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RECONNAISSANCE GEOLOGY BY HELICOPTER IN THE GIBSON DESERT, WESTERN AUSTRALIA.

by

A.T. Wells

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RECONNAISSANCE GEOLOGY BY HELICOPTER IN THE GIBSON DESERT, WESTERN AUSTRALIA

SUMMARY

The Gibson Desert lies in the central part of Western Australia and the six 1:250,000 Sheet areas dealt with in this report cover an area of about 40,000 square miles.

The oldest rocks exposed in the area are folded Precambrian igneous and metamorphic rocks which crop out on the south-east margin of the basin. Younger Precambrian sediments occur in the cores of diapiric structures on the Madley and Warri Sheet areas, at the Iragana Inlier and on the eastern margin of the basin. The sediments in the Iragana Hills are about 12,000 feet thick.

Possible Palaeozoic rocks, about 3,000 feet thick, unconformably overlie Precambrian sediments at the Iragana Hills and in turn are probably unconformably overlain by Permian rocks.

Horizontal Permian sediments of glacial or fluvioglacial origin probably underlie most of the Cretaceous and Mesozoic rocks that crop out in flat lying sheets over a major part of the area. The Permian sediments exposed near the Iragana Fault are about 500 feet thick. Mesozoic rocks probably of Jurassic or Triassic age, up to 300 feet thick, crop out beneath the Cretaceous rocks on the northern part of the area but were not deposited in this area further south than about latitude 25° south. The sediments are generally coarse grained and were probably deposited in a transitional environment. The Cretaceous rocks are at least 300 feet thick and were deposited in a transgressive sea which received mostly very fine detritus.

Aeromagnetic, gravity and seismic surveys in the Gibson Desert show that the sedimentary basin can be divided into two deep basins separated by a north-west trending basement ridge. Precambrian, Permian and Mesozoic rocks are exposed in diapiric structures in the western basin, and they probably occur beneath the thin veneer of Cretaceous rocks; the total thickness of sediments in the western basin is probably several thousand feet. This basin is most likely a sub-basin connected to the Officer Basin to the south. A large inlier with thick Precambrian and possible Palaeozoic sediments make up Iragana Hills. These rocks are indicative of the type of sediments that underlie the thin cover of Permian and Mesozoic sediments and which probably fill a large part of the eastern basin. The sediments at Iragana Hills show lithological similarities to some formations in the Amadeus Basin and the two basins may have had the same history.

INTRODUCTION

The geological investigation of the Gibson Desert area was carried out in June and July 1962 in conjunction with the regional helicopter gravity survey of the area by the Geophysical Section of the Bureau of Mineral Resources. The Gibson Desert was part of a large area covered by the gravity survey.

The geological observations in the six sheet areas in the Gibson Desert were made over a period of about 9 weeks and during this time a total of 76 geological points were visited and specimen collections were made at 30 locations. The helicopter was available for geological traverses alone on 7 days, but for the rest the geologist accompanied the geophysicist on planned gravity traverses and if practicable was left at outcrops along the traverse line and either picked up later at the completion of the traverse or during, and sometimes after the completion of succeeding traverses.

Some air-photographs covering the area are at a scale of 1:80,000 and the others at 1:40,000. One-mile photomosaics are available for some sheets and these proved invaluable when it was necessary to plan a geological traverse at short notice. On several occasions in areas where one-mile mosaics were not available, traverses were planned, and navigation carried out on 4-mile mosaics. The use of 4-mile mosaics for this purpose is unsatisfactory as geological points cannot be located accurately and landmarks and dunes which are used for navigation are difficult to see on the mosaics.

The geological information was plotted on uncontrolled 4-mile scale mosaics and then reduced to a scale of 1:500,000.

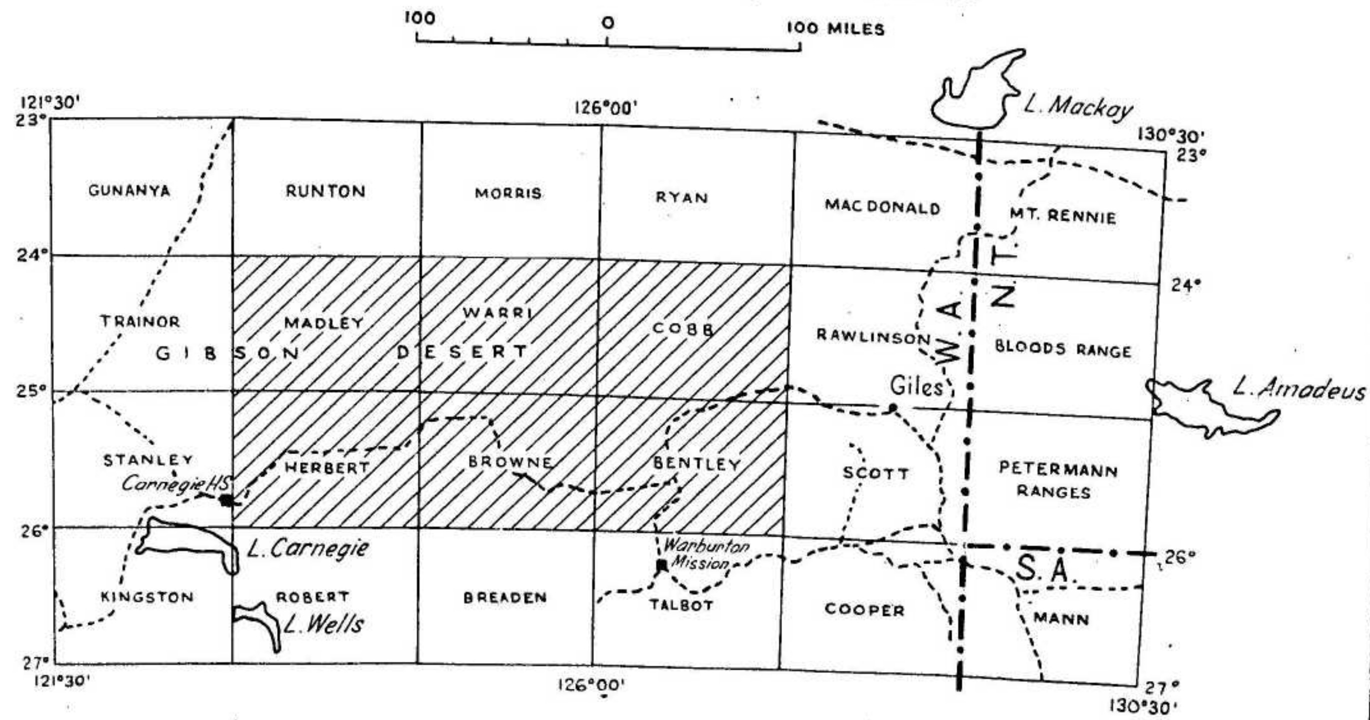
The area investigated lies in Western Australia between latitudes 24° and 26° south and longitudes 123° and 127°30' east. (Fig.1)

There are no permanent settlements in the area. Carnegie Homestead lies about 2 miles west of the western margin of the Herbert Sheet area, about 12 miles south of Lake Buchanan. The Warburton Native Mission is the closest point of habitation to the eastern part of the area.

Access to the area is gained by a dirt road which runs between Giles Weather Station and Carnegie Homestead. This road was constructed by the Weapons Research Establishment and enters the eastern part of the area south of Christopher Lake and branches on the Bentley Sheet area; one branch continues south to Warburton Native Mission and the other branch continues ~~east~~westward via Mt. Charles, Mt. Samuel, Mt. Beadell, Mt. Everard, Mt. William Lambert, Mt. Nossiter and Mt. Archie to Carnegie Homestead. An unsealed airstrip (Dekker Airfield) was made by the road crew about 6 miles south-east of

POSITION OF AREA DEALT WITH IN REPORT AND REFERENCE TO AUSTRALIAN 1:250,000 SERIES

Fig.1



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Mt. Everard. Well defined wheel tracks branch from the Giles-Carnegie road to Woolnough Hills and the Iragana Inlier.

Symbols used for reference points and specimen localities on the Sheet areas are - MA, Madley; W, Warri; C, Cobb; H, Herbert; B, Browne and BE, Bentley.

PREVIOUS GEOLOGICAL INVESTIGATIONS

In 1916, H.W.B. Talbot and E. de C. Clarke (1917) examined the area between Laverton and the South Australian border. Part of the Precambrian igneous and metamorphic rocks on the south-west area of the Bentley Sheet are described. In 1926 Talbot reported on the area north of Laverton and beyond Carnegie Homestead. In 1931, F.G. Forman (1931) also examined the area between Laverton and Warburton but his route lay north of the area covered by Talbot and Clarke.

E.P. Utting (1955) made a reconnaissance survey for Australian Oil Exploration Ltd in an area mainly to the south and south-east of the area dealt with in this report.

A reconnaissance geological survey was carried out in 1956 of the area to the north of the Gibson Desert by geologists of the Bureau of Mineral Resources, and the Woolnough Hills diapir on the Warri Sheet area was examined. The results of this survey are reported by Veevers and Wells (1959a and b, and 1961).

In 1959 Weegar and McQueen of Frome Broken Hill Co. Pty Ltd and C.L. Knight of Consolidated Zinc Pty made an aerial geological reconnaissance of the Gibson Desert Area (Weegar and McQueen, 1959).

Some of the traverses made during an aeromagnetic reconnaissance by the Bureau of Mineral Resources in 1960 (Goodeve 1961) are over the eastern part of the Gibson Desert area.

A large part of the Gibson Desert was covered in a geological reconnaissance by Leslie (1961) for the Frome Broken Hill Co. Pty Ltd.

Wells, Forman and Ranford (1961) reported the results of geological traverses in the Rawlinson and Macdonald Sheet areas which lie on the eastern edge of the Gibson Desert.

In 1961 (Watson, 1963) and 1962 (Fowler, 1963) seismic traverses were made by the Geophysical Branch of the Bureau of Mineral Resources at places along the Mt. Davies-Giles-Carnegie road, and also near Lake Keene and Lake Hopkins.

Soufoulis (1962) reported a reconnaissance made in the Warburton Range area, south of the Bentley Sheet area.

Gravity observations were made in the area described in this report as part of a regional helicopter gravity survey by the Geophysical Branch of the Bureau of Mineral Resources in 1962 (Lonsdale & Flavelle, 1963).

PHYSIOGRAPHY

The Gibson Desert area is mostly a flat plain with an average elevation of about 1400 feet. The contours shown in Plate I are drawn from barometric and instrument levelled heights that were observed during the course of the regional gravity survey. The observed heights are generally at intervals of about 7 miles.

The area can be conveniently divided into five physiographic divisions.

Sand Plains and Dunes.

Sand plains and dunes cover most of the Madley, Cobb, Herbert, and eastern part of the Bentley Sheet areas (Fig.2). The dunes trend mostly east-west or east-north-east but where they are braided they generally have no preferred orientation. The dunes average about 40 feet in height and the orange sand is now partly fixed by a scant growth of vegetation. In places, particularly on the western side of the Bentley and Cobb Sheet areas, the dunes have encroached low broad rises of pisolitic ironstone.

Dissected Hills and Ranges.

Dissected hills and ranges are found on the south-east and east part of the Bentley Sheet area, at Iragana Hills and along the western edge of the Madley Sheet area. The mesas and buttes which are con-concentrated near the centre of the area also fall within this division. Most of the hills do not rise more than 150-200 feet above the surrounding plain. A few of the peaks on the south-west part of the Bentley Sheet area are slightly above 2000 feet in elevation.

Ironstone Plains and Rises.

A large part of the Warri, Browne and western part of the Bentley Sheet areas are underlain by rolling plains and low broad rises which have a surface of pisolitic ironstone and ferruginised rubble. Most of this area is underlain by lateritised fine grained Mesozoic sediments. Some parts of this area have widely spaced sand dunes.

Red earth plains and alluvial fans.

Alluvial fans and outwash plains are most common around the areas of dissected mesas and buttes in the central part of the area. A large proportion of the alluviated areas are covered with mulga. In most of the mulga country the trees are not randomly distributed but occur in dense groves up to several hundred yards long and a few yards wide, separated by intergrove areas where trees are absent or sparse. The groves tend to be aligned along contours.

The red earth plains have only a poorly defined drainage system and are probably subject mainly to sheet water flow after heavy rain. Large claypans have formed in the low lying parts of the plains. Lake

Fig.2. Braided sand dunes on eastern part of Cobb Sheet area. Light patches are areas where spinifex has been burnt.

G/5483

Fig.3. Lake Gruska and surrounding red earth plain, Browne Sheet area. Large eucalypts are growing on the dry bed of the claypan.

Gruska (Fig.3) was filled with water when visited in 1961 by Army Surveyors. In June 1962 the lake was completely dry, and probably only fills with water after ephemeral floods.

Salt lakes are present in the low lying areas on the eastern margin of the Herbert Sheet area, at Christopher Lake and in low lying drainage channels at various localities. Many of the old drainage channels (e.g. Herbert Wash) have large deposits of travertine with a few small salt pans. Deposits of travertine occur around some of the larger salt lakes.

STRATIGRAPHY

General

Precambrian, Palaeozoic, Permian, Mesozoic and Cretaceous rock units have been mapped in the Gibson Desert area. About 12,000 feet of Precambrian sediments and 3000 feet of unconformably overlying Palaeozoic sediments occur at Iragana Hills. The Permian and Mesozoic sediments total about 1200 feet and include sediments deposited in glacial or fluvioglacial, transitional and marine environments.

Because of the regional nature of the investigation, only established formation names have been used where valid correlation with neighbouring areas can be shown. Other rock units are referred to under the various Periods.

The stratigraphy of the Gibson Desert area is shown in Table I, and the Geological Map of the area is Plate V.

PRECAMBRIAN

Metamorphic and Igneous Rocks

Precambrian igneous and metamorphic rocks cover a large part of the eastern and south-eastern Bentley Sheet area. The only other rock of igneous or metamorphic origin outside this area is a possible intrusive in Precambrian sediments on the north-west part of the Herbert Sheet area.

Many of the prominent topographic features on the Bentley Sheet area are made up of igneous and metamorphic rocks. These rocks comprise quartzite, sericitic quartzite, amphibolite, crenulated quartz-muscovite schist, phyllite, quartz-feldspar porphyry, granitic gneiss, granite, basalt, porphyritic rhyolite, porphyritic rhyodacite and gabbro (see Appendix I). Many of the rocks are cut by dykes of quartz and pegmatite.

TABLE 1

STRATIGRAPHY OF THE GIBSON DESERT AREA

AGE		FORMATION	MAP SYMBOL	THICKNESS AND LOCALITY	LITHOLOGY	TOPOGRAPHIC EXPRESSION AND PHOTO-PATTERN	CORRELATION AND REMARKS
QUATERNARY			Qa	-	Alluvium.	Small rivers and creeks, flood-plains and clay-pans.	
			Qt	-	Evaporites	Salt lake and salt pans.	
			Qs	-	Aeolian Sand.	Sand dunes and sand plain.	
			Ql	-	Travertine	Low mounds especially near salt lakes.	
MESOZOIC	CRETACEOUS	Bejah Beds	Ke	60' ± in mesas	White porcellanite, siltstone and some fine sandstone. Marine fossils.	Mesa topography. Light pattern with intricate drainage on photographs. Smooth pattern where ferruginised.	
			K	300' Young Range Bore + outcrop	Thin bedded siltstone and fine sandstone, in places opalised. Marine fossils, and plant spores.	Mesa and butte topography. Grey photo-pattern.	
			M	300' ± Iragana Fault	Medium, micaceous sandstone, siltstone and coarse poorly sorted, very ferruginous sandstone. Worm trails.	Large areas with dissected mesas and isolated pinnacles in sand plain. Very dark photo-pattern.	Probably Triassic or Jurassic in age. Lithologically similar to Cronin Sandstone. (Veevers & Wells, 1961)
		U N C O N F O R M I T Y					
PALAEOZOIC	PERMIAN	Paterson Formation	P	500' ± Iragana Fault	Coarse, pebbly sandstone, medium sandstone and siltstone and varves with slump structures. Fossil wood and plant spores.	Mesas, strike ridges, and low mounds.	Probably equivalent in part to Buck Formation.(Wells, et.al., 1961)
			Pa	100' ± in mesas	Coarse and medium sandstone and white siltstone with large erratics up to 3 feet across. Fluvioglacial.	Mainly prominent mesas. Some flats with scree chiefly of erratics.	
		ANGULAR UNCONFORMITY					
			Pzs	3000' ± Iragana Inlier	Medium, cross-bedded, silty sandstone with some well rounded pebbles and interbeds of pebble conglomerate.	Prominent strike ridges.	Possibly equivalent to Ellis Sandstone, Sir Frederick Conglomerate or Maurice Formation of the Rawlinson-Macdonald Area. (Wells, et.al., 1961)
		U N C O N F O R M I T Y					
PRECAMBRIAN			P€s	12,000' ± Iragana Inlier	Medium, silty, red-brown and white sandstone with interbedded red-brown siltstone. Dolomite with stromatolites, gypsum and some sandstone and siltstone at Woolnough Hills and Madley diapirs.	Prominent hills and strike ridges.	Sediments at Iragana Hills are similar to Carnegie Formation of the Rawlinson-Macdonald Area. (Wells, et.al., 1961)
		ANGULAR UNCONFORMITY					
			P€g	-	Igneous rocks including granite, quartz-feldspar porphyry, basalt, porphyritic rhyolite, porphyritic rhyodacite and gabbro.		
			P€m	-	Metamorphic rocks. Quartzite, quartz-mica schist, amphibolite, slate and gneiss.		

In the Bedford Range quartzite, amphibolite, crenulated quartz-mica schist, phyllite, granitic gneiss and slate crop out in a steeply plunging almost isoclinal fold. Large quartz dykes up to 3 feet wide cut the rocks. Several isolated prominent dark hills of gneissic or schistose amphibolite crop out five miles west of the Bedford Range.

A small outcrop of aplitic granite occurs at BE3 and much of the sand plain in this area is probably underlain by similar rocks. Large areas of granitic gneiss with abundant quartz veins crop out to the south of the aplitic granite at BE3.

At BE4 several varieties of acid and intermediate porphyritic rocks crop out which intrude metasedimentary rocks and both are cut by dykes of basalt and several other igneous rock types. Pyrite is present in many of the porphyries.

At BE5 there are outcrops of foliated granitic rocks which are part of the largest exposed area of granitic rocks on the Bentley Sheet area.

The metamorphic and igneous rocks show various grades of metamorphism, and in different places may be gneissic, schistose, crenulated, foliated and invariably steeply dipping. Insufficient details were obtained to determine precise relationships between the various rock types. Similar rocks probably form the basement to the Proterozoic, Palaeozoic and Mesozoic rocks in the sedimentary basin to the north-west of these outcrops. On the Bentley Sheet area the metamorphic and igneous rocks are unconformably overlain by Permian fluvioglacial sediments and undifferentiated Cretaceous rocks (Fig.4).

Sedimentary Rocks

Precambrian sedimentary rocks crop out at Iragana Hills, on the eastern sides of the Herbert and Madley Sheet areas, in the core of the Woolnough Hills diapir and in diapirs on the north-eastern part of the Madley Sheet area.

The Precambrian sediments form prominent hills north of Lake Buchanan on the Herbert Sheet area and occur as far north as Constance Headland on the Madley Sheet area. The predominant sediments in these areas are sandstone, finely micaceous, slightly sheared phyllitic sandstone and some siltstone. The sandstone is mostly medium and thin bedded, cross-bedded in sets 6 inches to 2 feet thick, mostly silicified, medium to fine grained, has clay discs up to 2 inches across in some beds and shows current lineation. Fine or coarse conglomerate is present in a few outcrops and at Constance Headland there are thick beds of conglomeratic sandstone with phenoclasts chiefly of quartz. The sandstone in these outcrops has both oscillation and translation ripple marks and sun cracks.

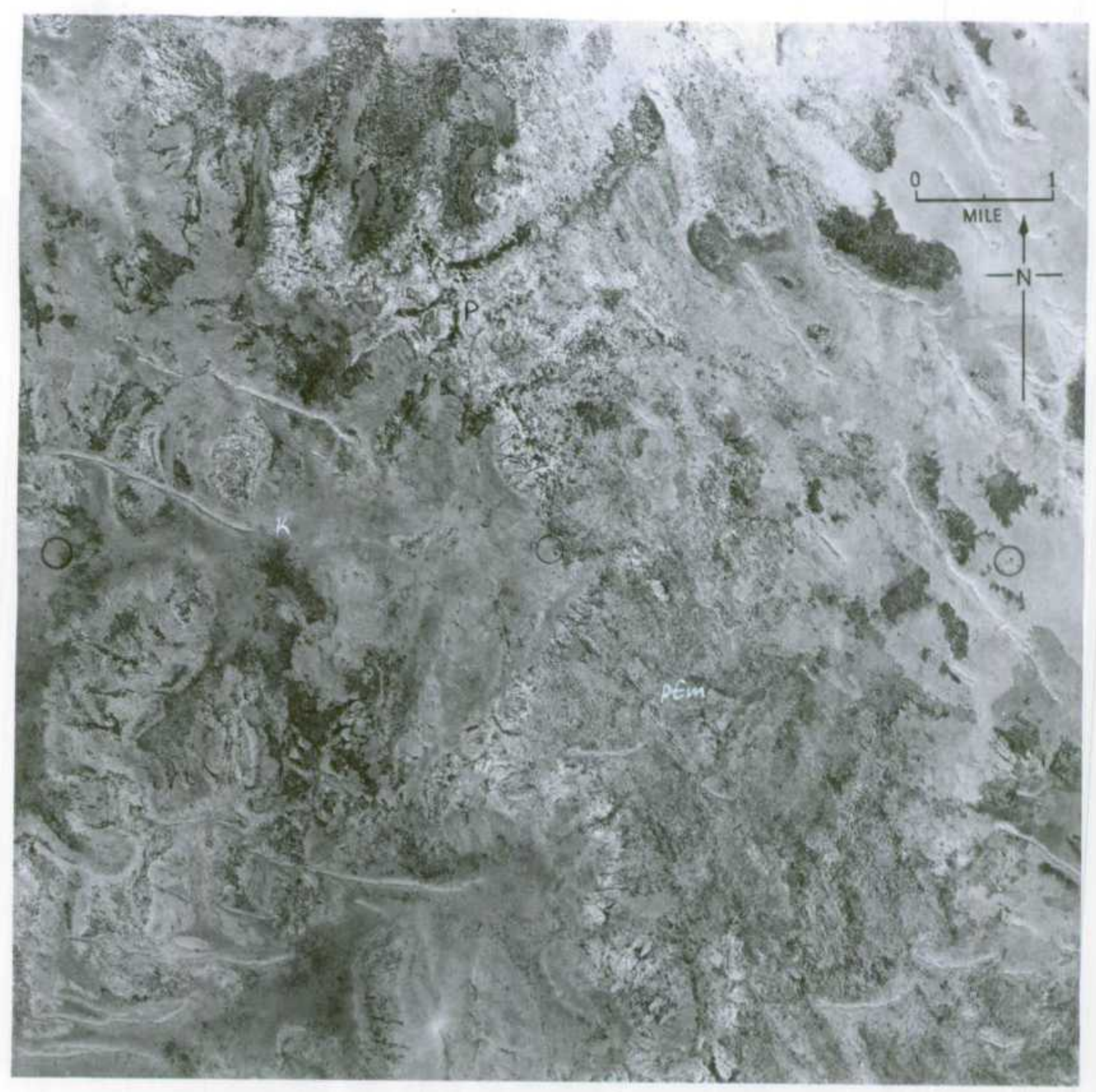

Fig.4. Air-photograph of steeply dipping Precambrian metamorphics (p€m) unconformably overlain by flat lying Cretaceous (K) and Permian (P) rocks, Bentley Sheet area.

G/5474

A deeply weathered outcrop of igneous rock was detected in the sandstone at H4 on the north-west part of the Herbert Shoot area. The rock is possibly a quartz-feldspar sill in the sediments.

In the cores of the Woolnough Hills and Madley diapirs there are masses of dolomite, dolomite breccia, gypsum, siltstone and sandstone which are probably Precambrian in age. The dolomite occurs as isolated brecciated masses over the sheared gypsum cores of the domes or in steeply dipping well bedded outcrops flanking the gypsum. The dolomite is mostly blue-grey or black, fine, thin bedded or laminated, with chert nodules and laminae and in places has abundant stromatolites. One specimen of laminated dark grey dolomite (MA 1A) from one of the Madley diapirs has pseudomorphs possibly after halite about 1-2 mm across. Sinkholes in the cores of the diapirs have exposures of sheared white or grey gypsum. This gypsum weathers to a white powdery amorphous mass which in places has embedded selenite crystals.

A few isolated outcrops of silicified, massive sandstone and poor outcrops of white, siliceous, laminated siltstone near the centre of Woolnough Hills may be Precambrian in age. Poor outcrops of siltstone with silicified stromatolites occur beneath Permian fluvio-glacial sediments on the south-west part of Woolnough Hills but no contacts were seen. On the western side of the Madley diapir at MA1 there are outcrops of well-jointed, medium, poorly sorted and bedded sandstone which are also probably Precambrian in age. Secondary gypsum crops out at the base of these hills and there are nearby outcrops of dolomite.

At Iragana Hills (Fig.5) there is a large thickness of steeply south-dipping Precambrian sediments. They consist mainly of medium and coarse poorly bedded silicified, red-brown and purple-brown, kaolinitic sandstone withcross beds and laminae of heavy minerals. Chocolate and red-brown siltstone occurs as minor interbeds in the sandstone. The steep dip of the beds and the width of the outcrop as measured on the air-photographs indicate a thickness of about 12,000 feet. They are unconformably overlain by possible Permian sediments and by undifferentiated Palaeozoic (pre-Permian) sandstone and conglomerate. The sediments at Iragana Hills are similar lithologically to Upper Proterozoic formations of the Rawlinson-Macdonald area, particularly the Carnegie Formation (Wells, et.al., 1961); their lithological similarity with the Carnegie Formation and unconformable relationships with younger formations suggest that they are Precambrian.

Fig.5. Steeply dipping Precambrian sandstone and siltstone forming the Iragana Inlier, Cobb Sheet area.

PALAEOZOIC

Undifferentiated

Undifferentiated Palaeozoic sediments have been mapped on the south side of the Iragana Hills. They crop out in an east trending ridge about 6 miles long and one mile wide. Another exposure occurs in a poorly defined outcrop about one mile south of this ridge.

The rock is predominantly kaolinitic, purple-brown, sandstone with large cross-beds and scattered well rounded quartzite pebbles. It is medium, well sorted, poorly thick bedded and weathers to give a very rugged topography. The sandstone has interbeds of conglomerate about 1 foot thick with well rounded pebbles and cobbles of quartzite and quartz which average about 3 inches across. The Precambrian sediments in the main mass of Iragana Hills to the north, dip steeply south and probably unconformably underlie the Palaeozoic rocks but no contacts were seen. The closest outcrops of other Palaeozoic rocks are flat lying Permian fluvioglacial sediments about 8 miles to the south and south-east. Some poor outcrops of flat-lying sandstone, possibly Permian in age, unconformably overlie the Precambrian sediments in the Iragana Hills but presumably have been removed from the outcrops of Palaeozoic rocks. The dip of the Palaeozoic sediments and the width of the outcrop measured on air-photographs indicate a thickness of about 3000 feet.

The Palaeozoic age of the sediments is deduced from their similarity to probable Palaeozoic formations in the Macdonald-Rawlinson area and from the unconformable relationships with older and younger rocks. The sediments are similar lithologically to the Maurice Formation and Ellis Sandstone (Wells et.al., 1961) which are unconformably overlain by Permian sediments.

PERMIAN

Paterson Formation

The Paterson Formation is named from the type locality at Paterson Range (Lat. 21°45'S, Long.122°10'E). The rocks were first referred to as the Paterson Range Series of sandstones and grits by Talbot (1910) and later changed to Paterson Formation by Traves et.al. (1956), because the sequence is of varied lithology. In the type area the sediments range from claystone to conglomerate and are unsorted and massive with slump structures and local contortion. The fragments are predominantly quartzite and granite up to 3 feet across with minor cleaved siltstone and quartz; 100 feet of the formation was measured in the Paterson Range. It overlies Lower Proterozoic rocks with an angular unconformity and the top is eroded. On the Runton Sheet area the Paterson Formation is overlain disconformably by the Cronin Sandstone which has Upper Triassic or Jurassic plant fossils (White, 1961) and conformably by the Permian Cuncudgerie Sandstone (Veevers and Wells, 1961). The formation is probably Sakmarian in age and is correlated with the Grant Formation which crops out in the northern part of the Canning Basin.

The Paterson Formation has been mapped only on the western margins of the Madley and Herbert Sheet areas. Sediments similar to those of the Paterson Formation have been mapped on the eastern part of the Bentley Sheet area, in the core of Woolnough Hills, and in the diapiric structures on the north-east part of the Madley Sheet area. These occurrences will be discussed under the heading Undifferentiated Permian Rocks as they are in areas far remote from known outcrops of Paterson Formation. The outcrops are mostly in prominent well dissected steep sided mesas and breakaways which occur near Linke Lakes (Fig.6), Lake Buchanan and as far north as Constance Headland. Many of the mesa tops have a stippled dark tone photopattern whereas their steep sides have a lighter tone and in places white where the sediments are recently dissected.

The thickest exposure of the Paterson Formation in any of the mesas is about 100 feet. The sediments consist of interbedded coarse pebbly sandstone, medium and fine well sorted sandstone and siltstone which is well sorted or may contain numerous small angular rock fragments and large erratics. Bedding is mostly poor except where large cross-beds occur in the coarse sandstone. Some of the siltstone is friable and easily weathered. Erratics up to 3 feet across occur in the poorly sorted siltstone; they are composed mainly of metamorphic and igneous rocks none of which were seen in situ in the area mapped. Some of the rock types included pink and grey biotite granite, muscovite schist, small white quartz fragments, kaolinite, quartzite and silicified green and grey oolitic limestone. Encrustations of secondary selenite are present in the scree slopes and at the base of the mesas which probably indicates the presence of primary gypsum in the siltstone of the formation.

No contacts of the Paterson Formation with older formations was seen but several photointerpreted mesas of Paterson Formation unconformably overlie Precambrian sediments at Constance Headland. On the north-western part of the Herbert Sheet area there is about 15-20 feet of poorly bedded claystone and siltstone overlying poorly sorted sandstone and boulder beds of the Paterson Formation. The claystone and siltstone is possibly Cretaceous in age.

Fig.6. Permian fluvioglacial sediments of the Paterson Formation in breakaways at Linke Lakes, south-west part of the Herbert Sheet area.

G/5490

Permian plant spores have been found in a core from a B.M.R. seismic hole near National Mapping Trig. Station NMF 23 about 28 miles west of Mt. Everard. The core was taken at a depth of 422-431 feet. The spores indicate the rock is the time equivalent of part of the Grant Formation of the Fitzroy Basin, and is approximately equivalent to the Nuskoisporites zone. (R. Evans, B.M.R., pers. comm.)

Undifferentiated

Undifferentiated Permian rocks are present in the cores of the diapiric structures on the north-east part of the Madley Sheet area, at Woolnough Hills, near Boyd Lagoon, Sutherland Range and Lake Breaden, south and south-east of Iragana Hills, south-west of Lake Cobb and on the western parts of the Bentley and Cobb Sheet areas. The sediments are exposed in mesas or low mounds and in ill defined ridges near the Iragana Fault. The exposures along the Iragana Fault and in the diapiric structures at Woolnough Hills and on the Madley Sheet area show that the sediments may be more than 500 feet thick. Most of the sediments show evidence of a fluvioglacial origin by facetted, erratic boulders and varved sediments (Figs. 7 & 8).

The sediments in the Sutherland Range are made of about 100 feet of white coarse cross-bedded, kaolinitic, poorly sorted and bedded sandstone, with conglomeratic beds about 3 inches thick. There are some subrounded erratics in the sandstone up to 3 feet across of quartzite, white quartz, granite, gneissic granite, quartz-mica schist, pegmatite, feldspathic sandstone and siltstone. Several of the quartzite erratics are facetted. There is some interbedded poorly sorted and bedded siltstone and white fine claystone.

Similar fluvioglacial sediments are present on the eastern part of the Bentley Sheet area and at C7 south-west of Iragana Hills. Varved sediments are exposed in these outcrops and penecontemporaneous slump structures are abundant (Figs. 7 & 8). About 20 feet of undifferentiated Mesozoic sandstone overlies the Permian fluvioglacial sediments at C7. An 89 foot section measured in a mesa of the Permian rocks 12 miles south-east of the Bedford Range is in descending order -

22 feet - Sandstone, white, weathers orange-brown, poorly thin bedded, moderately well sorted, small silt fragments in thin beds. Where laminated has alternating fine and medium sandstone.

39 feet - Sandstone, white and orange-brown, thin and medium well bedded, poorly sorted, some well sorted, medium and fine grained, siltstone fragments in thin beds.

28 feet - Sandstone, varicoloured, mostly ill sorted, rock fragments up to ½" and clay laminal and lenses, medium bedded and laminated, medium and coarse grained, slumps and small cross-beds, friable.

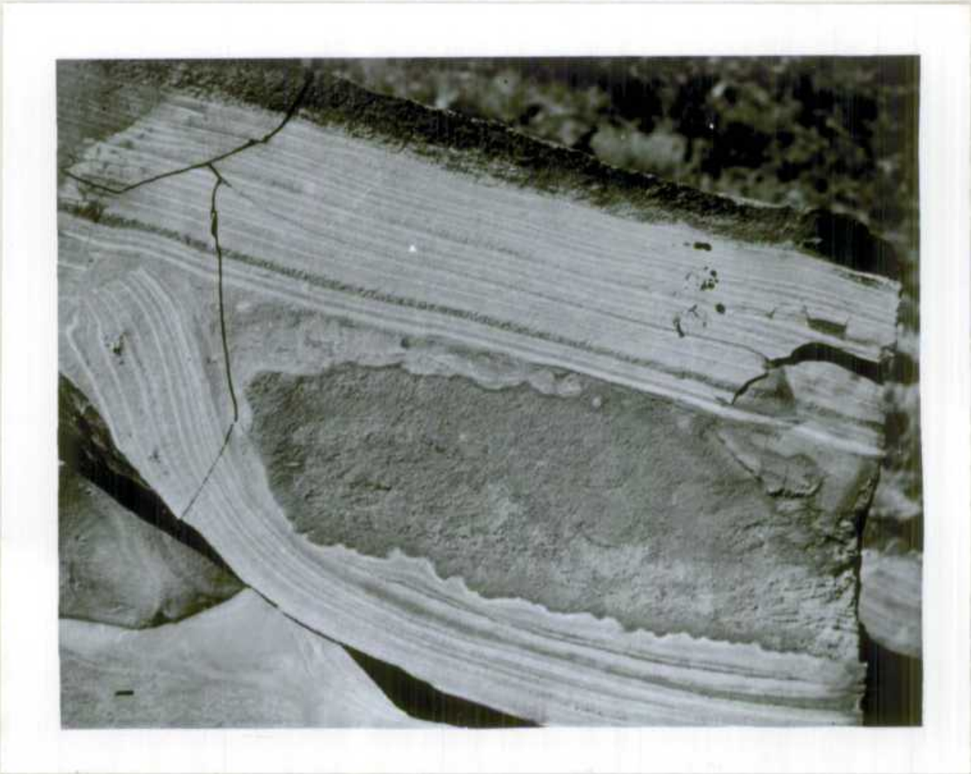

Fig.7. Varved Permian fluvioglacial sediments with "exotic" mass of coarse sandstone. Eight miles east of Bedford Range, Bentley Sheet area. G/5485

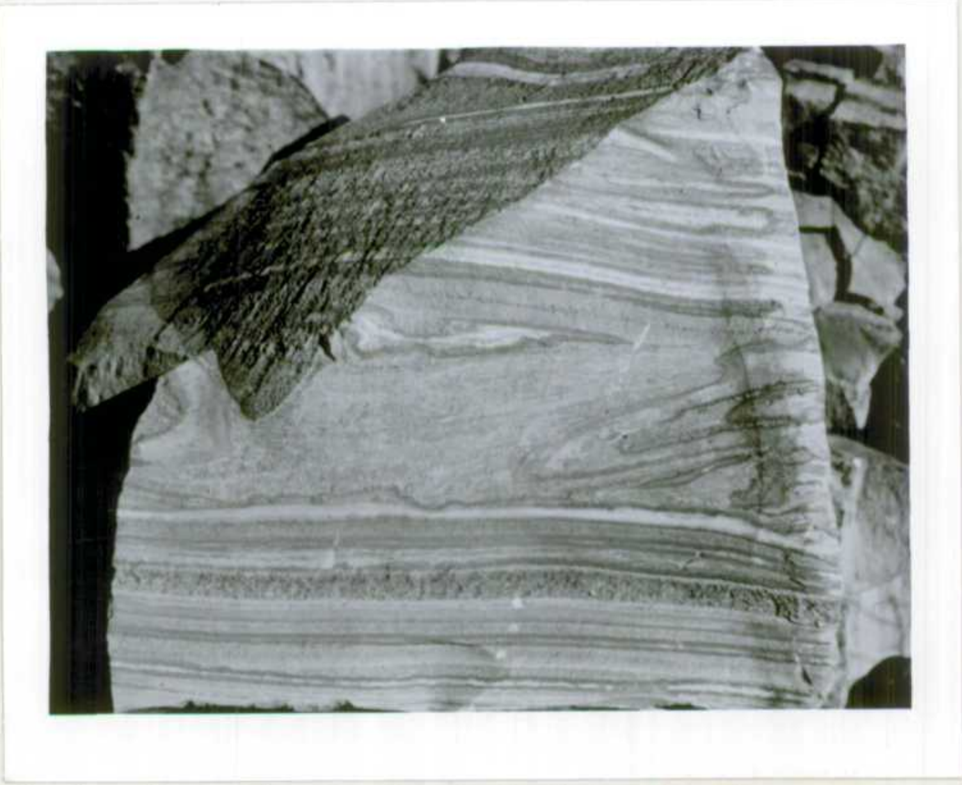

Fig.8. Varved Permian fluvioglacial sediments showing intricate penecontemporaneous slumping. Eight miles east of Bedford Range, Bentley Sheet area. G/5491

Thick sections of undifferentiated Mesozoic and Permian sediments are exposed along the Iragana Fault Line. The Permian sediments are predominantly poorly sorted, medium and coarse, cross-bedded, thin and medium bedded sandstone with angular quartz grains and pebble beds and thin bedded siltstone.

Some ill defined remnants of poorly bedded medium sandstone, probably of Permian age overlie the Precambrian sediments in the Iragana Hills. Permian sediments are exposed in a dome structure at C6, 18 miles south-south-east of Iragana Hills. The sediments are medium and coarse ferruginous sandstone, yellow-brown siltstone, and coarse conglomeratic sandstone with fragments of fossil wood.

Permian sediments crop out in the core of the Woolnough Hills diapir and in some of the diapirs on the north-west part of the Madley Sheet area. The sediments are poorly sorted and bedded sandstone and siltstone which have abundant clay and rock fragments and slump structures. Some of the varved, thin bedded sediments have alternating purple-brown siltstone and coarser white sandstone. The rock fragments are angular siltstone and quartz, and some of rounded quartzite and granite up to 6" across.

The fluvioglacial Permian sediments are similar to the Buck Formation (Wells et.al., 1961) but because the sediments in the Gibson Desert have not been studied in any detail they are mapped as undifferentiated Permian.

MESOZOIC

Undifferentiated

Undifferentiated Mesozoic rocks have been mapped at Ryan Buttes, on the west side of the Iragana Fault and in areas to the south-west, in the Madley diapirs and Woolnough Hills. The poor exposures on the northern parts of the Bentley and Madley Sheet areas have been photo-interpreted.

The Mesozoic rocks have a dark photopattern and are exposed in mesas and buttes (Fig. 9). Where they are deeply dissected the exposures are in isolated pinnacles in the sand plain or in dark toned deeply ferruginised rises.

The sediments exposed at the top of mesas are predominantly hard, poorly bedded, ferruginous, medium sandstone with some poorly sorted, angular sand lenses, concretionary structures, worm markings, and cross beds. The underlying sediments in these mesas consist of friable micaceous, white, medium, thin-bedded sandstone with some more resistant interbedded limonitic siltstone (Fig.10). The greatest thickness exposed in the flat lying sediments at Ryan Buttes is about 120 feet. In this area the Mesozoic sediments are overlain by undifferentiated Cretaceous sediments but their base is not exposed.

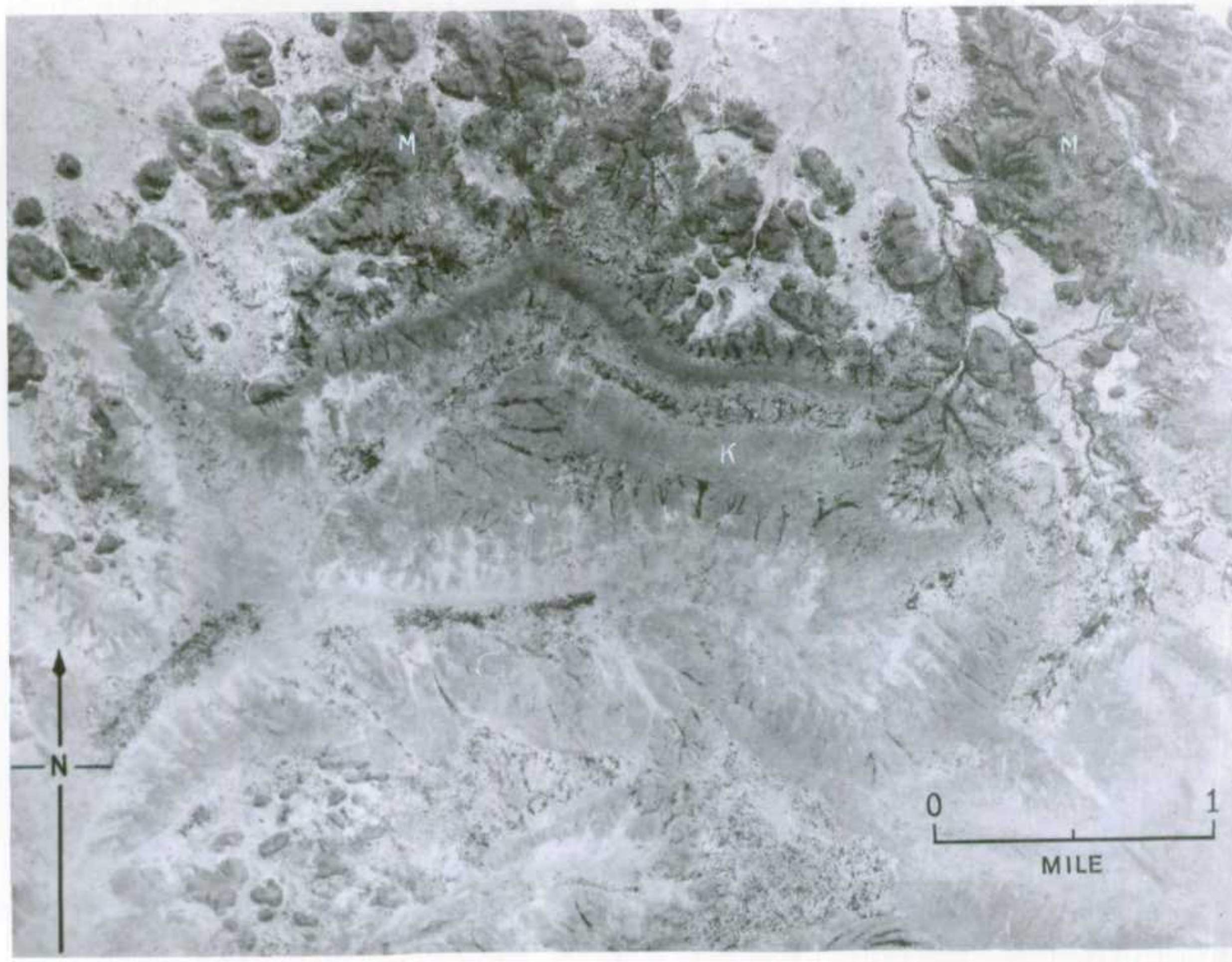

Fig. 9. Air-photograph of Mesozoic rocks (M) and overlying Cretaceous rocks (K) at Ryan Buttes. G/5473

Fig.10. Interbedded white, friable, micaceous sandstone and harder, limonitic, red-brown siltstone of Mesozoic age. Ryan Buttes, Cobb Sheet area.

Thicker sections (probably more than 300 feet) of Mesozoic rocks are exposed along the Iragana Fault Line (Fig.11). The sediments are poorly sorted, cross-bedded sandstone, ferruginised in part, red-brown or white, friable, silty, thin and medium bedded, medium and coarse with thin conglomeratic beds and numerous concretionary structures. The sandstone has some interbeds of thin bedded siltstone. The Mesozoic rocks in this area are underlain by Permian fluvioglacial sediments, and overlain by Cretaceous sediments (Fig.12). At C7 there is about 20 feet of poorly sorted ferruginous sandstone of possible Mesozoic age which overlies Permian fluvioglacial sediments.

Similar sediments are exposed in the Woolnough Hills and Madley domes. In these structures the Mesozoic sediments lie unconformably between Cretaceous sediments above and Permian sediments below.

Some outcrops of interlaminated and rhythmically interbedded siltstone and fine, medium and coarse sandstone occur on the Bentley Sheet area underlying Cretaceous sediments close to outcrops of Precambrian rocks. The sediments contain flakes of muscovite, are mostly thin bedded, and show cross-bedding. The coarser beds are poorly sorted. These outcrops are mapped as Permian but some of the sediments are similar to those in the Ryan Buttes and on the west side of the Iragana Fault, and for this reason as well as their stratigraphic position they may be in part Mesozoic in age.

The sediments of the Ryan Buttes area were previously mapped as Permian by Veevers and Wells (1961). However the stratigraphic position of these sediments below Cretaceous rocks and above Permian fluvioglacial sediments, the litholigical similarity to known fossiliferous Mesozoic sediments and their photopattern, indicate that they are Mesozoic in age. Foraminifera were not detected in several samples submitted for micropalaeontological examination.

CRETACEOUS

Bejah Beds

The Bejah Beds are named from Bejah Hill (23°46'S, 124°09'E) on the Runton Sheet area in the southern part of the Canning Basin. They are defined by Veevers and Wells (1961) as "...the hard white siliceous claystone (porcellanite) and shale with thin, medium to coarse sandstone that is exposed in the Runton, Morris, Warri and Ryan Sheet areas.". In the south Canning Basin the Bejah Beds overly undifferentiated Mesozoic sandstone and possible Cretaceous Kidson Beds. The top of the Bejah Beds is eroded or in some places the claystone is capped by coarse sandstone.

Fig.11. Permian and Mesozoic sediments dipping steeply east, Iragana Fault Line, Cobb Sheet area (C1).

G/5484

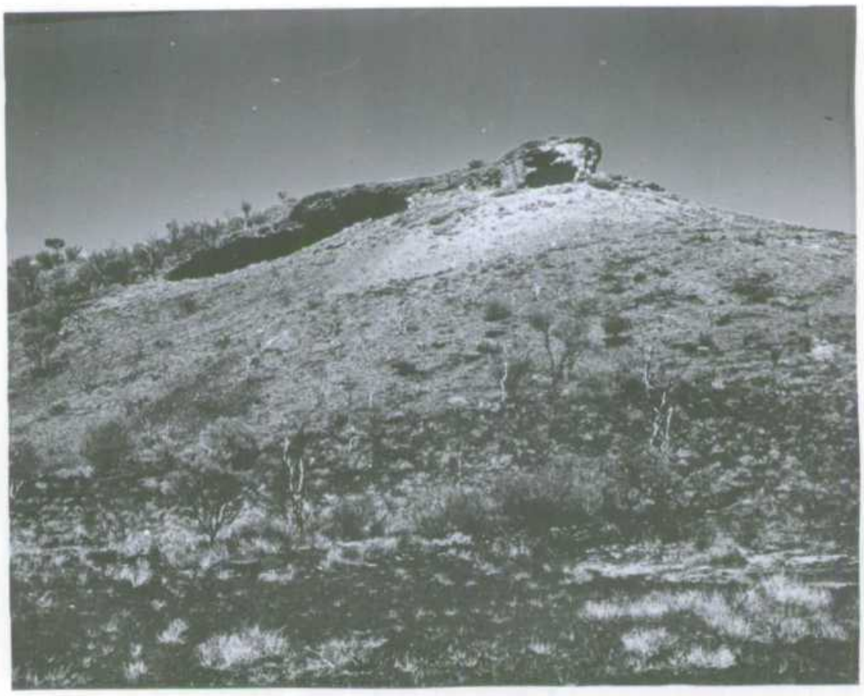

Fig.12. Thin Cretaceous sediments overlying undifferentiated Mesozoic sediments near Iragana Fault Line, Cobb Sheet area.

G/5487

The Bejah Beds have been identified and mapped on the Madley, Herbert, Warri and Browne Sheet areas in the Gibson Desert. Some of the undifferentiated Cretaceous rocks mapped on the eastern part of the Browne Sheet area and on the western part of the Bentley Sheet area may have thin cappings of Bejah Beds. The type of outcrops and the distinctive photopattern is described in detail by Veevers and Wells (1961). The Bejah Beds are the most widespread of any of the formations mapped in the Gibson Desert area, and many of the prominent features named in the central part of the area are made up of the Bejah Beds. The Bejah Beds crop out in mesas which in most places have a thick duricrusted capping (Fig.14). No sections were measured through the formation as in most places there is only a few feet of claystone exposed. The maximum thickness preserved in any one outcrop is about 60 feet.

The most characteristic lithology of the Bejah Beds is the white, poorly bedded claystone (Fig.13). The claystone is hard and splintery when silicified and has a conchoidal fracture. When examined under a lens some of the siltstone samples are faintly laminated or thin bedded but in outcrop the rock is thick bedded. The Bejah Beds also includes white thick-bedded siltstone, and minor fine thin to medium bedded sandstone. The sediments are well sorted. The porcellanite contains a high percentage of silica and analyses by A.M.D.L. on four specimens was -

B3	89.78%	SiO_2
W1	75.21%	"
H3/1	72.21%	"
H2	72.21%	"

A reason for the predominance of fine grained sediments in the formation is given by Veevers and Wells (1961). They say - "The narrow opening of the epicontinental Aptian sea possibly explains in part why claystone with radiolaria, rather than interbedded siltstone and fine sandstone with foraminifera, is the dominant sediment." The coarse sandstone which in places overlies the Bejah Beds is probably the final regressive shore-line deposits of the Mesozoic sea.

The Bejah Beds overlie undifferentiated Cretaceous rocks and in a few places are overlain by a few feet of silicified sandstone. In most places the top of the Bejah Beds is eroded.

Two samples from the Bejah Beds, a porcellanite from B3 and a siltstone from H3-1, contain probable radiolaria which were recognised in thin section by Lloyd (1963).

Marine fossils (Fig.15) have been collected from the Bejah Beds and are described by Skwarko (1963). They indicate a Lower Cretaceous (Aptian) age. The Bejah Beds contain fossils which are known from the Roma "Formation" of the Great Artesian Basin and similar Lower Cretaceous siliceous claystones and shales are widespread throughout Australia.

Fig. 13. Porcellanite of Cretaceous Bejah Beds at Mt. Beadell.

G/5486

Fig. 14. Dissected deep weathering pr file over Cretaceous sediments, Tsakalos Range, Browne Sheet rea.

G/5488

Fig. 15. Cretaceous marine fossils in Bejah Beds, B5, Browne Sheet area.

Pseudavicula anomala (Moore, 1870)
(radially ribbed)
and
"Glycimeris" sp. cf. "G" sulcata
(Etheridge Jnr., 1872)
(concentrically ribbed).

G/5489

<u>Undifferentiated</u>

A large part of the flat-lying Mesozoic rocks of the Gibson Desert are mapped as undifferentiated Cretaceous. These outcrops include fossiliferous Cretaceous sediments that lie conformably below the Bejah Beds and areas of poor outcrop where the Bejah Beds could not be differentiated by photointerpretation from the underlying sediments. Many of the areas of poor outcrop, where undifferentiated Cretaceous sediments have been photointerpreted may thus be made up of either Bejah Beds or underlying undifferentiated Cretaceous sediments or both.

Undifferentiated Cretaceous rocks occur over a large part of the Gibson Desert area. Good exposures occur at Mt. Charles, Mt. Samuel in the Baker Range, in hills about 8 miles east-south-east of Lake Gruska, at B1 on the Browne Sheet area, and in the Alfred and Marie Range on the south-east part of the Warri Sheet area.

The sediments crop out in rounded hills and low rises. The light grey photo pattern and the well rounded hills can be used to identify many of the Cretaceous outcrops on air photos.

The sediments are interbedded fine and medium sandstone, siltstone and claystone which are thin and medium bedded, in part finely micaceous, and contain some worm trails.

At W4 the Cretaceous rocks are about 150 feet thick of which the top 20 feet is made up of fossiliferous white claystone of the Bejah Beds. The underlying sediments are variegated interbedded finely micaceous, fine sandstone, siltstone and some white claystone. Undifferentiated Cretaceous siltstone, sandstone and claystone are also overlain by the Bejah Beds at McPhersons Pillar.

At Mt. Madley on the Madley Sheet area about 100 feet of Cretaceous sediments are exposed. The sediments are poorly thin bedded white sandstone with subordinate claystone and siltstone. Some of the sandstone is well jointed and massive, and has pellets of white siltstone and claystone.

About 100 feet of section is exposed at Mt. Charles (B6) with about 20-25 feet of fine, white, fossiliferous siltstone probably of the Bejah Beds capping the hill. The lower part of the section exposed here is partly opalised medium and fine sandstone and siltstone.

The sediments at BE7 and B6 are richly fossiliferous and consist predominantly of opalised thin bedded medium and some coarse sandstone, with thin interbeds of siltstone and claystone. At B6 some thin beds of sandstone are richly glauconitic (see description - Appendix I).

At H3 on the north-west part of the Herbert Sheet area there is about 15 feet of poorly bedded claystone and siltstone overlying Permian sediments.

Photointerpreted outcrops of Cretaceous rocks overlie Precambrian sediments on the western side of the Madley Sheet area, and Precambaian metamorphics on the Bentley Sheet area.

Aptian marine plant spores were found in a core from a B.M.R. seismic hole near the western end of the Young Range. (R. Evans, B.M.R. pers. comm.) The core was taken at a depth of 268-274 feet. Outcrops of Cretaceous rocks near the bore are about 50 feet thick, so that the total thickness of Cretaceous rocks in this area is at least 300 feet.

The marine macrofossils present in the Bejah Beds and in the underlying Cretaceous rocks show no difference in age for the two sequences. They are Lower Cretaceous (Aptian).

CAINOZOIC

QUATERNARY

Alluvium, aeolian, sand, travertine and evaporites

Aeolian sand is the most widespread Quaternary deposit. It occurs in seif dunes and large sand plains. Most of the dunes trend east-west but some areas of braided dunes show no preferred orientation.

A large part of the Gibson Desert is covered by red-brown alluvium. It is noticeably more widespread on flood-plains on the Browne Sheet area, where there is probably active transport and deposition of sediment only during flash floods. Several large clay pans, notably Lake Gruska which is about 2 miles across at its widest point, occur on the Browne Sheet area and have beds of clay and silt. Thick mulga is common on areas of alluvium.

Evaporites occur in the salt lakes on the western side of the Herbert Sheet area and in Christopher Lake. No samples were obtained.

Travertine in irregular mounds and low hills is present around the salt lakes. Some large areas of travertine occur along lines of drainage such as Herbert Wash. The deposits are made up of white limestone with varying amounts of chalcedony.

Thick deposits of pisolitic ironstone and strongly ferruginised zones are present over many of the outcrops of finer grained Mesozoic sediments (Fig.14). These deposits are probably part of a Tertiary laterite profile.

STRUCTURE AND GEOPHYSICS

Regional Structure

The Precambrian metamorphic rocks on the Bentley Sheet area are intricately folded and faulted and intruded by large bodies of porphyritic and granitic rocks. Dykes of quartz, pegmatite and basaltic rocks cut the igneous and metamorphic rocks. Similar rocks probably form the basement to the Proterozoic, Palaeozoic and Mesozoic rocks in the sedimentary basin to the north-west of the outcrops on the Bentley Sheet area.

The Precambrian sedimentary rocks are exposed in broad folds on the western margin of the basin (e.g. Constance Headland, Fig.16) with dips generally not exceeding 45°. The Precambrian sediments exposed in the core of the Madley diapiric structures and in Woolnough Hills are either severely brecciated in the centre, or steeply dipping on the flanks. The thick Precambrian sediments at the Iragana Inlier dip at 45° to the south and the eastern side of the outcrop is truncated by the Iragana Fault. The Precambaian sediments are probably unconformably overlain by undifferentiated Palaeozoic rocks. The structure of the Palaeozoic rocks indicates that they were folded before the Permian and after the folding that affected the Precambrian sediments. The undifferentiated Palaeozoic sediments only crop out at Iragana Hills.

Undifferentiated Permian rocks have been domed in the Madley diapirs and Woolnough Hills and dips up to 50° in the sediments are not uncommon. Permian rocks have been uplifted on the west side of the Iragana Fault and the beds dip steeply to the east. A small area of folded sediments about 8 miles south-west of Mt. Samuel may include Permian rocks. The Permian sediments overlying the Precambrian igneous and metamorphic rocks on the Bentley Sheet area have not been folded. The Permian sediments in the Sutherland Range and near Boyd Lagoon and the beds of the Permian Paterson Formation are flat lying.

The Mesozoic rocks are flat lying with the exception of the beds on the west side of the Iragana Fault area, which dip steeply east, and the outcrops in diapiric structures on the Madley and Warri Sheet areas where the beds are gently domed. The undifferentiated Mesozoic rocks were probably not deposited much further south than latitude 25° south. The Cretaceous Bejah Beds and undifferentiated Cretaceous sediments were deposited over the major part of the Gibson Desert and overlapped the undifferentiated Mesozoic rocks to rest disconformably on Permian sediments and unconformably on Precambrian igneous and metamorphic rocks.

At one locality on the western side of Madley Sheet area photointerpreted Cretaceous sediments unconformably overlie Precambrian sedimentary rocks.

Fig.16. Air-photograph of Precambrian sediments in south-east pitching syncline at Constance Headland.

G/5469

The large sheet of Cretaceous rocks is for the most part flat lying. Small local dips up to about 5° were observed in a few isolated outcrops and the beds are folded with dips up to about 12° near the Iragana Fault Line and in the folds 8 miles south-east of the Baker Range. The Cretaceous rocks are probably slightly domed in the Madeley and Woolnough Hills diapirs.

Iragana Inlier and Iragana Fault

In this report the large mass of undifferentiated Precambrian and Palaeozoic rocks that crops out at the Iragana Hills is termed the Iragana Inlier (Fig.17). The rocks of the Iragana Inlier occur in an area of essentially flatlying younger Permian and Mesozoic sediments.

The Iragana Fault cuts the Iragana Inlier at its eastern margin and continues intermittently as far south as a point on the northern part of the Bentley Sheet area, where it crosses the Giles-Warburton road.

The sediments on the south-western side of the fault have been upthrown. The Bouguer anomaly gradients across the structure suggest that it is a reverse fault (A. Flavelle, B.M.R., pers.comm.).

The Iragana Fault (Figs. 17 & 18) truncates the undifferentiated Precambrian and Palaeozoic sediments at the Iragana Inlier and outcrops of these sediments rise abruptly in steep hills on the west side of the fault. Sand plain obscures outcrops near the eastern side. Flatlying Cretaceous sediments compose all the outcrops near the eastern side of the fault and in places crop out adjacent to the fault line. From a point about 8 miles south of Iragana Hills to the southernmost limit of the fault there are outcrops of Permian, Mesozoic and Cretaceous rocks uplifted on its western side. The fault is not continuous and 18 miles south-south-east of Iragana Hills is interrupted by a dome in Permian, Mesozoic and Cretaceous rocks. The dome is elongated along a north-west axis. The trace of the Iragana Fault is visible again two miles south-east of the dome and it continues in a south-west direction. Along the southern trace of the fault Mesozoic and Permian sediments crop out on the western side and undifferentiated Cretaceous sediments on the east side.

The origin of the Iragana Inlier is probably closely allied to the Iragana Fault. The outcrop of the thick Palaeozoic and Proterozoic sediments in the Iragana Hills is unique to this large area of flat lying Cretaceous, Mesozoic and Permian rocks. The lithology of the sediments, their thickness and evidence from geophysical surveys suggest that they have undergone a similar structural history to sediments of the Amadeus Basin to the east. Sediments of the Iragana Inlier type were not found between the basement rocks and overlying sediments on the Bentley Sheet area, in the Madley diapirs and Woolnough Hills and on the western side of the Gibson Desert area.

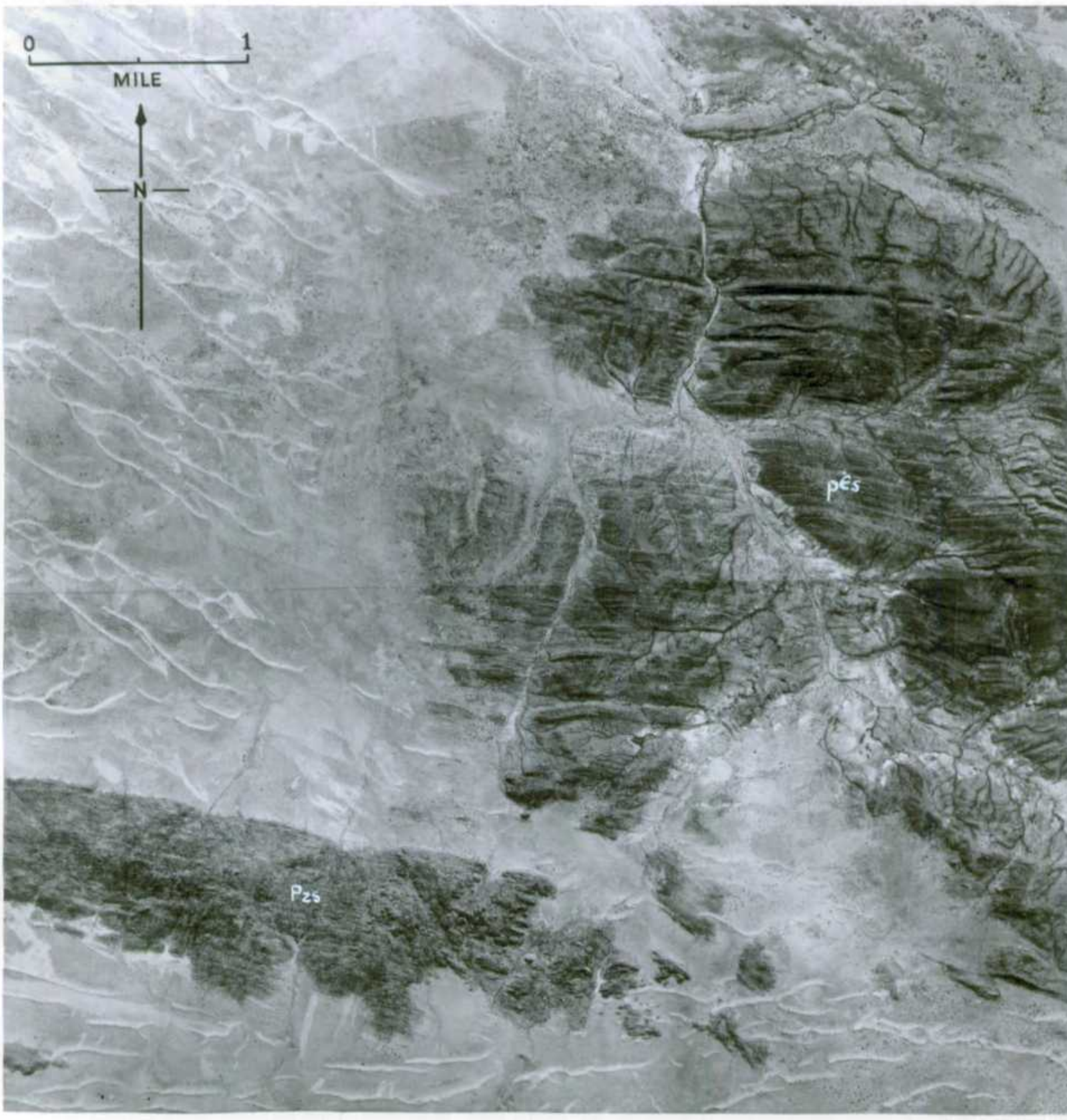

Fig. 17. Air-photograph of Precambrian (pЄs) and Palaeozoic (Pzs) sediments at the Iragana Inlier.

G/5478

Fig. 18. Air-photograph of the Iragana Fault showing steeply dipping Mesozoic and Permian rocks. Flat lying Cretaceous rocks are in the outcrops visible on the north-east corner of the photograph.

G/5475

Diapiric Structures

Several diapiric structures were discovered on the north-east part of the Madley Sheet area and possible diapirs were photointerpreted at Lake Cohen, at the western end of the Young Range, and on the northern part of the Madley Sheet area. A dome structure occurs along the Iragana Fault but there is no direct evidence that this structure is diapiric in origin.

The Woolnough Hills diapir was visited by B.H. Stinear and A.T. Wells in June 1956, and described by Veevers and Wells (1959a and 1959b). The dome is made up of a core with sheared gypsum, and masses of brecciated dolomite and silicified sandstone probably of Precambrian age. This core is surrounded by discontinuous outcrops of probable Precambrian dolomite and some siltstone dipping steeply away from the centre of the dome. The dolomite is overlain unconformably by domed Permian rocks. The Permian rocks are overlain unconformably by undifferentiated Mesozoic rocks which are in turn overlain unconformably by Cretaceous rocks. The description of the various rock types are dealt with under the respective headings in stratigraphy.

The core of the Woolnough Hills diapir is sheared gypsym but other evaporites may occur at depth. The unconformities in the sediments comprising the dome suggest that movement of the intrusive material probably commenced in the Precambrian. The latest movements of the intrusive material are not known with any certainty. The attitude of the Cretaceous rocks around the dome is not easily seen because of the deep weathering in these rocks. The air-photopattern suggests that there has been some tilting of the sediments and therefore movement of the diapir may have continued after the deposition of the Cretaceous rocks.

Five probable diapiric structures are present on the north-east part of the Madley Sheet area, one of which was seen on the ground (MA1, Fig.19). The geology of the dome at MA1 is practically identical to Woolnough Hills although the sediments are not as well exposed. The Madley diapirs are arranged in line along a south-south-west trending axis about 12 miles long. This axis, along which the diapirs are now distributed, may have originally have been a fault. The movement along the fault may have initiated the intrusion of gypsum (Fig.20) and possibly other evaporites which were intruded at points along the fault line. The sediments present in the diapirs are described in the section on stratigraphy.

A dome structure in undifferentiated Cretaceous rocks has been photointerpreted 20 miles north-north-east of MA1 on the Madley Sheet area. The dome may be diapiric in origin. Another dome in Permian and Mesozoic rocks, possibly of similar origin, is present at Lake Cohen. A poorly defined dome was photointerpreted in Cretaceous rocks at the eastern end of the Young Range. The dome structure near the Iragana Fault is made up of Permian, Mesozoic and Cretaceous rocks but there is no evidence of intrusive material at the centre of the dome.

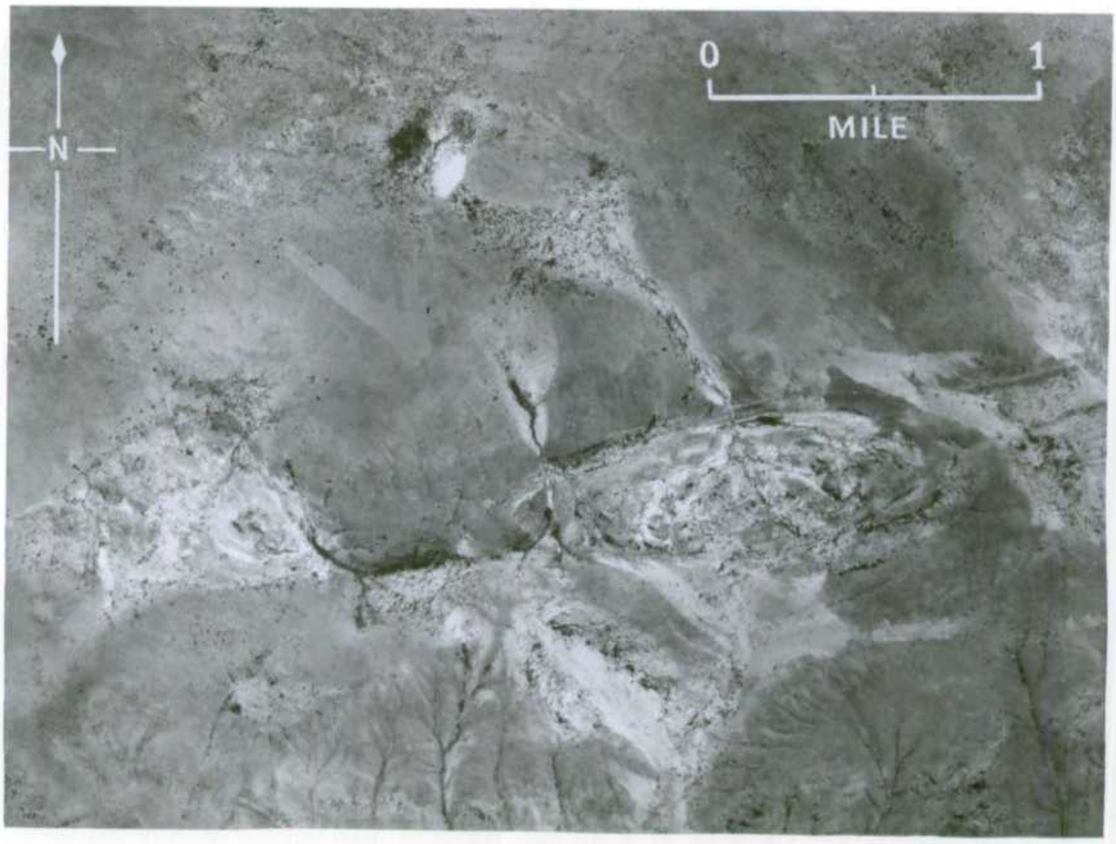

Fig.19. Air-photograph of diapiric structures on the north-east part of the Madley Sheet area.

C/5472

Fig.20. Sheared gypsum mass at sinkhole in centre of diapiric structure at MA1, north-east Madley Sheet area.

G/5492

Geophysics

A reconnaissance gravity survey was carried out in the Gibson Desert area in 1962 by the Geophysical Branch of the Bureau of Mineral Resources (Plate III). Most of the gravity stations are on a 7 x 7 mile grid. Some closer spaced gravity stations were placed over Woolnough Hills, Madley diapirs and at the southern end of the Iragana Fault.

Four main divisions have been identified from the reconnaissance survey (Lonsdale & Flavelle, 1963). They are:-

1. Gibson Gravity Depression.

This gravity depression occurs on the western side of the area centred about the central southern part of the Madley Sheet area. It consists of two irregular gravity depressions and has a comparatively narrow gravity "low" stretching to the south-east towards the Officer Basin. The Madley and Woolnough Hills diapirs indicate that there are thick Mesozoic, Palaeozoic and Precambrian sediments in the north-east part of the gravity depression. Movement and piercement by the gypsum and possibly other evaporites did not commence until there was a sedimentary load several thousand feet thick. The Precambrian sediments at Constance Headland are several hundred feet thick, and the bulk of the sediments underlying the Gibson Gravity Depression are probably Precambrian in age.

2. Cobb Gravity Depression.

Thick sediments in the north-east part of the area are indicated by the Cobb Gravity Depression. 12,000 feet of Precambrian sediments, and 3000 feet of Palaeozoic sediments are exposed in the Iragana Inlier on the western side of the Cobb Gravity Depression. The thick sediments in the Cobb Gravity Depression are separated from the Amadeus Basin by a Gravity High which may be caused by a basement ridge.

3. Blackstone Gravity High.

The Blackstone Gravity High occurs over outcrops of Precambrian, metamorphic and igneous rocks

4. Warri Gravity Ridge.

The Warri Gravity Ridge trends north-west of the Blackstone Gravity High and probably indicates a relatively thin cover of sediments over rocks similar to those on the south-west part of the Bentley Sheet area. The Warri Gravity Ridge appears to be an extension of the Anketell Gravity Ridge (Flavelle and Goodspeed, 1962) known further to the north-west. The Warri Gravity Ridge separates the Cobb Gravity Depression and the Gibson Gravity Depression.

Seismic reflection and refraction traverses were carried out in the Gibson Desert area by the Geophysical section, Bureau of Mineral Resources in 1961 (Watson, 1963) and 1962 (Fowler, 1963). Traverses were recorded between Iragana Turnoff and Mt. Everard on the Giles-Carnegie road and at Lake Keene. Refraction spreads were laid down at Mt. Davies, Giles, Rawlinson Range, Lake Christopher, and Lake Hopkins to obtain velocities in rocks of known age.

Refractor velocities of 8000 to 10,000 feet per second are taken as indicating Mesozoic sediments; 10,000 to 11,000 feet per second, Permian or other Upper Palaeozoic sediments; 16,000 to 18,000 feet per second as Proterozoic sediments and 19,000-20,000 feet per second as Precambrian basement rocks.

Plate IV shows correlations of refractor velocities between Lake Keene in the west and Signpost in the east. These traverses were recorded in the Gibson Gravity Depression and on the south-west side of the Warri Gravity Ridge.

The results of the seismic work indicated a considerable thickening of Palaeozoic and Precambrian sediments west of Mt. Charles to a maximum of about 14,000 feet between Mt. Samuel and Mt. Charles.

At Lake Keene a refractor of 16,500 feet per second was recorded at about 1700 feet which indicates that the Palaeozoic section is much thinner here. A refractor of 19,000 feet per second recorded at about 4,200 feet is tentatively interpreted as representing crystalline basement. This interpretation is considered doubtful as it appears to conflict with the gravity results, which suggest a much deeper depth of basement.

Near the southern end of the Iragana Fault (55.4 miles by road north of the Carnegie-Warburton turnoff) a refractor of 6000 feet per second extended to a depth of 500 feet, and a refractor of 9000 feet per second extended to 1700 feet. These refractors are probably in Mesozoic rocks. A refractor of 14,350 feet per second occurs below 1700 feet and is probably several thousand feet thick. This refractor is probably in Precambrian sediments.

The nature of the thick Precambrian sediments indicated by the seismic results can only be inferred from the types of sediments that crop out at the margin of the basin and in the diapiric structures. There is no indication of age and lithology of Palaeozoic sediments postulated in the seismic sections from surface outcrops except that they are probably pre-Permian in age. The only rocks possibly of Palaeozoic age which are older than Permian and unconformably overlie Precambrian sediments are exposed in the Iragana Inlier.

Aeromagnetic traverses were made over the eastern part of the area and are shown in Plate II. The reconnaissance was carried out in 1960 and reported by Goodeve (1961). The magnetic profiles on the Gibson Desert area have the character expected over a deep basement, i.e. one greater than 5000 feet. The traverses exhibit large broad anomalies through which a structural feature is suggested. The position of this feature corresponds approximately with that of the Warri Gravity Ridge. Goodeve (1961) suggests that the structure is deep and the magnetic basement is at a depth of about 10,000 feet. At a point about 10 miles north-east of Mt. Charles the structure is believed to be very near the surface. The traverse which crosses the south-east part of the Bentley Sheet area is over outcrops of Precambrian, igneous and metamorphic rocks and shows large magnetic anomalies.

ECONOMIC GEOLOGY

Petroleum Prospects

The geophysical survey of the Gibson Desert area has indicated two deep basins (the Gibson and Cobb Gravity Depressions) which contain thick sedimentary rocks. Although surface outcrops in diapiric structures, in the Iragana Inlier and at the margin of the basin, suggest that a large proportion of these sediments are Precambrian in age, they may include thick sections of Palaeozoic sediments which have been overlapped and are at present obscured by younger rocks. Until it can be proved that thick Palaeozoic sediments are present and information is available on their age and lithology, little can be said on the petroleum potential of the area.

The diapiric structures present on the Warri and Madley Sheet areas could act as structural traps for oil. The aeromagnetic, gravity and seismic surveys have indicated the presence of north-west trending basement ridge (the Warri Gravity Ridge) separating the two sedimentary basins. This basement ridge would also be a favourable area for petroleum prospecting. There may be unconformities, and pinch-outs on the ridge which could act as structural traps for oil migrating up dip from any source beds in the basin, and provide clean reservoir sands.

Water Supply

Three water bores were drilled in the area by the seismic party from the Geophysical Branch. Details of these water bores are as follows:

1. Bore 72 miles west of Signpost - Bentley Sheet area.
   Supply 80 gal/hr.
   Quality - excellent
   Depth - 100 feet.
   Water Level - 45-50 feet.
   Casing was placed in the hole from the top to a depth of 85 feet. The bottom 20 feet of casing was perforated.
   Probably drilled in Permian glacial sediments (fine, grey, powdery material).

2. Beevers Bore 11 miles south of Signpost - Bentley Sheet area.
   Supply 350 gal/hr.
   Quality - brackish.
   Depth - 80-90 feet.
   Water Level - 50-60 feet.

3. Bore 7 miles east of NMF 23 - Browne Sheet area.
Locality: Lat. 25°11', Long. 124°43'

In the vicinity of limestone outcrops and sparse gum-trees. It was not realised until after the bore was drilled, that it was within about a mile of a water soak used by David Carnegie in 1894.

Depth: 115 ft.
Water Level: 30 ft.
Supply: 240 gallons per hour
Drill Log: 0 - 4 ft. Sand.
4 - 110 ft. Sandstone.
110 - 115 ft. Clay.

Quality of Water: Good drinking water. The following is an analysis by the West Australian Government Chemical Laboratories, Perth.

Reaction:	Neutral (pH 7.7)
Appearance:	Clear
Colour:	Colourless
Ferrous iron:	Non detected
Total soluble salts:	1,000 parts per million (70 grains per gallon)
Sodium chloride:	497 parts per million (35 grains per gallon)

A station bore is present next to the main road a few miles east of Carnegie Homestead. The water is very salty.

The only other sources of water in the area are from native rock holes and some of the claypans in areas of red earth plains and alluvial fans occasionally contain water. Lake Gruska (Fig. 3) was filled with water when visited by Army Surveyors in 1961. The claypans probably only fill with water after heavy rain and the supply is only transitory.

Evaporites

Thick evaporites may occur beneath the gypsum core of the Woolnough and Madley diapirs and possibly in other dome structures in the area.

ACKNOWLEDGEMENTS

The author wishes to acknowledge the co-operation and valuable assistance given by Mr. A. Flavelle, the leader of the Helicopter Gravity Party.

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APPENDIX I

DESCRIPTIONS OF SELECTED ROCK SPECIMENS

by

W. Oldershaw.

Specimens BE1, BE2A, BE2B, BE4A-E and BE5 are from Precambrian metamorphic and igneous rocks in the Bentley Sheet area. Specimen H4 is a possible intrusive in Precambrian sediments on the north-west corner of the Herbert Sheet area, B6 is from Cretaceous sediments at Mt. Samuel and the sample from Carnegie Homestead is an erratic from the Permian Paterson Formation.

BE 2A
Rock No. 14019
Thin Section No. 9958.

Amphibolite

The specimen is a dense fine-grained foliated black rock. Under the microscope it is seen to consist of an equigranular mosaic of quartz and hornblende crystals approximately 0.2 mm across. There are a few irregularly shaped crystals of augite rimmed with granular hornblende. Apatite and sphene are accessory.

BE 1
Rock No. 14021
Thin Section No. 9960

Amphibolite

The hand specimen is a fine-grained granular black rock with a few irregularly shaped patches of white felspar and quartz.

Under the microscope the rock is seen to consist of an equigranular mosaic of quartz, oligoclase, and hornblende granules 0.2 - 0.5 mm across. Epidote occurs as irregularly shaped patches and as rounded grains. Apatite and zircon are accessory.

BE 4E
Rock No. 14026
Thin Section No. 9965

Amphibolite

The specimen is a black granular rock. Under the microscope it is seen to consist of a mosaic of irregularly shaped crystals of hornblende from 1-2 mm across containing randomly orientated inclusions of plagioclase, grains of hematite and crystals of apatite and some grains of scapolite.

The hornblende consists of aggregates of fibrous hornblende and limonite dust. The hornblende is pleochroic from green to blue-green indicating that it is a sodic hornblende. The plagioclase is poorly twinned and appears to be andesine. Its relationship with the enclosing hornblende is similar to the ophitic texture between plagioclase and augite characteristic of dolerites. Thus the rock may be an altered, or uralitised, dolerite.

BE 4B
Rock No. 14023
Thin Section No. 9962

Amphibolite

The specimen is a fine-grained granular black rock. Under the microscope it is seen to consist of interpenetrant, disoriented, irregularly shaped prisms and fibrous aggregates of hornblende, crystals of apatite, sphene, epidote and porphyroblasts of scapolite.

The hornblende has an unusual blue green to green pleochroism suggesting that it is a sodic form. The scapolite (colourless, uniaxial -ve, RI = 1.56) forms irregularly shaped porphyroblasts 1 mm across. Some could be amygdule fillings.

The rock is an amphibolite, probably a regionally metamorphosed basalt.

BE 5
Rock No. 14028
Thin Section No. 9967

Porphyritic Micro-granite

The hand specimen is a granular pink rock. Under the microscope it is seen to consist of large irregularly shaped crystals up to 2mm across of orthoclase and aggregates of strained quartz crystals set in a matrix of small fresh and unstrained crystals of quartz and microcline. Accessory muscovite, hematite, biotite and epidote occur.

The fine-grained granular quartz-microcline matrix is unusual. Some parts consist of symplectic intergrowths. The matrix may be a rapidly crystallised granitic residuum or it may be a later aplitic injection.

BE 28
Rock No. 14020
Thin Section No. 9959

Altered Gabbro

The hand specimen is a coarse-grained black and white rock consisting of large crystals of hornblende, up to 2 cms long, set in a matrix of white felspar.

Under the microscope the rock is seen to consist of approximately equal proportions of tabular labradorite, masses of granular scapolite and irregularly shaped crystals of augite rimmed with hornblende.

The crystals of augite have very irregular shapes and are rimmed with and invaded by granular hornblende. The augite close to areas of scapolite is crowded with small grains of sphene. The labradorite is well twinned; in places it shows pericline twinning. The labradorite is well shaped except in contact with scapolite where it is very irregularly shaped and is margined by a network of minute needles of epidote. The scapolite comprises large areas of granular scapolite some of which shows the prismatic cleavage and first order yellow birefringence.

The rock appears to be a pneumatolytically altered gabbro in which the augite has been partly altered to hornblende and part of the plagioclase altered to scapolite.

BE 4A
Rock No. 14022
Thin Section No. 9961

Porphyritic Rhyolite

The hand specimen is a dark fine-grained rock with a conchoidal fracture containing a few pink felspar phenocrysts. Under the microscope the rock is seen to consist of euhedral phenocrysts 1-2 mm across of orthoclase and some plagioclase surrounded by radiating irregularly shaped crystals of felspar set in a matrix of fine-grained granular quartz, orthoclase and hematite. Accessory minerals are epidote, zircon, hematite and pyrite.

The rock appears to have cooled rapidly and the felspar phenocrysts formed loci upon which radial outgrowths, or possibly radial recrystallization of felspar occurred.

BE 4D
Rock No. 14025
Thin Section No. 9964

Porphyritic rhyodacite

The specimen is a black glassy rock with a conchoidal fracture. It contains small white phenocrysts up to 1 mm across.

Under the microscope the rock is seen to consist of euhedral phenocrysts of orthoclase, anorthoclase and plagioclase and a few anhedral phenocrysts of quartz set in a devitrified flow banded matrix comprising 70-80% of the rock.

The felspar phenocrysts are crowded with minute inclusions of biotite, chlorite, apatite and magnetite. The anorthoclase shows well developed polysynthetic twinning.

The matrix shows good flow banding with trails of minute magnetite octahedra, limonite dust and chlorite flakes in a groundmass of minute amoeboid quartz crystals.

The rock is a porphyritic rhyodacite or soda rhyolite.

BE 4C
Rock No. 14024
Thin Section No. 9963

Porphyritic Alkali Rhyolite

The hand specimen consists of a granular pink rock with white phenocrysts and black specks. Under the microscope the white phenocrysts are seen to consist of euhedral microcline and poorly twinned plagioclase 0.5 - 2 mm across. Irregular aggregates of small biotite crystals and hematite grains occur and are surrounded by granular quartz and plagioclase. The rest of the rock consists of irregularly shaped masses of graphically intergrown quartz and felspar radiating out from the felspar phenocrysts and mafic clots.

The rock is a porphyritic alkali rhyolite.

H4
Rock No. 14027
Thin Section No. 9966

Weathered Porphyry

The hand specimen is a porous grey rock containing irregularly shaped white phenocrysts 1-5 mm across.

Under the microscope, the white phenocrysts are seen to be opaque aggregates of fine-grained grey clay minerals; probably after altered felspar. Much of the rock matrix disintegrated during during the preparation of the thin section but the remnant consists of spherulitic devitrified glass, aggregates of sericite and limonite dust and an unusually large amount of magnetite granules comprising 10% of the matrix. Half of the magnetite granules have a cubic shape and cleavage and have developed a reddish brown porous skin of goethite or limonite.

The rock is a deeply weathered magnetite rich felspar porphyry.

Carnegie Homestead
Rock No. 13093
Thin Section No. 9973

Fuchsite Greisen

The hand specimen is a granular quartzite rock containing small plates of pale green mica.

Under the microscope the rock is seen to consist of large grains of quartz which form 90% of the rock, as well as plates of fresh muscovite and trails of magnetite, epidote, zircon and tourmaline grains.

The quartz forms large strained sutured crystals up to 2 mm across. The mica occurs as parallel fresh flakes of slightly pleochroic pale green muscovite:- probably the chromium muscovite Fuchsite.

Qualitative X-Ray spectrographic analysis by S.C. Goadby of sample of the mica indicated the presence of chromium. A few thin bands of rounded grains of magnetite, epidote, tourmaline and zircon cross the rock independently of the boundaries of the quartz grains. These bands could be layers of detrital heavy minerals which occur in many sediments. There are also thin irregular bands of limonite dust which ramify through the quartz grains. These are probably old grain boundaries.

The sutured margins, strain shadows, irregular shapes and relict grain boundaries show that the rock has been extensively reconstituted. The bands of rounded detrital heavy minerals suggest that the rock was probably originally a sediment. Thus the rock may be a greisenised sandstone.

B6
Rock No. 13094
Thin Section No. 9974

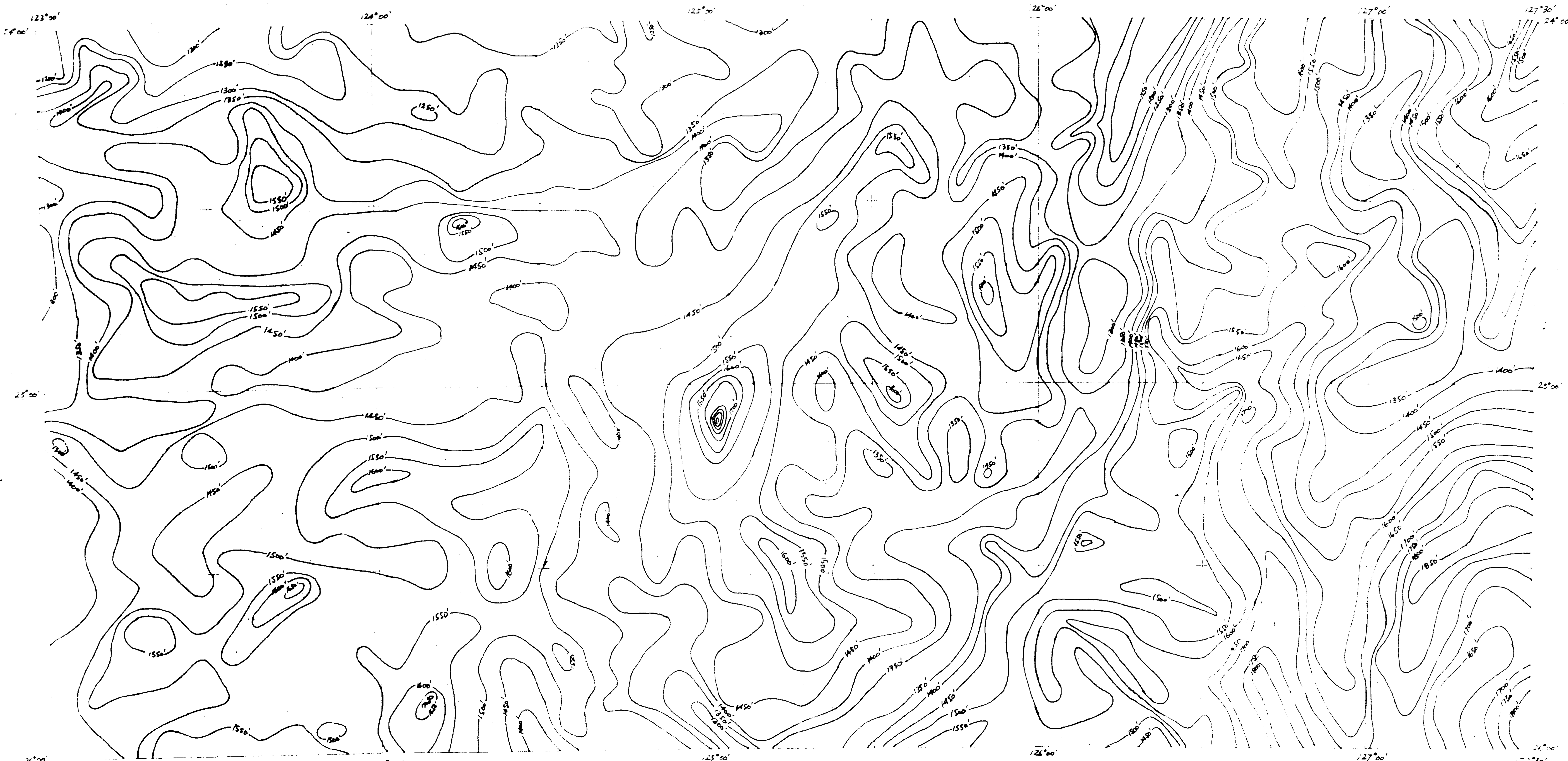
Glauconitic Sandstone

The rock is a pale brown well packed, well graded glauconitic sandstone containing 60-70% glauconite.

The glauconite occurs as rounded grains 0.05 - 0.1 mm across of aggregates of minutely granular glauconite. Some pellets contain curved septa and are probably casts of foraminifera. 10% of the quartz grains are large rounded grains 0.1 - 0.2 mm across; but the rest consists of minute angular chips less than 0.05 mm across.

The grains are cemented together by a sparse colourless isotropic matrix which is probably chalcedony. The thin dark brown layers in the rock contain a lot of hematite both as detrital grains and as interstitial cement.

There are a few flakes of fresh muscovite 0.1 mm across, a few grains of epidote and some calcite.



Bureau of Mineral Resources, Geology and Geophysics, March 1963.

Scale 1: [illegible]

Plate I - TOPOGRAPHIC CONTOUR MAP.

Contour interval — 50 feet

Compiled from barometric heights obtained during regional gravity survey by Geophysical Section, Bureau of Mineral Resources. Compiled and drawn in the Geological Branch.

To accompany Record No. 1963/59

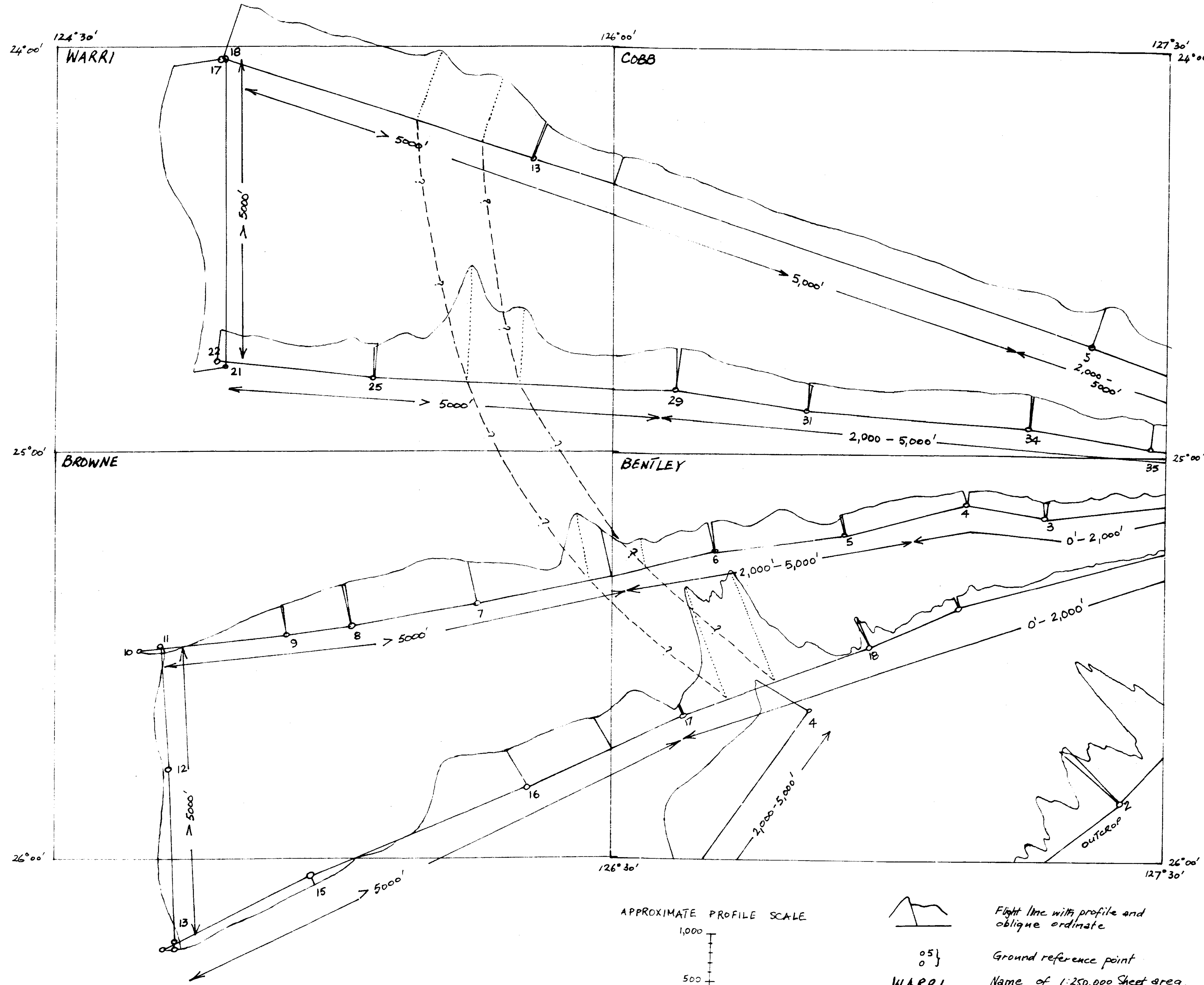


PLATE II - Magnetic Profiles Along Flight Lines

Scale

10 0 10 20 miles

Flight line with profile and oblique ordinate

°5 Ground reference point

WARRI Name of 1:250.000 Sheet area.

--?--- Postulated trend in basement.

←0'-2000'— Estimated depths of basement.

Data after Goodeve, 1961

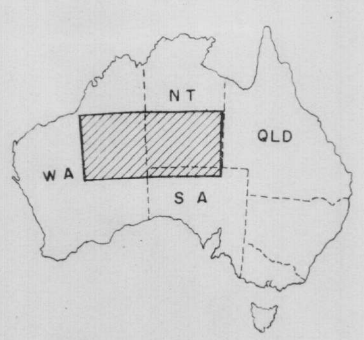
Bureau of Mineral Resources, Geology and Geophysics, March 1963.

To accompany Record No. 1963/59

PLATE 3

Based on G 69-475-0

LOCATION



Compiled March 1963.

LEGEND

- Isogals, values in milligals
- ▲ 35 BMR gravity pendulum station
- ▫ BMR gravity reading at aerodrome
- Ryan — BMR 4-mile gravity map area
- Gravity 'High'
- Gravity 'Low'
- 12 — Anomaly number
- Feature boundary
- A - - - - B Section line
- Ground traverse in area of sparse control
- Flight "B"

Bouguer anomalies are based on the observed gravity values at BMR pendulum stations:

No.22	Wiluna	978,954·4 milligals
No.23	Mundiwindi	978,745·9 "
No.26	Port Hedland	978,646·0 "
No.27	Anna Plains	978,624·9 "
No.29	Halls Creek	978,463·0 "
No. 35	Alice Springs	978,653·7 "
No. 36	Oodnadatta	979,100·0 "
No. 57	Birdsville	979,003·7 "

Elevation datum : Queensland State and M.S.L. Derby

AMADEUS BASIN - SOUTH CANNING BASIN RECONNAISSANCE GRAVITY SURVEY USING HELICOPTERS NT AND WA 1962

BOUGUER ANOMALIES

WITH SHADING EMPHASIS AND GRAVITY UNITS

SCALE IN MILES

40 0 40 80 120

Reference : Division of National Mapping 40 miles to 1 inch topographic map

Contour interval 5 milligals

RELIABILITY DIAGRAM

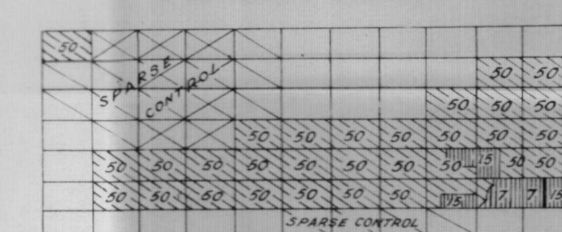


FIGURE IN EACH AREA DENOTES SQUARE MILES PER GRAVITY STATION

BOUGUER ANOMALY CONTOURS (ISOGALS) ARE BASED ON PRELIMINARY DATA AND MAY BE SUBJECT TO SLIGHT ALTER--ATIONS.

G R A V I T Y	
SURVEY	METHOD
Helicopter by BMR	Regular grid coverage, air photography, barometric levelling.
Ground traverses by BMR, WAPET & SA Mines Dep't; Scattered BMR helicopter traverses.	Widely dispersed traverses, air photography, conventional & barometric levelling, astrofixes.
Semi-detailed by Flamingo, Papuan Apinaipi, Geosurveys & Beach Petroleum.	Helicopter traverses, conventional & barometric levelling. Some ground traverses.

GEOPHYSICAL BRANCH, BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS G 69-475-2


LOCALITY MAP
TRACK
SEISMIC TRAVERSE
GEOLOGICAL BOUNDARY
BOUGUER ANOMOLY CONTOUR
WATER BORES
MAGNETIC ANOMALY
LAKE KEENE TRAVERSE
YOUNG RANGE
MT EVERARD
NMF 23
FAME RANGE
NMF 27
NMF 29
NMF 25
MT BEADELL
NMF 19
LAKE BREADEN
MT SAMUEL
MT CHARLES
SIGNPOST
CARNEGIE HS
25°00'
25°30'
124°00'
126°00'
LAKE KEENE
MOUNT EVERARD
MOUNT BEADELL
NMF 19
MOUNT SAMUEL
MOUNT CHARLES
SIGN POST
(1450' ASL)
DEPTH IN FEET
BOUGUER GRAVITY PROFILE
BASEMENT
BOUGUER GRAVITY (MILLIGALS)
CORRELATION BETWEEN MT EVERARD AND MT BEADELL IS BASED ON REFLECTION RESULTS.
T TERTIARY
K CRETACEOUS
J JURASSIC
P PERMIAN
Pz PALAEOZOIC
Ꝑ PROTEROZOIC
A ARCHAEAN
SCALE IN MILES
GENERALISED SECTION BETWEEN SIGNPOST AND LAKE KEENE
GIBSON DESERT 1962
BASED ON CORRELATION OF REFRACTOR VELOCITIES

PLATE 2.

PLATE 5.

REGIONAL GEOLOGY
GIBSON DESERT AREA
WESTERN AUSTRALIA

Reference

QUATERNARY			Qs	Aeolian sand
			Qt	Evaporites
			Qℓ	Travertine
			Qa	Alluvium
MESOZOIC	CRETACEOUS	Bejah Beds	Ke	White porcellanite, siltstone and some fine sandstone. Marine fossils
			K	Thin-bedded siltstone and fine sandstone, in places opalised. Marine fossils and plant spores
			M	Medium, micaceous sandstone, siltstone and coarse, poorly sorted, ferruginous sandstone
PALAEOZOIC	PERMIAN	Paterson Formation	Pa	Coarse and medium sandstone and white siltstone with large erratics up to three feet across. Fluvioglacial
			P	Coarse, pebbly sandstone, medium sandstone, siltstone and varves with slump structures. Fossil wood and plant spores
			Pzs	Medium, cross-bedded, silty sandstone with some rounded pebbles and interbeds of conglomerate
PRECAMBRIAN			p€s	Medium, silty sandstone, siltstone, dolomite and gypsum
			p€g	Granite, gabbro, basalt, quartz-feldspar porphyry and acid and basic porphyritic rocks
			p€m	Quartzite, quartz-mica schist, slate, amphibolite and granitic gneiss

- Geological boundary
- Fold, with plunge
- Fault

Where location of boundaries, folds and faults is approximate, line is broken; where inferred queried; where concealed, boundaries and folds are dotted; faults are shown by short dashes.

- Strike and dip of strata
- Dip <15° (air-photo interpretation)
- Dip 15-45° (air-photo interpretation)
- Dip >45° (air-photo interpretation)
- Trend of bedding (air-photo interpretation)
- Joint pattern (air-photo interpretation)

- Macrofossil locality
- × BE 6 Text reference to specimen locality

- Road
- R.H. Rock hole
- Landing ground

Compiled and issued by the Bureau of Mineral Resources, Geology and Geophysics, Department of National Development. Topographic base from uncontrolled photo mosaics supplied by the Western Australian Department of Lands and Surveys. Aerial photography by the Royal Australian Air Force and Adastra Airways Pty Ltd. at 1:40,000 and 1:86,000 respectively. Transverse Mercator Projection.

INDEX TO AUSTRALIAN 1:250,000 SERIES

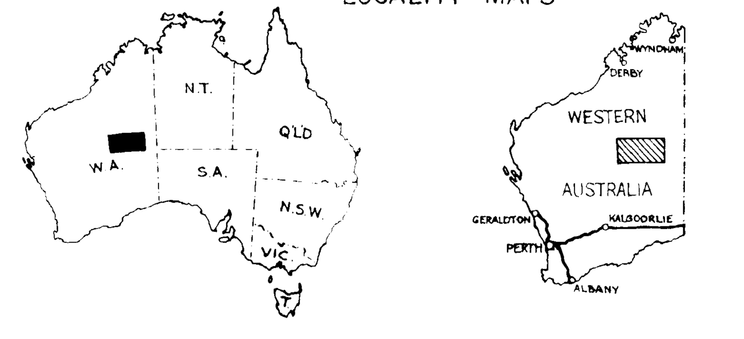
MADLEY	WARRI	COBB
HERBERT	BROWNE	BENTLEY

Scale 1:500,000

10 0 10 20 30 40 MILES

10 0 10 20 30 40 50 60 KILOMETRES

LOCALITY MAPS



Geology and compilations by : A.T.Wells.

To accompany Record 1963/59.