1:250,000

GEOLOGICAL SERIES

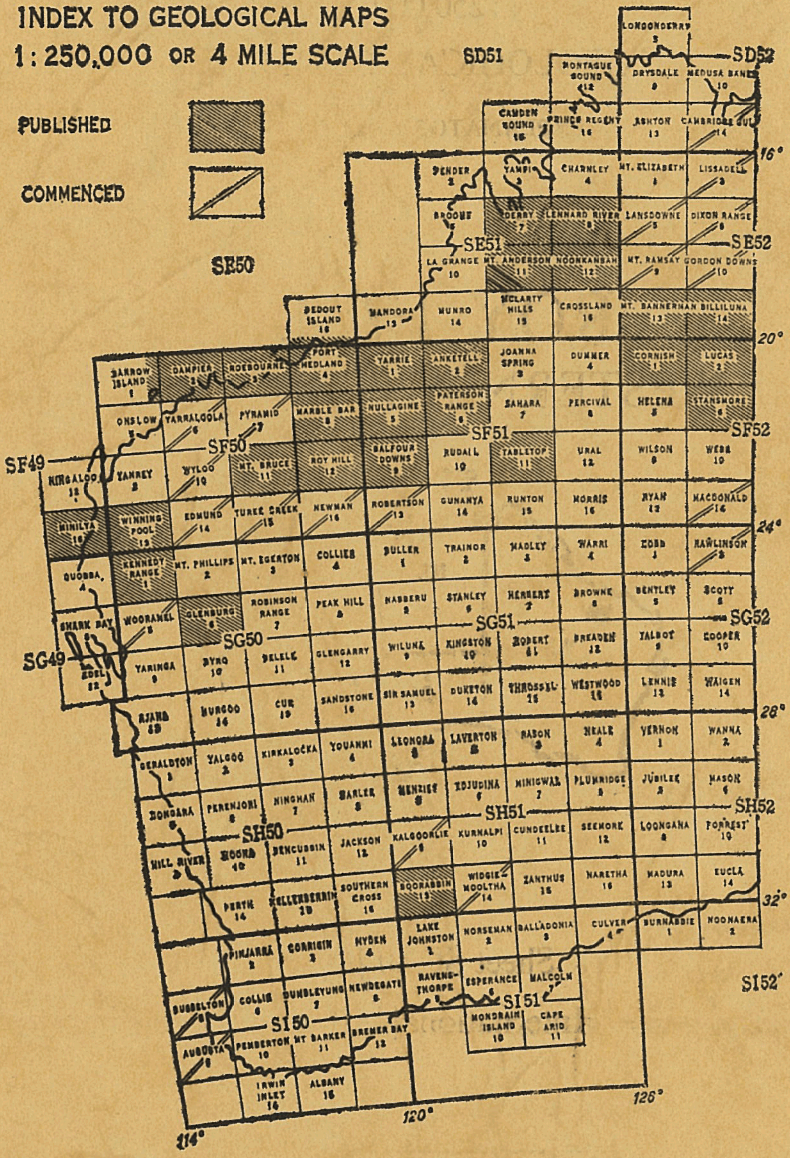
EXPLANATORY NOTES

ROY HILL
WESTERN AUSTRALIA

Sheet SF/50-12

International Index

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

ROY HILL
WESTERN AUSTRALIA

Sheet SF/50-12

Compiled by W. N. MacLeod and L. E. de la Hunty

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6266—1

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 Roy Hill Geological Sheet

Compiled by

W. N. MacLeod and L. E. de la Hunty

INTRODUCTION

The Roy Hill 1:250,000 Sheet, SF/50-12, is bounded by latitude 22° and 23°S and by longitude 118° and 120°E. There are no towns within the area, but Wittenoom Gorge lies about 12 miles beyond the western boundary, and the small centre of Nullagine is about 10 miles north of the northeastern corner. The eastern section is traversed by the Great Northern Highway, the central section by the main road from Wittenoom Gorge to Roy Hill, where it joins the Great Northern Highway, and the northwestern section by the road from Wittenoom Gorge to Port Hedland.

Pastoral stations and access roads and tracks are numerous in the central and northern sections of the area, but to the south it is uninhabited and tracks are few. The flat and comparatively well-grassed broad plain of the Fortescue River, which occupies most of the centre, is suitable for grazing, in contrast to the rough and sparsely vegetated hilly country of the Hamersley Range in the south. Pastoral stations wholly or partly in the map area are Roy Hill (sheep and cattle); Ethel Creek and Hillside (cattle); and Mulga Downs, Marillana, Bonney Downs, Bamboo Springs, and Warrie (all sheep).

No mines are being worked at present. Small quantities of blue asbestos have been mined in the past at Dales Gorge and near Weeli Wolli Spring. The economic minerals of greatest potential are the large hematite deposits in the iron formations near Weeli Wolli Spring and in the Chichester Range, and the pisolitic limonite deposits at Dales Gorge, Yandicoogina Creek, Mindy Mindy Creek, Coondiner Creek, and Weeli Wolli Creek. The existence of these iron deposits stimulated the present geological investigation.

HISTORY OF INVESTIGATIONS

In the early survey of the Pilbara Goldfield between the years 1903 and 1905, A. G. Maitland (1908) traversed the extreme northern portion of the Roy Hill Sheet area, but his geological observations were mainly confined to the granite. H. P. Woodward (1910) traversed the valley of the Fortescue River in 1909 and a more complete geological reconnaissance of the area was made by H. W. B. Talbot between 1912 and 1914 (Talbot, 1920).

L. de la Hunty (1955) made a brief report on a manganese deposit on Warrie Station, and (1963) on several others in the Sheet area. In the course of mapping the adjacent Balfour Downs 1:250,000 Sheet area in 1959, de la Hunty and Sofoulis (de la Hunty, 1964) mapped a strip about 5 miles wide down the eastern edge of the Roy Hill Sheet area, and Sofoulis (1960) sampled a hematite deposit 6 miles north of Roy Hill homestead, on the eastern side of the Great Northern Highway. In 1960, de la Hunty (1962) sampled a limonite deposit at Yandicoogina Creek.

In 1961, The Broken Hill Pty. Co. Ltd. was granted reserves extending westwards from the Roy Hill deposit to the western part of the Sheet area, and the hematite deposits on the Marra Mamba Iron Formation were mapped by the Company. The Company also put down numerous diamond and percussion drill holes in these deposits, mainly in the Roy Hill locality, and investigated the pisolitic limonite deposits in Yandicoogina Creek.

The Roy Hill Sheet area was mapped in the winter of 1963 by W. N. MacLeod and L. E. de la Hunty. MacLeod mapped the Hamersley Range area south of the Wittenoom Gorge/Roy Hill road and de la Hunty mapped the greater part of the Fortescue Plain and the Proterozoic sediments in and north of the Chichester Range. The Institut Français du Pétrole, Bureau des Etudes Géologiques, Mission in Australia, made a photo-interpretation map of the Roy Hill 1:250,000 Sheet at the request of the Geological Survey of Western Australia (de Lassus St. Genies, 1963). The interpretation map was not available until after the completion of field mapping but it was of considerable value in the ultimate compilation.

United States Metal Refining Co. Ltd., a wholly owned subsidiary of American Metal Climax Inc., began a regional survey of the iron ore deposits in the eastern Hamersley Range and Ophthalmia Range in September 1963. The company generously made their chartered helicopter available to the Geological Survey to facilitate mapping of inaccessible country near the southern boundary of the Roy Hill Sheet and on the adjoining Newman Sheet. W. N. MacLeod assisted the company geologists in the search for and mapping of hematite deposits in the Weeli Wolli area. Some of the hematite deposits in the extreme southwestern sector of the Sheet were examined and sampled by R. Halligan of the Geological Survey.

PHYSIOGRAPHY

There are three well-defined physiographic divisions in the area of the Roy Hill Sheet, which are consequential on the lithology and structure of the underlying geological units. These are:

1. The rugged and elevated country of the Hamersley Range, which occupies the southwestern part of the Sheet area.
2. The level monotonous Fortescue Plain, which extends across the area from east to west and ranges between 16 and 45 miles in width.
3. The dissected hilly country north of the Fortescue Plain, which extends across the entire northern section of the Sheet area.

The *Hamersley Range* presents essentially the same physiographic character as is seen in the adjoining area of the Mt. Bruce Sheet to the west (de la Hunty, 1965). The topography is controlled by the disposition and attitude of the resistant iron formations within the Hamersley Group of Proterozoic sediments, in particular the thick and widespread Brockman Iron Formation. The bold scarp along the northern edge of the Hamersley Range marks the present northernmost extent of the Brockman Iron Formation. This scarp has been formed by headward erosion of the iron formation and the softer underlying dolomite and shale by the north-flowing tributaries of the Fortescue River.

Within the range there is a succession of plateaux and broad basins which mirror the gentle fold patterns of the overall regional structure. Anticlines are cored with the resistant Brockman Iron Formation and, as the general fold trends are in an easterly direction, most of the prominent hill masses and ranges have a similar orientation. The deep, broad valley occupied by the western branch of Yandicoogina Creek is a syncline underlain by the less resistant ferruginous shale and dolerite of the Weeli Wolli Formation. The east-trending syncline just north of Weeli Wolli Spring has the same geological structure occasioned by the lower resistance of the geological units which lie above the Brockman Iron Formation.

The large drainage basin south of Weeli Wolli Spring is an anticline formed by regional doming of the Brockman Iron Formation and dissection of the softer underlying units in a similar fashion to the northern edge of the Hamersley Range along the Fortescue Valley.

The old Tertiary land surface is extensively preserved within this area of the Hamersley Range and there is abundant evidence of the vigorous stream rejuvenation which must have been initiated in late Tertiary or early Pleistocene time. The old surface is best preserved towards the western section of the area between Dales Gorge and the headwaters of Yandicoogina Creek, and in the extreme southern area between Coondiner and Mindy Mindy

Creeks, where there are deep, vertical-walled gorges which have been incised into the old surface, producing a topography similar to that in the vicinity of Wittenoom Gorge.

The broad and almost featureless *Fortescue Plain* presents a striking topographic contrast to the Hamersley Range. The generally level surface is punctuated by occasional low hills and ridges capped with chert breccia or opaline silica. The channel of the Fortescue River is ill-defined for most of its length in this area and is completely lost in salt marsh in the eastern half. Tributaries from north and south have ill-defined, braided, meandering channels which often end in distributaries, 2 or 3 miles short of the channel of the main river.

Along the northern edge of the Hamersley Range there are wide outwash fans of detrital material extending in places for several miles on to the plain. The Wittenoom Dolomite, which has comparatively low resistance to erosion, underlies the plain, whose great width is due to the extremely low angle of dip of the sediments. In the course of protracted erosion the broad valley has been progressively infilled with a variety of detrital materials and local thicknesses of these deposits suggest that lacustrine conditions may have existed in more pluvial periods. In different areas the plain is capped with laterite, calcrete, opaline silica, and unconsolidated dune sand. The plain offers the best prospects for underground water supplies and for this reason most pastoral activity is to be found there.

The *northern physiographic unit* is defined on its southern side by the Chichester Range, which extends as a continuous line of low hills across the full width of the area for a distance of 100 miles. This range is capped by outcrop of the Marra Mamba Iron Formation, which here emerges from beneath the dolomite underlying the Fortescue Plain in consequence of the low southerly regional dip of the sediments. The Chichester Range is the principal watershed, dividing the Fortescue from the Shaw drainage system to the north. The shales, calcareous sediments, basalts, and pyroclastics which conformably underlie the Marra Mamba Iron Formation with a gentle regional dip to the south have been dissected to a terrain of low mesaform hills separated by steep-walled narrow valleys. The topography is rigidly controlled by the relative resistance to erosion of the various components in the succession, and by minor zones of gentle folding which cause local deviations in dip and strike of the beds. The granite near the extreme northern boundary of the area weathers to a gently undulating stony terrain broken by occasional low bouldery hills.

STRATIGRAPHY

The area covered by the Roy Hill Sheet is within the Hamersley Iron Province (MacLeod and others, 1963). The geology is essentially the same as that of the Mt. Bruce Sheet, adjoining to the west (de la Hunty, 1965), and the nomenclature established there has been preserved. However, the nomenclature for the Balfour Downs Sheet (de la Hunty, 1964) adjoining to the east, is somewhat different, so the relevant units are correlated in Table 1.

TABLE 1

CORRELATION OF LOWER PART OF LOWER PROTEROZOIC SUCCESSION ON ROY HILL AND ADJOINING SHEETS

Group	Formation		
	Mount Bruce Sheet	Roy Hill Sheet	Balfour Downs Sheet
Lower part of Hamersley Group	Wittenoom Dolomite	Wittenoom Dolomite	Carawine Dolomite
	Marra Mamba Iron Formation	Marra Mamba Iron Formation	Lewin Shale
Fortescue Group	Jeerinah Formation	Jeerinah Formation	
	Mount Jope Volcanics	Mount Jope Volcanics	Little De Grey Lava and Tumbiana Pisolite
	Hardey Sandstone		Beatons Creek Conglomerate

In Western Australia the time boundary between the Archaean and Proterozoic is provisionally placed at about 2,500 million years. Leggo and others (1965) determined the age of the Woongarra Volcanics (by radioactive methods) at 2,100 million years, so the Mt. Bruce Supergroup is now assigned to Lower Proterozoic.

Archaean and Lower Proterozoic rocks occupy more than half of the area of the Roy Hill Sheet and no younger systems are represented, apart from an extensive cover of Tertiary and Quaternary superficial deposits in certain areas.

The Archaean rocks crop out in the extreme northern section only; they are the basement upon which the Lower Proterozoic formations have been

6266—3

deposited. Granite and gneiss predominate in the Archaean but there are small areas of metasediments and volcanics of the Warrawoona Series, which are continuous with those exposed in the more northern part of the Pilbara Goldfield.

The Lower Proterozoic rocks are represented by the Fortescue and Hamersley Groups of the Mt. Bruce Supergroup. The Wyloo Group does not occur in the Sheet area and there is only a small area of outcrop of the Boolgeeda Iron Formation, the uppermost unit of the Hamersley Group. The Fortescue Group includes a somewhat different lithological assemblage from that found in the southern and western parts of the iron province and has been studied in some detail. The Hamersley Group includes the same stratigraphic units as appear elsewhere, but erosion has greatly restricted the extent of outcrop of the Woongarra Volcanics and apparently removed most of the Boolgeeda Iron Formation. The remaining units of the Hamersley Group show little divergence in lithology or thickness from their equivalents in other parts of the iron province.

There is little doubt of the equivalence of the Wittenoom Dolomite with the Carawine Dolomite, as the underlying succession of iron formation, shale, chert, thin-bedded dolomite and mudstone, on vesicular basalt, can be followed along the strike from the Roy Hill Sheet area into the Balfour Downs Sheet area.

Superficial deposits of the Roy Hill Sheet area include thick deposits of colluvium of both Tertiary and Quaternary age, limestone and opaline silica of the Oakover Formation, pisolitic limonite-goethite of the Robe Pisolite in the long established drainage channels, alluvium (including thick river gravels), sand, and soil cover. Rejuvenation of the drainage in late Tertiary or early Pleistocene time has led to a re-distribution of much of the older valley fill in the present drainage system.

ARCHAEAN

Archaean rocks in the area of this Sheet include the Warrawoona Series, granite and gneiss, dolerite and quartz. Although the total area of outcrop is about 250 square miles only, there is 50 miles of continuous outcrop of Archaean rocks along the northern boundary of the Sheet area. Granite also crops out at the northern part of the eastern boundary.

WARRAWOONA SERIES

Noldart & Wyatt (1962) mapped long belts of Warrawoona rocks to the north, but there is very little extension into the area of this Sheet. The small area of outcrop is due firstly to assimilation by granite and secondly to covering by Proterozoic rocks.

TABLE 2. ROY HILL 1:250,000 GEOLOGICAL SERIES
STRATIGRAPHIC COLUMN

Age		Group	Map Symbol	Formation and Member	Lithology	Thickness (feet)
CAINOZOIC	Quaternary		Qs		Sand, with dunes	30
			Qa		Alluvium	50
			Qc		Colluvium	50
			Qb		Residual soil on basalt	20
	Tertiary		Tc		Colluvium	100
			To	Oakover Formation	Limestone, opaline silica	80
			Tp	Robe Pisolite	Limonite deposits	50 av.
			Th		Hematite deposits	10–100+
			Tb		Chert breccia	20
				—UNCONFORMITY—		
LOWER PROTEROZOIC	Mount Bruce Supergroup	Hamersley	Pho	Boolgeeda Iron Formation	Siltstone, ferruginous shale, jaspilite	200+
			Phw	Woongarra Volcanics	Dacite, rhyolite, glass	1,000+
			Phj	Weeli Wolli Formation	Jaspilite, shale. Intruded by dolerite	1,500
			Phb	Brockman Iron Formation	Jaspilite, chert, shale, some crocidolite	2,100
			Phs	Mount McRae Shale	Shale, siltstone, dolomite, chert	300
			Phs	Mount Sylvia Formation	Thin jaspilite, dolomitic shale	150
			Phd	Wittenoom Dolomite	Dolomite, dolomitic shale	600
			Phm	Marra Mamba Iron Formation	Chert, jaspilite	600
		Fortescue	Pfj	Jeerinah Formation	Shale, chert, jaspilite, mudstone, quartzite, dolomite. Intruded by dolerite	(570)
			Pfjr	Roy Hill Shale Member	Leached pyritic shale	100
			Pfjw	Warrie Member	Shale, chert, mudstone, dolomite	270
			Pfjo	Woodiana Sandstone Member	Sandstone, mudstone	200
			Pfb	Mount Jope Volcanics	Basalt, pyroclastics, pillow lava	(1,100)
			Pfm	Maddina Basalt Member	Vesicular and amygdaloidal basalt	200
			Pfk	Kuruna Siltstone Member	Siltstone, mudstone, oolite	60
			Pfn	Nymerina Basalt Member	Basalt, some pillows	500
			Pft	Tumbiana Pisolite Member	Pisolitic tuff, siltstone, limestone with *Collenia*	250
			Pfy	Kylena Basalt Member	Vesicular and amygdaloidal basalt	100
				—UNCONFORMITY—		
ARCHAEAN			Agn		Gneiss	
			Ag		Granite	
			Aw		Volcanics, talc-chlorite schist, jaspilite	

6266—J35

The Warrawoona Series consists of steeply dipping jaspilite and quartzite with interbedded volcanics and talc-chlorite schist. The jaspilite is strongly resistant to weathering and is responsible for the formation of many parallel ridges. There are many remnants of Warrawoona rocks in the surrounding granitic gneiss.

Dolerite and quartz intrude the Warrawoona rocks.

Granite and Gneiss

The main area of granite outcrop is on Hillside and Bamboo Springs Stations. The granite is medium-grained. It consists mainly of quartz, feldspar, and biotite, and is generally separated from outcrops of the Warrawoona Series by zones of gneiss, which have been formed by partial assimilation of the Warrawoona rocks by granite.

Both the granite and the gneiss are intruded by dolerite and quartz.

Minor Intrusive Rocks

Dolerite dykes, trending mainly north-northeast, intrude the Archaean rocks but are overlain by the Proterozoic rocks, and quartz veins in the area are mainly restricted to the Archaean rocks.

Dolerite sills in the Jeerinah Formation and in the Weeli Wolli Formation are Proterozoic intrusives.

LOWER PROTEROZOIC

Fortescue Group

The Hardey Sandstone is not represented in this area and the base of the Fortescue Group is the basal vesicular basalt member of the Mt. Jope Volcanics.

The Fortescue Group extends across the northern half of the Sheet in a belt with an average width of 10 miles. In the northeast the outcrop width exceeds 20 miles. In the southwest there are small outcrops of the Jeerinah Formation but no exposures of the Mt. Jope Volcanics.

Mt. Jope Volcanics

The Mt. Jope Volcanics consist of vesicular and amygdaloidal basalt with interbedded pyroclastics and sediments. Some of these units are lenticular, but others persist in strike across the Sheet area. Pillow structures have been seen in the basalt, but they are not as obvious as in the type area, and correlation of the individual members between Sheet areas is difficult.

Good sections of this formation can be seen in several places: the one along the Port Hedland/Wittenoom road, in the northwest, is probably the best, although the pillow structures were identified in the east. There are also more sedimentary bands in the east.

Although the average thickness of the Mt. Jope Volcanics in this Sheet area is about 800 feet, the Nymerina Basalt Member thickens markedly to the east and the maximum thickness of the formation is about 1,100 feet. It has a general low dip to the south.

The *Kylena Basalt Member* is the basal unit of the Mt. Jope Volcanics in this area. It consists of dark green vesicular and amygdaloidal basalt and has a maximum thickness of 100 feet. The best exposure extends northeast from Kylena Well (lat. 22°07′S, long. 118°09′E) in a belt 2 miles wide, on the eastern edge of the main granite outcrop. It also overlies gneiss and outcrops of the Warrawoona Series.

To the north, within the Marble Bar Sheet area, this member thickens and contains some pyroclastic and sedimentary bands near the base.

The *Tumbiana Pisolite Member* can be traced across the area from east to west and has been observed to extend many miles farther on either side. It has previously been considered a formation (Noldart & Wyatt, 1962; de la Hunty, 1963, 1964) but since it is a part of the Mt. Jope Volcanics, which is itself a formation, the rank of " member " seems more desirable.

It is 250 feet thick in a section at the Port Hedland/Wittenoom road, but is thinner at other localities. It lenses out at places on the Balfour Downs Sheet area to the east.

It is composed of pyroclastics, including pisolitic tuff, and sediments, including fossiliferous limestone. The section at the Port Hedland/Wittenoom road is:

		Thickness (feet)
Top	Arkose	20
	Siltstone	40
	Tuff	20
	Crystalline dolomite with *Collenia*	70
Base	Tuff with a little calcite ..	100
	TOTAL	250

In other localities there is a development of blue-green-grey pisolitic tuff with calcite and pyrite in the matrix.

Algal fossils were first located in a limestone bed in the Tumbiana Pisolite in 1959 (de la Hunty, 1963, 1964) and H. S. Edgell has identified '*Collenia* cf. *undosa* type' in specimens from Corkbark Spring and Crossing Well in the northeast. He also identified 'chertified dolomite containing a large algal knoll or stromatolite of general *Collenia* type' from the top of the dolomite bed at the Port Hedland road.

The *Nymerina Basalt Member* consists of dark-green vesicular and amygdaloidal basalt with some pillow lava bands, also interbedded pyroclastics and sediments. It is named after Nymerina Spring (lat. 22°12′S, long. 118°01′E). The sediments include limestone, siltstone and pisolite (?) with calcite matrix. The member is about 150 feet thick in the western part of the area, but may be 500 feet thick where the sedimentary bands are well developed in the vicinity of Emu Springs. The pillow lava structures have only been observed in this thicker part of the member.

The *Kuruna Siltstone Member* is well exposed across the width of the Sheet area at the edge of a south-dipping escarpment. The name is taken from Kuruna Bore (lat. 22°15′S, long. 118°06′E). The member is 60 feet thick in a section 4 miles southeast of Nymerina Spring, where the succession is 10 feet of mudstone on 30 feet of oolite on 20 feet of siltstone; but is thinner in other localities. The rocks are generally dull grey-green. In view of the association of pyroclastics with sediments lower in the formation, it seems likely that pyroclastics are present in the Kuruna Siltstone Member, but none were observed.

The *Maddina Basalt Member* crops out in the vicinity of Maddina Spring (lat. 22°14′S, long. 117°58′E) and across the Sheet area to east and west of the spring. It is the topmost Member of the Mt. Jope Volcanics and is conformable with the overlying Jeerinah Formation. It consists of about 200 feet of dark-green vesicular and amygdaloidal basalt and has an average outcrop width of 3 miles, much of which is covered with patches of residual clay and small boulders of basalt. These patches contain numerous " crabholes " typical of gilgai terrain and have been mapped as a Quaternary unit.

Jeerinah Formation

In the southwestern corner of the Sheet area, the Jeerinah Formation is concordantly intruded by dolerite, as in the type locality, but there are no intrusives in the extensive outcrop of the Jeerinah Formation in the Chichester Range. There the formation was mapped in three lithologically distinct members, one of which was further subdivided.

The formation has a low but variable southerly dip and the total thickness is about 570 feet, though in the type locality in the Mt. Bruce Sheet area, it is 3,000 feet thick. The Jeerinah Formation is conformable with the underlying Mt. Jope Volcanics and the overlying Marra Mamba Iron Formation. A good section is exposed 2 miles west of Woodiana, an old camp 14 miles north-northeast of Cowra Outcamp.

The *Woodiana Sandstone Member*, the basal unit of the Jeerinah Formation in this area, ranges in lithology from sandstone to mudstone, with some surface silicification. It forms a prominent north-facing escarpment along the northern edge of the outcrop of the formation. The escarpment is more than 50 feet high and the dip slope is exposed for widths up to 7,000 feet. At Woodiana the member consists of sandstone. It is possibly 200 feet thick and has a southerly dip. It overlies the Mt. Jope Volcanics and is overlain by the Warrie Member.

The *Warrie Member* consists of of interbedded shale, chert, mudstone, and thin-bedded dolomite, about 200 feet thick, with a further 70 feet of thin-bedded grey dolomite at the top. The main unit generally has mudstone at the base, with pisolitic structures developed; and balls of oxidized pyrite are associated with the interbedded dolomite. The upper dolomite unit is eroded in many places, and concealed by superficial deposits, but it is seen to be conformable with the Roy Hill Shale Member. It contains concretions of iron oxide and some thin chert bands and is well exposed on the Great Northern Highway in the eastern part of the area. Although the Warrie Member crops out 3 miles south of Warrie Homestead, it can be seen to best advantage near Woodiana.

The *Roy Hill Shale Member* can be traced right across the area, beneath the Marra Mamba Iron Formation. It has been leached white in all outcrops and has an outstanding air-photo expression. It is well exposed on the Great Northern Highway 16 miles north of Roy Hill Homestead, where it overlies the upper dolomitic unit of the Warrie Member and underlies the Marra Mamba Iron Formation. It is 100 feet thick and has a general low southerly dip. Two miles south of Woodiana, a dry well has exposed a less weathered section of the Roy Hill Shale. The material on the well dump is dark grey, pyritic, carbonaceous (?) shale with unoxidized, brassy balls of pyrite, about a half-inch in diameter.

Hamersley Group

All units of the Hamersley Group are represented within the area of the Roy Hill Sheet. The Woongarra Dacite is restricted to small outcrops in the core of a syncline east of Weeli Wolli Creek and at Coondiner Creek. The Boolgeeda Iron Formation is exposed only at Coondiner Creek.

Marra Mamba Iron Formation

The basal formation of the Hamersley Group is the Marra Mamba Iron Formation, which is best exposed in the Chichester Range. The only other large exposure within the Sheet area is the core of the Weeli Wolli Anticline near the southern boundary. In both localities the Marra Mamba Iron Formation consists of interbedded chert and jaspilite. The chert bands are yellow to yellow-brown with a characteristic 'pinch and swell' structure. Separate lenses and elliptical pods of chert are common in the jaspilitic matrix. In hematite zones the chert has entirely disappeared, leaving a mass of structureless hematite which is fine-grained and has a sub-conchoidal fracture.

Owing to the low dip of the Marra Mamba Iron Formation, and the complete removal by erosion of the overlying Wittenoom Dolomite, no reliable estimate of the thickness of the formation can be made in the Chichester Range. The maximum thickness exposed there is 200 feet and it seems likely that the true thickness of the iron formation is less than the 600 feet recorded at the type locality (MacLeod & others, 1963). This zone is close to the northern margin of the original basin of deposition, so some thinning of the formation could be expected. Thinning of the Marra Mamba Iron Formation has been recorded in the south-central area of the Pyramid Sheet (Kriewaldt & Ryan, in press), which includes the westerly continuation of the Chichester Range.

The base of the Marra Mamba Iron Formation is exposed over a very limited area in the core of the Weeli Wolli Anticline and a thickness of 600 feet is inferred for the formation in that locality. A similar thickness is apparent in the exposures in the synclinal structure near the south-western corner of the Sheet area. Both of these occurrences are close to the central axis of the basin of deposition.

Wittenoom Dolomite

The Wittenoom Dolomite conformably overlies the Marra Mamba Iron Formation, but the contact between the two formations is rarely exposed. The dolomite crops out almost continuously along the northern edge of the Hamersley Range for a distance of over 200 miles and it is characteristically well exposed in that section of the range which falls within the confines of the Roy Hill Sheet. Numerous traverses have been made across the dolomite in the foothills of the range. The lowermost sections consist of blue-grey crystalline dolomite with a minor admixture of dolomitic shale. Higher in the formation, shale becomes more abundant, as do chert nodules and beds. The chert and shale content in the uppermost 100 feet greatly exceeds the content of dolomite. The maximum exposed thickness in the area is about 600 feet, but the base is not exposed so the total thickness is greater than this.

The dolomite is assumed to underlie the greater part of the area between the Chichester Range and the Hamersley Range. Outcrops of this unit are in the Goodiadarrie Hills and at Coondiner Pool, 18 miles southeast of Marillana homestead. Chert breccia at Mt. Marsh, in isolated outcrops nearby, and at Roy Hill, indicate dolomite in these areas also.

A roll in the dip of the dolomite, such as that shown in the diagrammatic section, is the explanation suggested for such a wide area of blind outcrop of the Wittenoom Dolomite. The increased width of this area to the east may be explained in a similar way.

The Wittenoom Dolomite flanks the lower slopes of the range comprising the northern limb of the Weeli Wolli Anticline and probably underlies the greater part of the broad basin south of Weeli Wolli Spring. This area is marked by an impressive development of calcrete, which is 80 feet thick in places and covers an area of about 30 square miles. Close to the range the dolomite is strongly folded and contorted and has a general steep northerly dip due to a regional monoclinal warp.

Mt. Sylvia Formation and Mt. McRae Shale

In the Hamersley Range, the Mt. Sylvia Formation and Mt. McRae Shale are exposed to the same degree and in the same localities as the Wittenoom Dolomite which they conformably overlie. The uppermost jaspilite unit of the Mt. Sylvia Formation, the so-called 'Bruno's Band', can be followed along the edge of the Hamersley Range without a break, and serves as an excellent marker bed. The two lower jaspilites are much less obvious in many places, but are as clearly seen in the Weeli Wolli area as in the type area of the formation at Mt. Sylvia in the central part of the Hamersley Range. The jaspilites are separated by shale and chert bands, and the thickness of the Mt. Sylvia Formation ranges from 100 to 150 feet.

The Mt. McRae Shale has been traversed in many sections and little variation in lithology has been seen. Near Dales Gorge it is composed essentially of chert and dolomite in the uppermost 100 feet below the base of the Brockman Iron Formation. Between the western boundary of the Sheet area and Mt. Lockyer there is a persistent chert band about 6 feet thick in the middle section of the Mt. McRae Shale. A similar chert band of comparable thickness occurs at the same horizon in the Weeli Wolli area. Along the range, west of Weeli Wolli Spring, shale and dolomitic shale predominate, with occasional intercalations of coarser clastic material in the lower section of the formation, whereas in the upper sections there is an abundance of yellow to pink chert in beds up to 3 inches thick. The thickness of the formation is usually between 200 and 300 feet.

Brockman Iron Formation

Despite the wide area of outcrop of the Brockman Iron Formation in the southern section of the Roy Hill Sheet, complete well-exposed sections are rare. One excellent section, however, is available at Weeli Wolli Spring, where the complete thickness is exposed in low cliffs along the creek. The measured thickness of this section is 2,100 feet, after allowing for some repetition of beds by strong folding in the basal zones of the formation. The lowermost 1,500 feet of the formation consist of a monotonous succession of jaspilite with some chert. The remainder is composed mainly of reddish chert with rare iron-rich bands, the top 200 feet of which is essentially a ferruginous shale with minor intercalations of chert and jaspilite. In this section the basal zones of the formation have been converted to hematite. The top 1,000 feet of the Brockman Iron Formation is exposed in the anticline about 3 miles north of Weeli Wolli Spring, but only the uppermost shaly section of the formation is traversed on the track between Marillana and Weeli Wolli, where it enters the Hamersley Range. In the headwater region of Yandicoogina Creek the upper sections of the Brockman Iron Formation are in many places covered by thick deposits of Tertiary colluvium. The prominent hills along the northern escarpment of the Hamersley Range are capped with Brockman Iron Formation and many residuals have been isolated from the main range by erosion.

Crocidolite occurs in association with riebeckite and dolomitic shale, near the base of the Brockman Iron Formation at Dales Gorge and at the same stratigraphic level elsewhere in the Sheet area.

Weeli Wolli Formation

There is no sharp lithological break between the uppermost sections of the Brockman Iron Formation and the Weeli Wolli Formation. Ferruginous shale and jaspilite are the essential sedimentary constituents of the Weeli Wolli Formation and appear to have resulted from alternating phases of chemical and fine clastic deposition within the basin. Jaspilites in the Weeli Wolli Formation often contain abundant red jasper, which is rarely seen in the Brockman Iron Formation.

The base of the Weeli Wolli Formation is marked by a remarkably persistent concordant dolerite intrusion which can be followed for many scores of miles within the ferruginous shale. This sill weathers to form a pronounced trough, which serves as an excellent marker both in ground traversing and in air-photo interpretation. The sill thickens and thins but has never been observed transgressing the host sediments. The more fissile shaly sediments have apparently served as a favourable zone for intrusion of this and many other thinner dolerites in this part of the succession. In some sections the volume of dolerite equals or even exceeds that of the enclosing sediments, and individual sills range in thickness down to less than a foot.

The ferruginous shales and thin jaspilites are much less resistant to erosion than the thicker jaspilite beds of the Brockman Iron Formation and weather to low conical hills and cuestas separated by dendritic drainage. In the central area of the Yandicoogina Syncline a group of high conical hills rises 600 feet above the creek level, with benched slopes due to numerous dolerite sills.

The most extensive exposure of the Weeli Wolli Formation is within the long Yandicoogina Syncline. The boundaries between the Brockman Iron Formation and Weeli Wolli Formation are ill-defined in this area, being mainly concealed beneath a thick cover of Tertiary valley fill.

The intrusive character of the dolerite is excellently exposed at the base of the low hill a quarter of a mile north of Weeli Wolli Spring. The dolerite has chilled margins against the jaspilite and has arched the overlying sediments into a dome with fracturing and intense crenulation. This exposure was recorded and photographed by Talbot (1920).

The thickness of the Weeli Wolli Formation cannot be reliably calculated within the area of the Roy Hill Sheet, as the top of the formation has generally been removed by erosion: it is preserved only in Mindy Mindy Creek near the eastern end of the Yandicoogina Syncline, where thickness is between 1,000 and 1,500 feet. In this area a thick scree cover conceals both the upper and lower boundaries of the formation. The overall thickness of the Weeli Wolli Formation varies according to the degree of dolerite intrusion. This character is particularly well shown in the Ophthalmia Range, which is south of the area covered by the Roy Hill Sheet.

Woongarra Volcanics

The only exposures of the Woongarra Volcanics within the Sheet area are at the eastern end of the Hamersley Range Syncline, in the valley of Mindy Mindy Creek, and on the eastern side of Coondiner Creek. These acid lavas have been preserved in downfaulted blocks. At Mindy Mindy Creek, the lava is about 200 feet thick, most of the upper sections having been removed by erosion, but at Coondiner Creek it is probably over 1,000 feet thick. The contact of the Woongarra Volcanics with the overlying Boolgeeda Iron Formation is exposed in this locality, but the lower boundary of the lavas is in the Newman Sheet area to the south. The Woongarra Volcanics contains several flows. Grey to black porphyritic rhyolite with abundant phenocrysts of quartz and feldspar is the commonest rock type. Devitrified glass and some silicified green chloritic lava are also present.

Boolgeeda Iron Formation

The only exposure of the Boolgeeda Iron Formation in the Sheet area is that already mentioned, at Coondiner Creek. It is crossed by the track running south from Poonda Outcamp to an ochre mine in the Newman Sheet area. At Coondiner Creek the formation is a downfaulted remnant of the southern flank of the Hamersley Range Syncline, and has a northerly dip. This eroded remnant is possibly 200 feet thick.

As in the type area (MacLeod & others, 1963), the Boolgeeda Iron Formation consists of purplish flaggy siltstone and ferruginous shale with jaspilite. Small patches of manganese dioxide are also associated with the formation in this locality.

CAINOZOIC

No Palaeozoic or Mesozoic rocks were recognized in the area. The Cainozoic rocks unconformably overlie the Lower Proterozoic and Archaean. The Cainozoic Era is most significant in this area since much of the mineral wealth has resulted from weathering, concentration, and deposition during that time. The hematite deposits were formed by supergene enrichment in the Tertiary Period, as were the pisolitic limonite deposits (Robe Pisolite). About 70 per cent of the aquifers are Cainozoic in age.

TERTIARY

Chert Breccia

There is a siliceous cap on the outcrops of Wittenoom Dolomite at Goodiadarrie Hills, Mt. Marsh, Coondiner Spring, and Roy Hill, which often contains many angular fragments of chert. The silica also occurs in reniform layers with numerous small quartz crystals in cavities. Similar chert breccia, of Tertiary age, has also been observed overlying Carawine Dolomite in the Balfour Downs Sheet area to the east, and overlying Duck Creek Dolomite in the Mt. Bruce Sheet area to the west. This cap is usually only a few feet thick but may exceed 20 feet in places.

Hematite Deposits

Hematite deposits have been formed by supergene enrichment of iron formations of the Hamersley Group, by leaching out of silica and reconcentration of iron oxides. The associated canga deposits have been formed by the cementing together of fragmentary hematite with goethite. The principal hematite deposits are associated with the Brockman Iron Formation in the vicinity of Weeli Wolli Spring. These are discussed below and, in more detail, by MacLeod (1964). There are other occurrences on the Brockman Iron Formation along the northern edge of the Hamersley Range and also on the Marra Mamba Iron Formation in the Chichester Range.

Robe Pisolite

The Robe Pisolite was defined by de la Hunty (1965). It consists of pisoliths of limonite, cemented together with limonite and goethite, and it characteristically contains fragments of fossil wood and a little hematite. The formation was originally deposited in river channels and has since been dissected by rejuvenated streams, leaving mesas and valley-side benches with caps of pisolite.

The largest pisolite deposits are at Dales Gorge and Yandicoogina Creek, in the Hamersley Range, and there are smaller occurrences along Coondiner, Mindy Mindy, and Weeli Wolli Creeks, and in the headwaters of the Shaw and Nullagine Rivers. These deposits are discussed under 'Economic Geology'.

Oakover Formation

Calcrete is widespread in the broad valley of the Fortescue River, and in the valleys of Weeli Wolli Creek and the western branch of Yandicoogina Creek. The calcrete is a white limestone with considerable amounts of magnesia and opaline silica. It is correlated with the Oakover Formation (Noldart & Wyatt, 1962) because of similarities in age, lithology, and environment. The calcrete is porous and is a good aquifer, although much of its outcrop in the Fortescue Valley is in an area of saline groundwater.

Just south of Weeli Wolli Spring the formation is 80 feet thick in places, and covers an area of 30 square miles. It has been deeply dissected and weathered in the current erosion cycle, leaving a rough stony terrain with sparse vegetation cover. The calcrete serves as a high-level aquifer and the permanence of Weeli Wolli Spring is attributed to the large storage of water within this deposit.

In the Hamersley Range, calcrete is best developed on the Wittenoom Dolomite, particularly where the drainage from the dolomite is constricted by resistant formations. At Weeli Wolli Spring the north-flowing creeks are constricted to a gorge within the Brockman Iron Formation after traversing a broad basin underlain by dolomite. This constriction could conceivably induce a rise in water table as the resistant barrier was approached with consequent capillary deposition of lime and silica from solution, at or near the surface. For this to occur, it would be necessary to have the pronounced seasonal rainfall of tropical savannah regions, rather than the somewhat drier climate which prevails today.

Colluvium

Valley-fill colluvium covers a large area in the southwest, and the top of this 'fill' represents the low part of the Tertiary land form prior to rejuvenation of the drainage. This colluvium is possibly 100 feet thick in places. It is consolidated, partly cemented, and contains many boulders, including some of pisolitic limonite. It is now strongly dissected and the boulders have been further redistributed in outwash and river gravels. A little Tertiary colluvium also overlies the Warrie Member of the Jeerinah Formation in the Chichester Range. Outcrops of calcrete on the western branch of Yandicoogina Creek are surrounded or overlain by this valley-fill colluvium in places, and some of the calcrete could have been formed after the colluvium was laid down, although the calcrete is generally considered older.

QUATERNARY

Four Quaternary units have been mapped in this area.

Residual Soil on Basalt

Extensive areas, up to 20 square miles, of residual clay soil cover the basalt on the northern flank of the Chichester Range, especially on the Maddina Basalt Member. These gilgai areas, which have good air-photo expression, are covered with small boulders of basalt and contain numerous 'crabholes', and it is difficult to cross them in a motor vehicle. They do not support the growth of spinifex or scrub but grasses sometimes flourish there.

Colluvium

The Quaternary colluvium includes outwash fans and talus deposits in almost continuous belts, of average width in excess of 5 miles, along both the northern and southern edges of the broad valley of the Fortescue River. These deposits have been formed by interconnecting fans where the swift-flowing tributaries of the Fortescue River reach grade and deposit their load. This colluvium is generally considered a good aquifer, although salinity sometimes reduces its potential.

Alluvium

Of the many areas of alluvium, including river gravels, the largest is along the indefinite course of the Fortescue River. There alluvium overlies Wittenoom Dolomite and calcrete. It is probably less than 50 feet thick anywhere in the area.

Sand

Red sand covers large areas in the southeast. Short dunes are numerous 10 miles northwest and 5 miles south of Poonda Outcamp, but elsewhere the sand is present as a thin veneer.

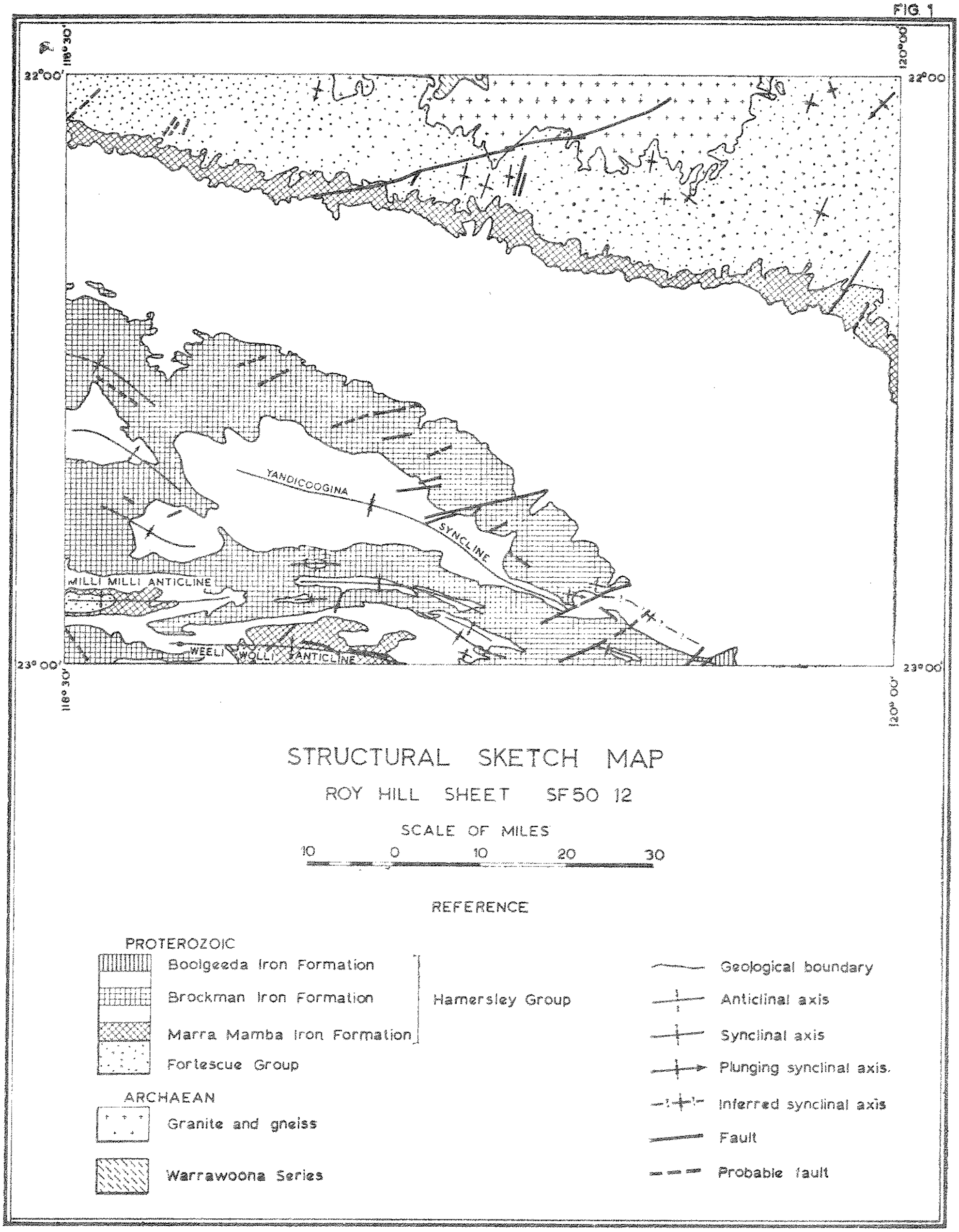
STRUCTURE

FOLDING

Folding has been very gentle over the greater part of the Sheet area. Between the Hamersley Range and the northern boundary of the Sheet area the Proterozoic sediments have a regional dip to the south of less than 5°. This regional attitude is locally disturbed by minor warpings and dip reversals, which find an expression in the widths of outcrop of the components of the Fortescue Group.

The section of the Hamersley Range that lies within the Sheet area is part of the eastern zone of the major Hamersley Range Syncline, which trends west-northwest and which controls the structural pattern of the northern Hamersley Range for over 250 miles. The Syncline is actually a regional synclinorium within which smaller folds have been developed. Such smaller folds are exemplified by the Yandicoogina Syncline, whose limbs dip at angles of less than 10° (See Fig. 1).

FIG 1



The only folding of any intensity lies south of an east-west line passing through Weeli Wolli Spring, from which folding becomes progressively more intense to the southern boundary of the Hamersley Iron Province. The northern limb of the large Weeli Wolli Anticline falls within the Roy Hill Sheet Area and is characterized by a persistent monoclinal warp with intense subsidiary fold structures along its entire length of 50 miles. The minor folds, like the major structure, trend easterly and are of low plunge.

In the comparatively undisturbed area along the front of the Hamersley Range, overlooking the Fortescue Plain, restricted zones of strong flexuring or monoclinal warping are common but rarely persist for any great distance.

FAULTING

As the area has been disturbed only slightly since the Lower Proterozoic sediments were laid down, there has been much less faulting than in the southern and western sections of the iron province. The most heavily faulted zone is the valley of Yandicoogina Creek, which is traversed by a series of parallel gravity faults trending east-northeast, whose maximum throw would be several hundreds of feet. A large fault along the line of Coondiner Creek has its northern termination just within the southern boundary of the south-eastern sector and there are some minor faults within the limbs and core of the Weeli Wolli Anticline with a similar northeasterly trend.

It has been postulated that the northern edge of the Hamersley Range is a fault scarp associated with graben development in the Fortescue Valley. In view of the regional stratigraphy and the general appreciation of the tectonics which has been gained in recent years, this is considered to be unlikely. However, it is possible that there has been some block faulting in the Fortescue Valley, and the thick accumulation of detrital material may be the result of ponding of the upper Fortescue drainage system due to fault movements.

ECONOMIC GEOLOGY

No mines are now being worked within the Sheet area. Small quantities of crocidolite have been mined from Dales Gorge and from near Weeli Wolli Spring, but there has been no production since 1938.

The main mineral potential is in the large deposits of hematite ore in the vicinity of Weeli Wolli Spring and along the Chichester Range. The hematite resources in the Weeli Wolli area have been estimated as about 40 million tons per vertical foot, and in many places the ore is more than 100 feet thick (MacLeod, 1964).

Pisolitic limonite–goethite deposits are distributed along the headwaters of the Shaw River, in the northern part of the area, and along Yandicoogina, Weeli Wolli, Mindy Mindy, and Coondiner Creeks and Dales Gorge, in the Hamersley Range.

Numerous showings of manganese dioxide, mainly in the Chichester Range, are too small to be economic.

Sufficient underground water is available for pastoral activity over most of the Sheet area north and northeast of the Hamersley Range, in spite of the high salinity of the Salt Marsh between Roy Hill and the Goodiadarrie Hills.

HEMATITE

The two principal developments of hematite are at Weeli Wolli Spring near the southern boundary and along the Chichester Range between Roy Hill Station and the Wittenoom/Port Hedland road. Other minor occurrences of hematite have been recorded, but not examined in detail, along the northern front of the Hamersley Range at Mt. Lockyer and in Coondiner Creek.

Weeli Wolli Deposits

The hematite deposits at Weeli Wolli Spring are disposed along the limbs of a major regional anticline (the Weeli Wolli Anticline) within the Brockman Iron Formation. The northern limb of this fold is warped monoclinally and secondary synclinal troughs have been formed within the disturbed zone. These troughs are favourable loci for the hematite, which results from leaching and desilication of the parent iron formation. The eastern end of the Weeli Wolli Anticline has a gentle easterly plunge, and basal sections of the Brockman Iron Formation are preserved in a series of east-plunging synclines which have resulted from tighter folding in this zone. Hematite is prolifically developed to more than 100 feet thick in many places, within these troughs. Hematite is also developed within the complementary syncline on the southern limb of the Weeli Wolli Anticline.

A more detailed description of the structure and iron ore deposits of the Weeli Wolli area is given by MacLeod (1964).

The total hematite resources of the Weeli Wolli deposits have been estimated as 40 million tons per vertical foot. Most of the ore contains at least 60 per cent iron, and some extensive zones of hard, blue hematite are of better grade than 65 per cent iron. The deposits are readily accessible along the broad open valley of Weeli Wolli Creek.

Chichester Range Deposits

The Chichester Range deposits are developed within the Marra Mamba Iron Formation. They are mostly thin and the grade deteriorates to well below 60 per cent iron at shallow depth. This deterioration of grade is characteristic of hematite deposits in the Marra Mamba Iron Formation throughout the Hamersley Iron Province. Small patches and coatings of manganese dioxide are also common to these d posits.

Other Deposits

There are numerous minor occurrences of hematite along the northern front of the Hamersley Range, within the Brockman Iron Formation. They are generally related to minor zones of tight flexuring within the generally flat-lying iron formation. The largest deposit (5 to 10 million tons) is at Mt. Lockyer, and there are numerous other occurrences between Mt. Lockyer and Weeli Wolli Creek. In most deposits the ore is patchy and seems unlikely to persist in depth. Hematite occurs in several places in the Brockman Iron Formation at Coondiner Creek, but none are of economic dimensions under present conditions.

LIMONITE—GOETHITE AND CANGA

Pisolitic hydrated iron ores are abundantly developed at Dales Gorge and in the valley of Yandicoogina Creek, and there are smaller occurrences at the headwaters of the Shaw River, in Coondiner and Mindy Mindy Creeks.

At Dales Gorge the pisolite has been formed within an internal drainage basin on the high plateau within the Hamersley Range. The surface profile of the deposits is concordant with that of the ancient valley-fill deposits which flank the lower slopes of the hills and merge with the smooth valley floor. This ancient profile has been deeply incised by the rejuvenated drainage, and pisolite deposits are now exposed in the walls of the gorges. The pisolite at Dales Gorge is up to 70 feet thick, thinning rapidly towards the perimeter of the basin. Some of the ore is conglomeratic and transitional in texture to canga or hematite conglomerate. Because there are few exposed sections, resources are difficult to assess, but they could be as much as 300 million tons.

In the western branch of Yandicoogina Creek the pisolite is developed almost continuously for 20 miles along the fossil drainage channel which almost coincides with the present course.

The ore examined is of excellent grade for its type, with an iron content between 53 and 58 per cent. In the central and upper parts of the drainage channel the pisolite is markedly stratified with an overlying bed of more vitreous material in which pisoliths are less apparent. Most of the deposits are between 20 and 40 feet thick and the total reserves must be of the order of

300 million tons. In view of the abundant nearby deposits of high-grade hematite it seems unlikely that these pisolitic ores will be of any economic consequence within the forseeable future.

There are numerous mesaform deposits of the pisolitic ore in Mindy Mindy Creek similar to those in the Robe River and Duck Creek in the western section of the iron province. They are barely 20 feet thick and the reserves along this drainage would scarcely amount to 15 million tons. In Coondiner Creek there is a small-scale repetition of the pattern of the pisolite deposits in the upper sections of the Robe River. The pisolite is intimately admixed with canga and left as remnant terraces flanking the steep walls of the gorge-like valley. Small deposits of vitreous limonitic ore occur along the banks of Weeli Wolli Creek. In one such deposit, in the gorge about 2 miles north of Weeli Wolli Spring, the pisolite is transitional into canga away from the central line of the old drainage channel, and the canga merges with an unaltered jaspilite conglomerate, which is only slightly desilicified. Such transitional relationships have been noted elsewhere in the iron province.

Several small mesaform deposits of pisolitic limonite—goethite occur along the valleys of the headwaters of the Shaw and Western Shaw Rivers and Bonnie Creek, in the northeast. They are less than 20 feet thick, although the grade is comparable with that of other pisolite deposits in the area.

CROCIDOLITE

About 26 tons of crocidolite were mined in the Dales Gorge area in 1938, and a little was produced from a zone about 8 miles east of Weeli Wolli Spring. At both localities the asbestos seams occur within the lowermost 150 feet of the Brockman Iron Formation—the most productive zone in the main mining area at Wittenoom Gorge. In places near Weeli Wolli the crocidolite has been silicified to form ' tiger's eye ' opal and in other localities it has been completely replaced by limonite. The limonitized asbestos seams can be followed through a hematite ore zone just west of Weeli Wolli Spring. This seam is about 50 feet above the base of the Brockman Iron Formation. Crocidolite seams are also present in the Brockman Iron Formation between Mt. Lockyer and Weeli Wolli Creek.

MANGANESE

The manganese deposits are generally small and low-grade. None of them have been proved economic. The manganese is present as oxides and the main impurities are iron oxide and silica. There are many small patches of manganiferous material on outcrops of the Marra Mamba Iron Formation along the southern edge of the Chichester Range. The largest, 6 miles south of Warrie Homestead, was sampled in 1952 (de la Hunty, 1963) and found to be low-grade and small. There is a small deposit of medium-grade ore

2 miles west of Cowra Outcamp, in the northwestern part of the Sheet area. This deposit, another 2 miles southeast of Coondiner Pool, and several about 10 miles west of Marillana Homestead, appear to overlie Wittenoom Dolomite. However, the manganese has probably been derived from manganiferous sections of the overlying Brockman Iron Formation, or from the underlying Marra Mamba Iron Formation in the case of the Cowra deposit.

WATER

There are 239 bores and wells in the Sheet area (see Fig. 2).* Of the water supplies, 59 are described as 'stock', 6 are 'salt', 10 have gone dry, and the quality of 3 is unknown. The remaining 161 (67 per cent of the total) are potable. Most of the potable wells have a good yield, but during prolonged dry spells the water level falls in those put down in basalt in the northeast. The yield from all 'stock' wells is good.

About 70 per cent of the wells and bores are in Cainozoic rocks; a few good supplies have been encountered in weathered zones of the older rocks. Depths to water are in the range 15-190 feet, and yields range from 1,000 gallons per day to more than 2,000 gallons per hour. More than half of the wells and bores have a depth to water of less than 50 feet, and only 12 per cent are deeper than 100 feet. The more saline supplies are in the centre of the drainage basin of the Fortescue River, becoming highly saline at the Salt Marsh.

There are 30 surface supplies (9 springs and 21 pools) in the Sheet area; most of them are permanent. Thirteen are on areas of outcrop of Proterozoic rocks, 12 are on Cainozoic rocks and 5 are on Archaean granite.

* Details for wells and bores shown on Figure 2 are available at the Geological Survey of Western Australia.

TABLE 3

TYPICAL UNDERGROUND WATER SUPPLIES—ROY HILL SHEET

Name	No.*	Depth of Hole (feet)	Depth to Water (feet)	Quality	Yield (gallons)	Aquifer
Mulga Downs						
Yampire Bore ..	M21	—	25	Potable	500+/hr	Alluvium
Maddina Well ..	M25	—	25	Potable	500−/hr	Alluvium
Cowra Outcamp Well..	M38	—	22	Stock	500+/hr	Alluvium
Hooley						
Bungina Well ..	O3	—	25	Potable	500+/hr	Basalt
Hillside						
No. 10 Well ..	H10	—	30	Potable	500+/hr	Granite
Bamboo Springs						
Gap Well	S7	55	45	Potable	3,000+/day	Granite
Trig Hill Well ..	S24	—	30	Potable	1,000+/day	Pisolite
Bonney Downs						
Emu Well	B4	—	29	Potable	2,000+/day	Basalt
Warrigal Well ..	B19	—	21	Stock	2,000+/day	Colluvium
Outcamp Well ..	B20	—	36	Potable	2,000+/day	Colluvium
Warrie						
Banjo Well	W6	—	30	Potable	3,000+/day	Basalt
Sandy Creek Bore ..	W9	40	—	Potable	3,000+/day	Colluvium
Suraski Bore ..	W15	50	—	Stock	3,000+/day	Colluvium
Roy Hill						
Wattles Bore ..	R1	82	—	Stock	2,000+/hr	Colluvium
22-mile Well.. ..	R3	—	70	Potable	500+/hr	Colluvium
Willows Deep Well ..	R39	—	112	Potable	2,000+/hr	Alluvium
Marillana						
Ajax Bore	A11	31	—	Stock	3,000+/day	Alluvium
Woolshed Bore ..	A19	78	—	Good stock	3,000+/day	Alluvium
Corkwood Bore ..	A23	63	—	Potable	3,000+/day	Colluvium
Poonda Outcamp Bore	A49	102	—	Potable	3,000+/day	Colluvium

* Refers to number of well or bore as used in Fig. 2.

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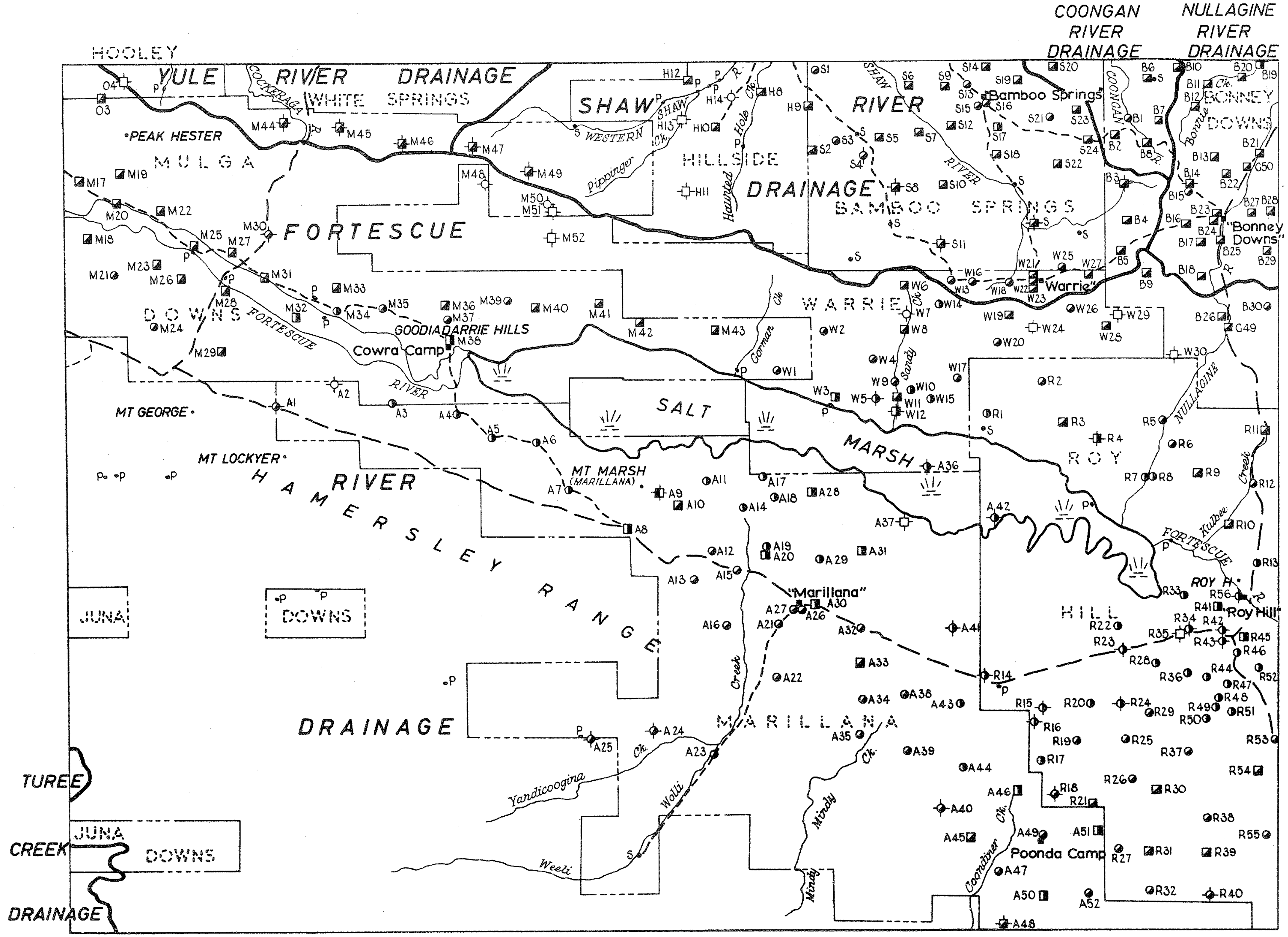
6266/7/70-350-O ALEX. B. DAVIES, Government Printer, Western Australia

FIG. 2



DRAINAGE PROVINCES AND WATER SUPPLIES

ROY HILL SHEET SF 50-12

SCALE OF MILES

5 0 5 10 15 20

REFERENCE

- Main road
- Roads and tracks
- Station boundary
- Homestead — "Warrie"
- Hill — MT. GEORGE
- Drainage province boundary
- Stream (non-perennial)
- Pool — P
- Spring — S
- Well – quality not specified
  - quality potable — H9
  - quality stock — S17
  - quality saline — A9
  - abandoned — R35
- Bore – quality not specified — M48
  - quality potable — B30
  - quality stock — W15
  - abandoned — M50

NOTE: Details for wells and bores shown on this sheet are available at the Geological Survey of Western Australia

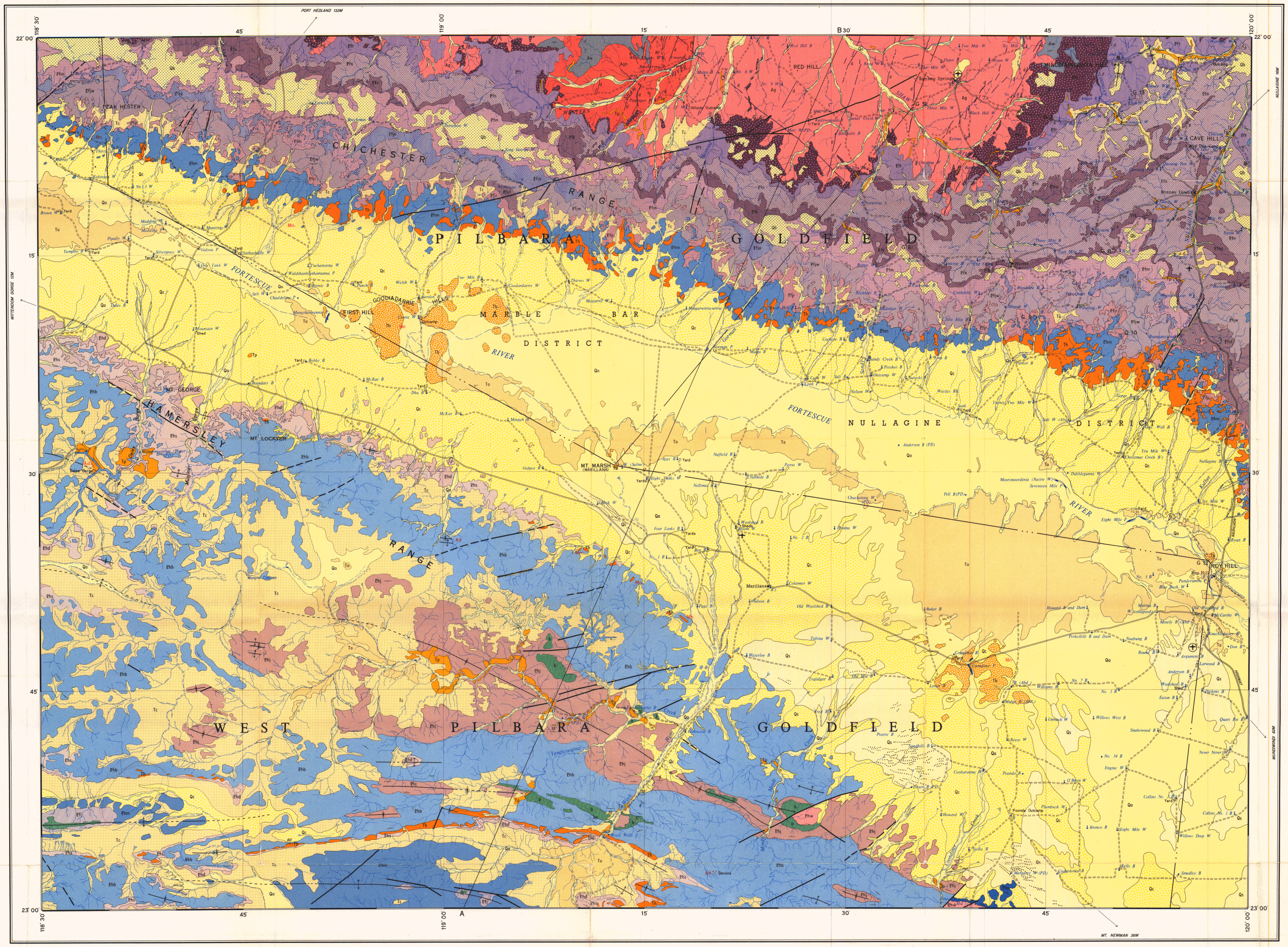
6266–J35

AUSTRALIA 1 : 250,000 GEOLOGICAL SERIES

ROY HILL

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

SHEET SF 50-12



SYMBOLS

- Geological boundary
- Anticlinal axis
- Anticlinical axis showing direction of plunge
- Anticlinical axis concealed
- Synclinal axis
- Synclinal axis showing direction of plunge
- Fault
- Fault probable
- Strike and dip of bedding
- Strike of vertical bedding
- Trend of bedding showing direction of dip
- Macrofossil occurrence

- Goldfield boundary
- Goldfield District boundary
- Highway
- Formed road
- Track
- Homestead
- Airfield
- Landing ground
- Trigonometrical Station, Minor

- Well or bore with windpump
- Well — W
- Bore — B
- Spring — S
- Waterhole — WH
- Pool — P
- Watercourse (non perennial)
- Position doubtful — (PD)

- Mining area
- Mineral occurrence
  - Crocidolite — Ad
  - Manganese — Mn

REFERENCE

CAINOZOIC

QUATERNARY

- Qs — Sand
- Qs — Aeolian sand
- Qa — Alluvium—including river gravels
- Qc — Colluvium—outwash fans and talus deposits
- Qb — Residual soil and boulders on basalt

TERTIARY

- Tc — Colluvium—partially cemented valley-fill deposits containing boulders of limonite
- To — OAKOVER FORMATION: Limestone and calcareous gravels with opaline silica
- Tp — ROBE PISOLITE: Pisolitic limonite deposits with fossil wood fragments—occurs along old river channels. Contains *Iron Ore*
- Th — Hematite deposits, including canga, mostly residual on MARRA MAMBA IRON FORMATION and BROCKMAN IRON FORMATION. Contain *Iron Ore*
- Tb — Chert Breccia—chert fragments with siliceous matrix

LOWER PROTEROZOIC — Mt. Bruce Supergroup

Hamersley Group

- Pho — BOOLGEEDA IRON FORMATION: Jaspilite, purplish flaggy siltstone and ferruginous shale
- Phw — WOONGARRA VOLCANICS: Grey to black porphyritic acid lavas, devitrified glass and silicified green chloritic lava
- Phj — WEELI WOLLI FORMATION: Banded jaspilite with interbedded shale; intruded by medium-grained dolerite
- Phb — BROCKMAN IRON FORMATION: Banded jaspilite and chert with some shale, dolomitic with riebeckite and crocidolite at Dales Gorge
- Phs — MT. McRAE SHALE: Shale, siltstone and dolomitic shale with jaspilite and chert, and MT. SYLVIA FORMATION. Three thin jaspilite beds and dolomitic shale
- Phd — WITTENOOM DOLOMITE: Grey crystalline dolomite with intercalations of chert and dolomitic shale in the upper part
- Phm — MARRA MAMBA IRON FORMATION: Chert and jaspilite with pronounced "pinch and swell" structures, small occurrences of manganese

Fortescue Group

- Pfj — JEERINAH FORMATION: Shale, chert, jaspilite, mudstone, quartzite and dolomite. Intruded by dolerite sills
- Pfjr — **Roy Hill Shale Member**—Leached white shale in cliff sections. Grey, with pyrite balls, in unweathered sections
- Pfjd — Upper dolomitic unit of **Warrie Member**, not always differentiated. Contains concretions of iron oxide and thin chert bands
- Pfjw — **Warrie Member**—Interbedded shale, chert, mudstone and thin-bedded dolomite, often with pistolitic mudstone at the base
- Pfjo — **Woodiana Sandstone Member**—Lithology variable from sandstone to mudstone, with some surface silicification
- Pfb — MT. JOPE VOLCANICS: Dark green vesicular and amygdaloidal basalt, pyroclastics and pillow lavas
- Pfm — **Maddina Basalt Member**—Dark green vesicular and amygdaloidal basalt
- Pfk — **Kuruna Siltstone Member**—Siltstone, sometimes silicified, mudstone and oolite
- Pfn — **Nymerina Basalt Member**—Dark green vesicular and amygdaloidal basalt with some pillow structures
- Pfnp — Pyroclastic and sedimentary bands within the **Nymerina Basalt Member**
- Pft — **Tumbiana Pisolite Member**—Pisolitic tuff, siltstone and crystalline limestone with *Collenia*
- Pfy — **Kylena Basalt Member**—Dark green vesicular and amygdaloidal basalt

ARCHAEAN — Warrawoona Series

- Aw — Volcanics, talc-chlorite schist and jaspilite

INTRUSIVE ROCKS

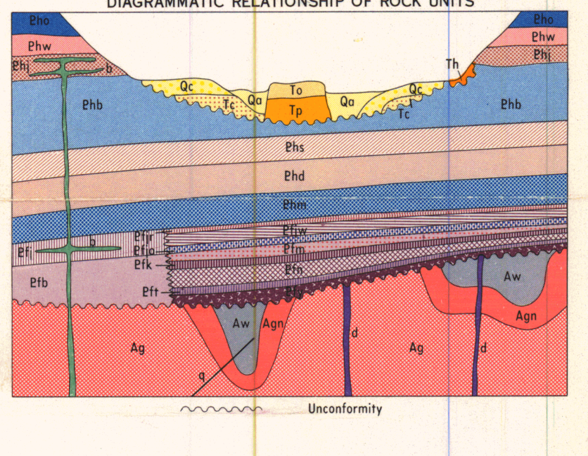
PROTEROZOIC

- b — Dolerite sills in JEERINAH FORMATION and WEELI WOLLI FORMATION

ARCHAEAN

- q — Quartz veins
- d — Dolerite dykes
- Agn — Gneiss
- Ag — Granite

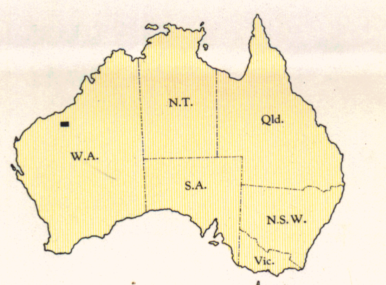
DIAGRAMMATIC RELATIONSHIP OF ROCK UNITS



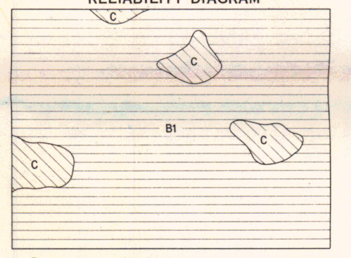
Compiled by Geological Survey of Western Australia. Cartography by Geological Drafting Section, Mines Department. Topographic base from compilations by Lands and Surveys Department.

Published by Bureau of Mineral Resources, Geology and Geophysics, Department of National Development, Canberra, A.C.T.

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



RELIABILITY DIAGRAM



B1 Numerous traverses with air photo interpretation
C Air photo interpretation

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

SCALE 1:250,000

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

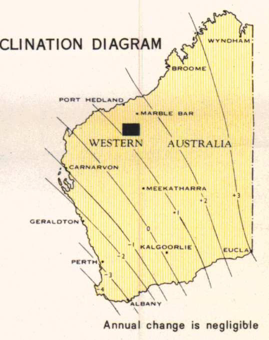
TRANSVERSE MERCATOR PROJECTION
ZONE 2 AUSTRALIA SERIES

INDEX TO ADJOINING SHEETS

PYRAMID SF 50-7	MARBLE BAR SF 50-8	NULLAGINE SF 51-5
MT BRUCE SF 50-11	ROY HILL SF 50-12	BALFOUR DOWNS SF 51-9
TUREE CREEK SF 50-15	NEWMAN SF 50-16	ROBERTSON SF 51-13

Geology by W. N. MacLeod and L. E. de la Hunty, 1963.
Additional information by The B.H.P. Co. Ltd.

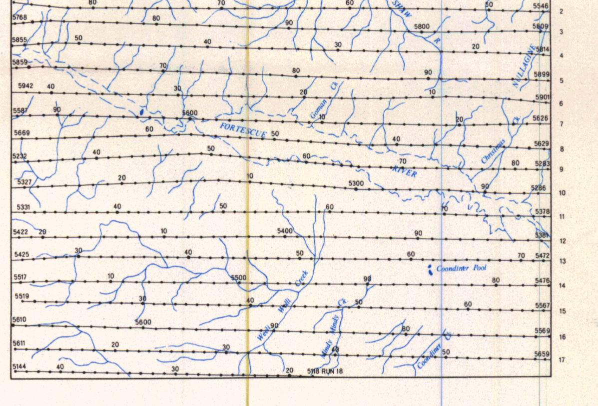
DECLINATION DIAGRAM



Annual change is negligible

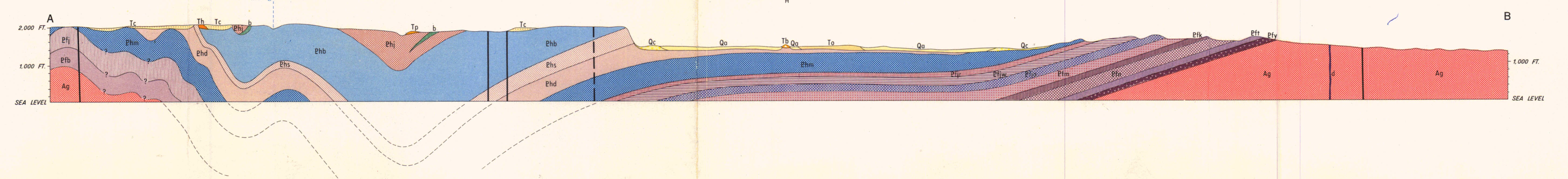
FLIGHT DIAGRAM

Air Photography Lands and Surveys Department of Western Australia, September 1957 Scale 1: 40,000



DIAGRAMMATIC SECTION A - B

SCALE $\frac{V}{H} = 10$



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ROY HILL
SHEET SF 50-12

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