are rare north of the Pinnacle Fault line but are found in the Barbwire Range.

ECONOMIC GEOLOGY.

Underground Water.

Surface water supplies do not meet all the needs of the pastoral community in this area, and the underground water resources are of great importance. At least 124 bores and wells are known to yield water. In most of them, the water is sub-artesian and is pumped out by mills. The underground waters are generally suitable for stock, but not all are potable. Table 2, which lists available data on successful bores, is derived from tables in Guppy et al. (1958). Brief notes on the underground water resources of the different formations are included in Table 1.

Petroleum.

No oil or gas seepages are known, but traces of petroleum have been obtained from shallow bores in the Ordovician rocks at Prices Creek, where oil was first reported from a water bore in 1919. Oil showings have also been reported from the Poole Range bores in the Grant Formation.

The Ordovician Prices Creek Group contain potential source beds in the Emanuel Formation and possible reservoir beds in the Gap Creek Formation. The Ordovician rocks may continue at depth south of the Pinnacle structure line. Some 20,000 feet of sediments are suggested by seismic survey below the Talbot Syncline and near the Poole Range Structure.

The Devonian rocks, in outcrop, do not reveal obvious potential source rocks, except possibly the fine silty facies of the Mt. Pierre Group, which also

contains suitable cap rocks. The Upper Devonian conglomerates form potential reservoir rocks. Outcropping reefs and bioherms point to the possibility of buried reef structures south of the Pinnacle Fault Line, but only if sufficiently elevated sea floors existed there in Devonian times.

Outcrops of Carboniferous rock consist of siltstone, limestone and sandstone. The siltstone and limestone are possible source rocks and cap rocks, and the sandstone is a possible reservoir rock.

The Permian rocks known in outcrop contain possible reservoir rocks in the Grant, Poole and Liveringa Formations, with cap rocks in the Noonkanbah Formation and in the Triassic Blina Shale. The Noonkanbah Formation might be in part a source rock.

The known outcropping potential oil structures are the Poole Range-Mount Hutton Dome and the St. Georges Range Dome; both are faulted. Seismic surveys indicate that the Poole Structure persists in depth with unconformities at 8,000 and 13,000 feet on the north-east flanks. The Freney Oil Co. Ltd. (forerunner of Freney Kimberley Oil Co.) sank five bores in the Poole Range from 1926 to 1930. The deepest of these—No. 3—went to 3,264 feet in Grant Formation. Oil was reported at 2,085 feet, and a small sample sent to the Government Analyst, Perth, had a mixed paraffin and asphaltic base.

Oil showings were reported from shallow bores put down in the Ordovician rocks at Prices Creek between 1919 and 1923. The B.M.R. No. 3 bore, sunk for stratigraphical information, went through 200 feet of dolomitic sandstone, 390 feet of arkosic sandstone, 62 feet of basic volcanics and about 40 feet of basement schist and hornfels.

The St. Georges Range structure is larger than the Poole Structure, but is farther away from known Ordovician rocks and from known reef conditions in the Devonian. Bores drilled in the Grant and Nerrima structures, farther west, have been unsuccessful. In both these bores, thick successions of unexpected lacustrine to shallow marine Upper Carboniferous rocks were met at depth. These formations were generally too tight to act as reservoir rocks.

B.M.R. No. 2 bore went through about 1,400 feet of Carboniferous Laurel Beds and bottomed in Devonian rocks at 4,000 feet. No oil traces were obtained.

The surface structures (Poole and St. Georges Ranges) offer the best promise for locating oil; possible buried reefs and other structures should also be sought. More exploratory drilling and detailed geophysical survey will be necessary to locate any such buried structures.

Other Economic Materials.

No mineral other than water has been exploited, as far as is known. The abundant limestone and dolomitic limestone could form a source of agricultural lime and dolomite. If suitable clays are available, the limestone could be utilized for cement making.

Water Bores.	Depth.	Type.*	Strata.
	Feet.		
Liveringa Station—			
Butler's No. 15	65	S.A.	Liveringa
Audrey No. 29	150	B	Liveringa (aquifer)–Noonkanbah
Boundary	178	S.A.	Liveringa
Churchill No. 32	375	S.A.	Liveringa
Darling	165	S.A.	Liveringa
Mickey No. 2	183	S.A.	Liveringa
Mount Hardman	461	S.A.	Liveringa
Mount Hardman Dam ..	206	S.A.	Liveringa
Outcamp No. 2	113	B	Liveringa (below Blina)
Ross No. 1	580	S.A.	Liveringa
Ross No. 2	105	S.A.	Liveringa
Roosevelt No. 1	230	S.A.	Liveringa
Roosevelt No. 2	152	S.A.	Liveringa
Salty No. 35	285	S.A.	Liveringa
Sears	215	S.A.	Liveringa–Noonkanbah
Scholls	435	S.A.	Liveringa (aquifer)–Noonkanbah
Stock Gate	72	S.A.	Liveringa
Shadford	170	S.A.	Liveringa
No. 21	..	..	..
Kalyeeda Station—			
Andy's	190	S.A.	Liveringa
Rodney's	300	S.A.	Liveringa
Robert's	175	S.A.	Liveringa
Calwynyardah Station—			
Boundary	?	B	..
Egan's	248	S.A.	Liveringa
Laymans	500	W	Noonkanbah (aquifer)–bottom Liveringa
Little Laymans	?	W	..
Jerome	210	S.A.	Liveringa (aquifer)–top Noonkanbah
Metters	350	S.A.	Liveringa–top Noonkanbah
Noonkanbah Station—			
No. 2	360	S.A.	Noonkanbah
No. 4	150	S.A.	Noonkanbah
No. 3	600	S.A.	Noonkanbah
No. 5	97	S.A.	Liveringa
No. 6	341	S.A.	Blina–Liveringa
No. 7	500	S.A.	Blina–Liveringa (aquifer)
No. 8	208	S.A.	Blina–Liveringa (aquifer)
No. 9	192	S.A.	Liveringa
No. 10	150	S.A.	Noonkanbah
No. 12	363	S.A.	Liveringa
No. 13	650	S.A.	Blina–Liveringa (aquifer)
No. 14	672	S.A.	Liveringa
No. 15 Ballinger Tank ..	494	S.A.	Blina–Liveringa (aquifer)
No. 16 Fred's Tank ..	344	S.A.	Blina–Liveringa (aquifer)
No. 17	684	B	Blina
No. 18	800	S.A.	Blina
No. 19	485	S.A.	Blina
No. 20 White Rocks ..	780	S.A.	Blina
No. 21 Emu Hole	160	B	Liveringa
No. 23	423	S.A.	Blina
No. 29 Maranghi	107	S.A.	Noonkanbah
No. 32 Mickeys	42	S.A.	Liveringa
No. 33	398	B	Blina
No. 34	356	S.A.	Liveringa–Blina
No. 35 Boundary	422	S.A.	Liveringa
No. 37	35	S.A.	Liveringa
No. 38 Warrimbah	100	S.A.	Liveringa
No. 39	295	S.A.	Liveringa

* A = artesian; S.A. = sub-artesian; B = bore on which no flow data are available; W = well.

Water Bores.	Depth.	Type.*	Strata.
	Feet.		
Noonkanbah Station—continued.			
No. 40	..	S.A.	..
No. 42 Paddy's	80	S.A.	Liveringa
No. 43 Mallala	60	S.A.	Liveringa
No. 44 Lizzie's	210	S.A.	Liveringa
No. 45 Duncans	..	S.A.	Liveringa
No. 46 Thommy's	..	S.A.	..
No. 47 David	..	S.A.	..
Little Bohemia	..	S.A.	..
Quanbun Station—			
Boab	150	S.A.	Liveringa
Bloodwood	365	S.A.	Liveringa
Bowden	179	B	Blina–Liveringa
Brennan	206	S.A.	Blina–Liveringa
Egan	150	S.A.	Blina–Liveringa
Furlong	202	S.A.	Poole
Laymen	540	S.A.	Noonkanbah
Leichhardt	215	S.A.	Noonkanbah–Poole (aquifer)
Little Bohemia	284	S.A.	Liveringa
Minnie	300	S.A.	Noonkanbah
Pinjarra	238	S.A.	Poole
Thompson	167	S.A.	Triassic
2 mile	707	S.A.	Liveringa
Victory	..	B	..
Quanbun Butte	..	B	..
Youella	190	S.A.	Poole
Jubilee Station—			
No. 1	180	S.A.	Liveringa–Noonkanbah (aquifer)
No. 2	120	S.A.	Grant
No. 3	230	S.A.	Grant
No. 4	335	S.A.	Grant
No. 5	350	S.A.	Grant
No. 6	300	?	Liveringa–Noonkanbah
Laurel Downs Station—			
Laurel Downs Homestead ..	?	B	Laurel
Unnamed bore	?	B	Laurel
Fossil Downs Station—			
Bullock Paddock	..	S.A.	..
Champagne	68	S.A.	Fossil Downs Fm.
Fossil Downs Homestead ..	..	S.A.	Fossil Downs Fm.
Nelliabubbaca	107	S.A.	Fossil Downs Fm.
Old Fossil	..	S.A.	Stony Creek Conglom.
Red Hill	?	S.A.	? Stony Creek Conglom.
Cherrabun Station—			
Alberts	?	S.A.	Noonkanbah–Poole
Big Moana	..	B	Noonkanbah–Poole
Brutens	?	S.A.	Noonkanbah
Blue Bush	?	S.A.	Noonkanbah–Poole
Cockatoo	?	A	Noonkanbah
Donkey Gorge	?	S.A.	Noonkanbah–Poole
Gap Mill	?	S.A.	Noonkanbah–Poole
Paradise	..	S.A.	..
Rexona	170	S.A.	Poole
Surprise	?	S.A.	Noonkanbah

* A = artesian; S.A. = sub-artesian; B = bore on which no flow data are available; W = well.

Water Bores.	Depth.	Type.*	Strata.
	Feet.		
Christmas Creek Station—			
Barry	161	S.A.	Noonkanbah–Poole (aquifer)
Figtree	?	S.A.	Noonkanbah
Homestead	518	A	Noonkanbah–Poole (aquifer)
Six Mile	?	S.A.	Poole–Grant
Dusty Outcamp	..	B	..
Prices Bore	..	B	..
Bloodwood	..	S.A.	..
Woods	?	A	Noonkanbah–Poole
Middle	?	A	Noonkanbah–Poole
Margaret Downs Station—			
Bobs	216	B	Sparke Conglom.
Three Mile	70	S.A.	Grant
Eight Mile	50	S.A.	Grant
Snake	148	S.A.	Grant
Turkey Well	..	B	..
Chestnut	..	S.A.	..
Virgin Creek	?	B	Sparke Conglom.
No. 2	200	S.A.	Grant
No. 3	360	S.A.	Grant
Emanuel	..	S.A.	..
No. 1	165	S.A.	Grant
Brooking Springs Station—			
Egans Bore	?	B	Laurel Beds

* A = artesian; S.A. = sub-artesian; B = bore on which no flow data are available; W = well.

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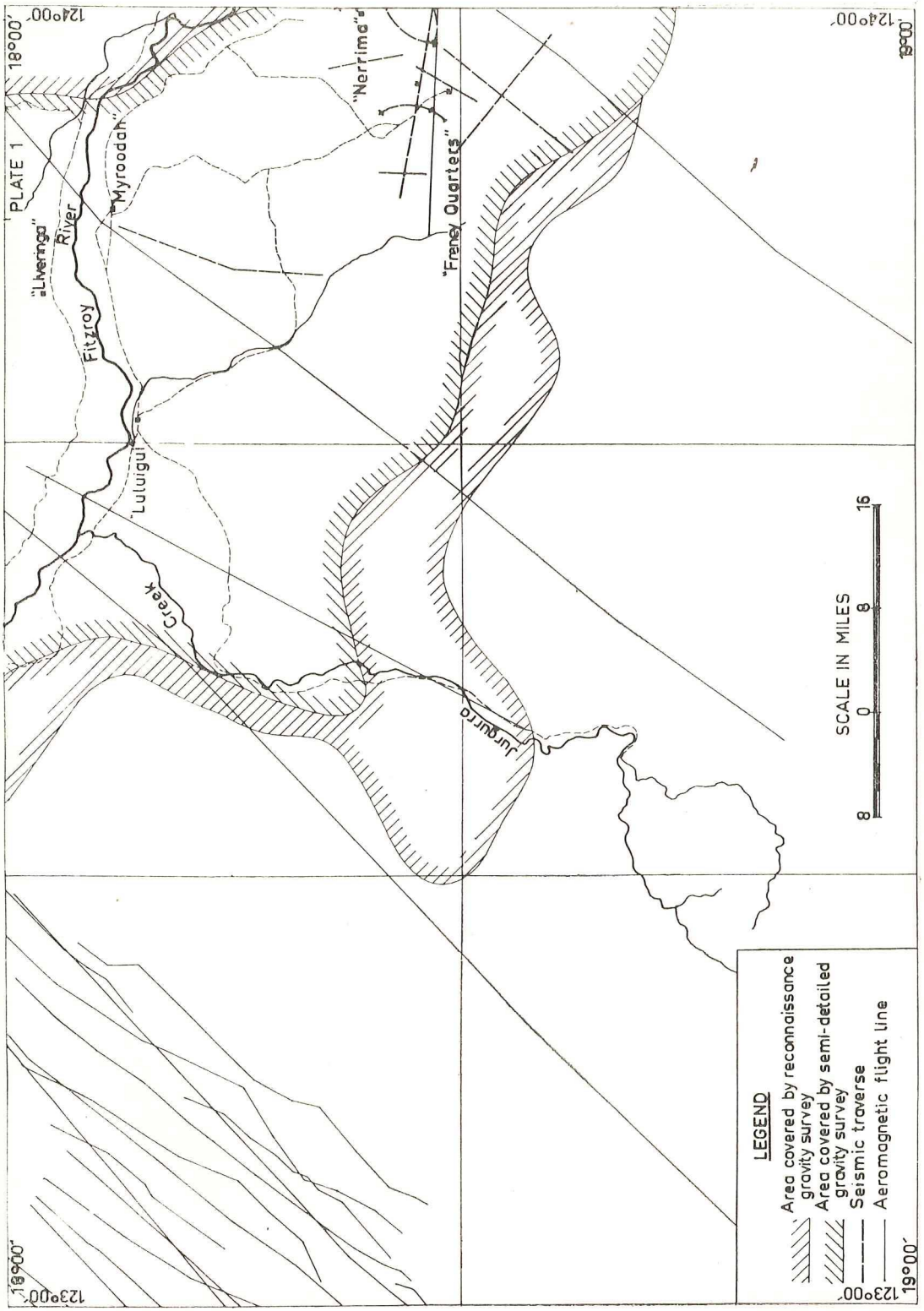

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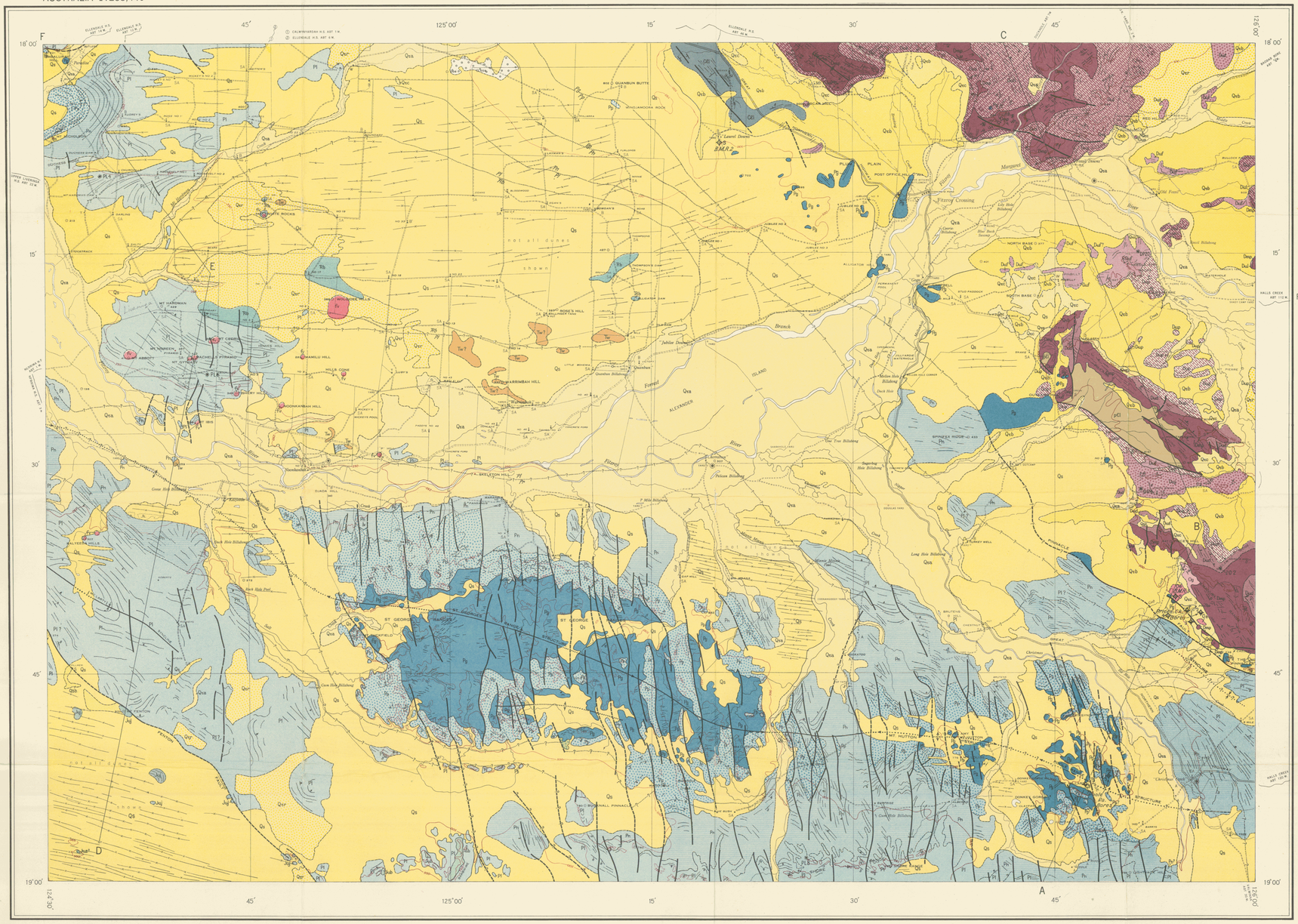
NOONKANBAH

WESTERN AUSTRALIA

AUSTRALIA 1:253,440

4 MILE GEOLOGICAL SERIES SHEET E51-12

FIRST EDITION 1956



Reference

Geological boundaries

- Established boundary, position accurate
- Established boundary, position approximate
- Inferred, probable or indefinite boundary
- Established boundary, concealed by younger formation
- Inferred, probable or indefinite boundary, concealed

Strike and dip of strata

- Inclined
- Dip 0°-15° (from photo-interpretation)
- Dip 15°-45° (from photo-interpretation)
- Trend of bedding (from photo-interpretation)

Folds

- Established anticlinal crest - position accurate (showing direction of plunge)
- Established anticlinal crest - position approximate (showing direction of plunge)
- Established synclinal trough - position accurate (showing direction of plunge)
- Established synclinal trough - position approximate (showing direction of plunge)
- Established fold axis concealed, position accurate
- Established fold axis, concealed, position approximate

Faults and Joints

- Established fault - position accurate
- Established fault - position approximate
- Probable fault
- Established fault concealed by younger formation
- Inferred, probable or indefinite fault, concealed
- Joint patterns from photo-interpretation
- PL6 Text reference-B.M.R. Bull. 36

- Highway
- Vehicle track
- Homestead
- Telephone or telegraph line
- Fence
- Aerodrome
- Bore with wind pump
- Sub-artesian bore with wind pump
- Tank
- Well
- Spring
- Swamp
- Dune
- Minor control points.
- Dry oil bore, S= stratigraphic bore only
- Dry oil bore with show of oil.
- Contour - interval 250 feet
- Spot height in feet

Reference

QUATERNARY		Qxb	Residual black soil
		Qxr	Other residual soils
		Qza	Alluvium
		Qzc	Travertine, tufa[calithe]
		Qs	Sand, dunes
TERTIARY			Pisolitic ironstone
	Warrimbah Conglomerate	Tw	Poorly consolidated boulder beds forming old river terraces
	? Unconformity ?		
JURASSIC	Alexander Formation	Jua	Thin bedded sandstone with alternations of siltstone; marine fossils
	James Sandstone	Jsj	Strongly cross-bedded ferruginised conglomeratic sandstone
	Barbwire Sandstone	Jub	Unsorted conglomeratic silty sandstone, and white siltstone
	? Unconformity ?		
POST TRIASSIC	Fitzroy Lamproite	Fz	Leucite-rich volcanic rocks
	Unconformity		
TRIASSIC	Blina Shale	Trb	Grey and brown siltstone, shale and sandy shale exposed; blue grey shale in bores; marine fauna
	? Unconformity ?		
PERMIAN	Liveringa Formation	Pl	Micaceous silty sandstones, conglomeratic sandstone and silty sandstones; strongly ferruginised
	Noonkanbah Formation	Pn	Shale, siltstone, limestone, intraformational conglomerate
			Disconformity
	Poole Sandstone	Pp	Well or thinly bedded micaceous silty sandstone and sandstone: well developed current bedding and ripple marking
			Unconformity
	Grant Formation	Pg	Massive aqueoglacial unsorted silty sandstones, conglomeratic sandstone, tillite, siltstone shale, and varved rocks
	Unconformity		
CARBONIFEROUS	Laurel Beds	Clb	Calcarenite, sandy and silty limestone, and siltstone
	Unconformity		
UPPER DEVONIAN	Fairfield Beds	Duf	Limestone breccia, calcarenite, sandy and silty limestone, marl and sandstone
	Geikie Formation	Dug	Grey calcarenite, oolitic limestone, and limestone breccia; small bioherms
	Oscar Formation	Duo	Limestone breccia, calcarenite, and biohermal limestone
	Brooking Formation	Dub	Red, grey and mottled limestone breccias, calcarenite, sandy limestone, silty limestone, oolitic limestone, small bioherms
	Copley Formation	Duc	Interbedded grey, red, and mottled clastic limestone, oolitic limestone, sandy limestone, and silty limestone
	Fossil Downs Formation	Duf	Calcarenite, limestone breccia, limestone, and biohermal limestone
	Stony Creek Conglomerate	Dus	Boulder and pebble beds
	Mt. Pierre Group	Dup	Grey and brown-bedded limestone, siltstone, and shale; and red calcareous siltstone, silty limestone, shale, and bioherms
	Sparke Conglomerate	Dus	Boulder and pebble beds
	Sadler Formation	Dud	Clastic limestone, silty limestone, sandy limestone, and bioherms
	Unconformity		
MIDDLE DEVONIAN	Pillara Formation	Dmp	Biostromal limestones, well bedded limestone, calcareous sandstone, siltstone, and marl
	Unconformity		
ORDOVICIAN (Prices Creek Group)	Gap Creek Formation	Og	Dolomite, sandstone, and silty dolomitic limestone
	Emanuel Formation	Oe	Limestone and shale
	Unconformity		
LOWER PROTEROZOIC & (?) ARCHAEOZOIC	Lamboo Complex	pCl	Schists, gneiss, slate, phyllite, granite, and granitized sediments

Compiled by the Bureau of Mineral Resources, Geology and Geophysics, Department of National Development. Topographic base from compilations by Royal Australian Survey Corps and Department of Lands and Surveys, Western Australia, from vertical small scale air photography by the Royal Australian Air Force. Published by the Bureau of Mineral Resources. Transverse Mercator Projection.

INDEX TO ADJOINING SHEETS
Showing Magnetic Declination

DERBY	LENNARD RIVER	LANSDOWNE
MT ANDERSON	NOONKANBAH	MT RAMSAY
MC LARTY HILLS	CROSSLAND	MT BANNERMAN

ANNUAL CHANGE 1°42'W

Scale
4 Miles to 1 inch

0 4 8 12 16 Miles
5 0 5 10 15 20 Kilometres

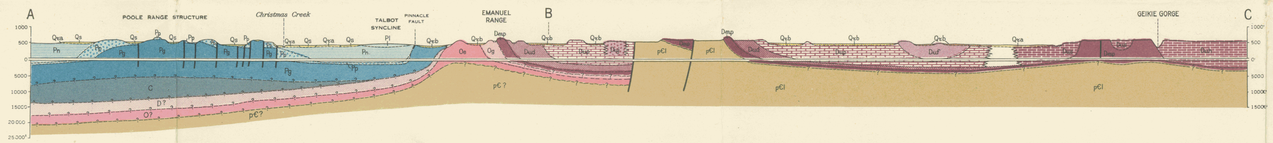
GEOLOGICAL RELIABILITY DIAGRAM

B Detailed reconnaissance - numerous traverses with photo-interpretation
C Photo-interpretation

Geology and compilation by: D. J. Guppy, A. W. Lindner, J. H. Rattigan, J. N. Casey, J. O. Cuthbert, G. A. Thomas, December, 1955
Sections compiled by: G. A. Thomas and M. A. Condon August, 1956.
Drawn by: A. J. Saunders.

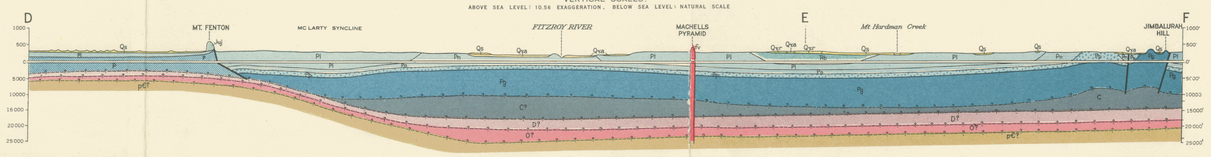
Section A-B-C

VERTICAL SCALES:
ABOVE SEA LEVEL: 10.56 EXAGGERATION. BELOW SEA LEVEL: NATURAL SCALE



Section D-E-F

VERTICAL SCALES:
ABOVE SEA LEVEL: 10.56 EXAGGERATION. BELOW SEA LEVEL: NATURAL SCALE



IN SECTION ONLY:
Undifferentiated

- P PERMIAN
- C CARBONIFEROUS
- D DEVONIAN
- O ORDOVICIAN
- pC PRECAMBRIAN

NOONKANBAH
SHEET E51-12

Copies of this map may be obtained from Bureau of Mineral Resources, Geology and Geophysics, Canberra, A.C.T., or Geological Survey of Western Australia, Perth, W.A.

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