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EXPLANATORY NOTES ON THE MT. BANNERMAN 4-MILE GEOLOGICAL SHEET

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GENERAL

The Mt.Bannerman Sheet area lies between latitudes 19° and 20° south and longitudes 126° and 127° 30' east. The area is uninhabited by white people, and is rarely crossed by nomadic aborigines, as they usually inhabit even more isolated country. The north-western corner of the Sheet is about nine miles south-east of Christmas Creek Homestead on the Great Northern Highway; the homestead is about 230 miles by road from the nearest seaport at Derby. Access to the Sheet area is difficult as station tracks cover only small areas in the north-western and south-eastern corners, which are used for cattle-raising. Tracks run from Christmas Creek Station as far south as Tonka Spring, and from Billiluna Station as far west as Chungla Well in the south-eastern corner of the Sheet. The remainder is mostly barren sand plain. A small subsidiary stock route from the Canning Stock Route near Godfreys Tank, on the adjoining Cornish Sheet, runs across the western half of the Mt.Bannerman Sheet to Christmas Creek Station, but is not used, because cattle from Christmas Creek Station are taken to Derby.

The rainfall is generally less than ten inches a year, and surface water is scarce. Small springs feed Salt Creek and Soda Creek in the north-western area, but the water can only be used for stock. Sturt Creek, Christmas Creek, and Shiddi Creek contain semi-permanent pools; the only other sources of supply in the central areas are scattered native rock-holes and sand soaks. Any party entering the area must carry sufficient supplies of food and water to last the duration of the traverse, together with emergency rations.

HISTORY OF INVESTIGATIONS

In 1856 A.C. Gregory followed Sturt Creek southwards and discovered Gregory Salt Sea, into which the creek drains (Gregory, 1857). D.W. Carnegie travelled to Mt.Bannerman from Godfreys Tank and then farther north to Christmas Creek and Halls Creek in 1896 during his journey from the Western Australian goldfields to Halls Creek (Carnegie, 1898). In the same year F.Hann explored part of the Sheet, but no record has been found of his investigation.

The Canning Stock Route, which crosses the south-east corner of the Sheet, was surveyed by A.W. Canning between 1906 and 1907. In 1908, H.W.B. Talbot accompanied Canning when the stock route was opened, and published an account of the geology and water supplies (Talbot, 1910).

Air photographs of the Cummins Range and Mt.Bannerman were taken by W.G. Woolnough in 1932 during a flight from Louisa Downs to Gregory Salt Sea (Woolnough, 1933). He considered that the sediments exposed at these two localities were "Permo-Carboniferous", stratigraphically above the "Grant and Poole Range Beds". This flight was only a small part of an extensive aerial survey reconnaissance in Australia. C.St.J. Bremner (1940) carried out a preliminary aerial reconnaissance of the desert area and one flight from Noonkanbah east to Godfrey Tank crosses the Sheet.

W.H. Maddox (1941) carried out a geological reconnaissance in the north-eastern part of the Fitzroy Basin, and included rocks in the Cummins Range in the Proterozoic. F.Reeves (1949) examined Mt.Bannerman: he considered that the rocks belong to the "Poole Range Sandstone". Matheson and Guppy (1949) carried out a reconnaissance survey of the Mt. Ramsay 4-mile Sheet to the north.

In 1953 the Sheet area was photographed by the R.A.A.F. from 25,000 feet, giving vertical coverage at a scale of approximately 1 : 50,000. Uncontrolled 4-mile and 1-mile photo-mosaics supplied by the Division of National Mapping were, with the aid of a distorted graticule, used for the geological compilation.

In 1954 the Geophysical Section of the Bureau of Mineral Resources carried out an airborne magnetometer reconnaissance of the north-eastern areas of the basin. The flight lines are shown in Figure 1.

A geological party from the Bureau of Mineral Resources investigated the area in 1955, using 4-wheel-drive vehicles for cross-country travelling. State Lands and Surveys Department surveyors accompanied the party and observed astrofixes at several localities. The conditions encountered and methods of investigation are described by Casey and Wells (1956). Geologists from West Australian Petroleum Pty Ltd took gravity readings on the western half of the Sheet in 1955 (Garrett, 1956). Gravity observations in the central part of the Sheet were taken as part of a reconnaissance geological and geophysical survey of the Canning Basin by helicopter (Veevers, 1957).

The astrofix results shown in Table 1 were supplied by the State Lands and Surveys Department, Perth.

Table 1 - Astrofix results for the Mt.Bannerman Sheet.

Station	Latitude	Longitude	East	North
N21	19°00'40.0"	126°03'27.0"	406621	2616177
N22	19°27'28.8"	126°00'28.7"	400915	2562081
N7	19°02'43.5"	126°48'21.3"	492781	2611812
N8	19°33'52.44"	126°50'15.0"	496114	2548945
N9	19°54'22.58"	126°48'19.8"	492245	2507593
Tonka Spring	19°15'36.7"	126°08'51.0"	-	-

PHYSIOGRAPHY

The surface is almost entirely desert sand plain; a small area of dissected hills of Precambrian rocks occurs on the northern margin. The predominant desert plains underlain by Palaeozoic and Mesozoic sediments are covered by orange or red sand, with very small prominences such as Mt.Bannerman and Mt.Erskine, which are mostly the last remnants of a dissected higher plain. Small rounded rises which are mostly no higher than the surrounding sand-dunes are common. Large areas near the central west of the sheet consist of flat rubble-covered plains with a thin veneer of black soil over bedrock and very little sand-cover. In some places sand-dunes encroach on these plains, although the interdune areas may contain very little sand. Many of these areas are occupied by lakes or large claypans, such as Lakes Lonergan, Betty and McLennon, probably because they offer an impervious foundation of shale and fine sandstone. Low mesas are common near the claypans.

The sand plain is almost entirely covered with tussocks of spinifex, stunted low acacia, mallee scrub, desert and white gums, needlewoods and a few distinctive desert walnuts. Thick belts of desert oak (Casuarina) grow on the west side of Sturt Creek. Seif dunes form a dominant pattern: they are many miles in length, ¼ to 1 mile apart and 10 feet to 90 feet-mostly 30 to 40 feet high. The dunes trend east-west and are fixed by a scant growth of   of spinifex and herbaceous plants. The crestal areas are commonly devoid of vegetation, though occasional large gum trees grow on them, and most movement of the sand now occurs on them. The dunes end abruptly against the eastern margin of any obstruction such as small hills or mountain ranges, but continue unobstructed over most low rises.

In the northern part of the Sheet area, where comparatively high ranges and dissected hills of resistant Precambrian rocks are present, dunes are absent, but sand lies in the intervening plain areas. Drainage is well developed in the dissected hills, and the larger streams, such as Christmas Creek and Junction Creek, eventually flow into the Fitzroy River. In the desert area, on the other hand, stream channels drain small groups of mesas and low rises, and end abruptly where they empty on to the sand plain. A few indistinct lines of stream-courses are visible on the sand plain and were probably only formed during exceptionally heavy falls of rain. Any alluvial deposits formed by these streams have been covered by the wind-blown sand deposits. The greater part of the drainage is subterranean.

The altitude of the sand plain ranges from about 800 feet at the south-west corner of the Sheet to about 1,100 feet near Mt.Bannerman. The highest parts of the Cummins Range and the dissected hills bordering Christmas Creek are about 1,300 feet high.

STRATIGRAPHY AND PALAEONTOLOGY *

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* All numbers (e.g.M27) marked on the Sheet refer to specimen localities. All specimens are housed in the Bureau of Mineral Resources Museum, Canberra.

Permian and Mesozoic, and possible Devonian and Ordovician, rocks of the Canning Basin rest with an angular unconformity on Precambrian metamorphic, granitic, and sedimentary rocks. The Palaeozoic and Mesozoic rocks are comparatively thin sequences of predominantly clastic sediments.

Wherever possible existing names have been used with some slight revision in accordance with the current Australian Code of Stratigraphic Nomenclature (Raggatt, 1956). Selected rock specimens from the Mt.Bannerman Sheet have been described by Lovering (in preparation).

The small area of Precambrian rocks cropping out on the northern part of the Sheet has been divided broadly into Upper Proterozoic sediments and Lower Proterozoic Metamorphics and granite.

TABLE II- STRATIGRAPHY OF THE MT.BANNERMAN 4-MILE SHEET

AGE	MAP SYMBOL	FORMATION	THICKNESS (feet)	LITHOLOGY	FOSSILS	ECONOMIC GEOLOGY	TIME EQUIVALENT
QUATERNARY	Qa	Alluvium	20'±	Alluvial soil	-	Shallow water	Similar deposits occur in neighbouring parts of the Canning Basin
	Qg	Gravel	10'+	Alluvial gravel and sand	-	"	
	Qs	Sand	0-120'+	Iron-stained medium to fine sand	-	"	
	Qb	Black Soil	10'+	Alluvial black soil and clay	-	-	
	Ql	Travertine	10'+	Hard marl and limestone with varying amounts of chalcedony	-	Limestone	
TERTIARY	Tl	Lawford Beds	100'±	Lacustrine marl and limestone with hard chalcedony capping	-	Limestone	Oakover Beds of S.W.Canning Basin.(Traves, Casey & Wells, 1956).
	Tp	Pisolitic Ironstone	30'±	Pisolitic ironstone and some laterite profiles.	-	Road surfacing	Pisolitic ironstone in other parts of basin
UPPER TRIASSIC or LOWER JURASSIC	Mc	Culvida Sandstone	50'±	Current-bedded, red-brown sandstone with interbedded fine white shale.	Leaves and wood	Water	Possibly part equivalent of Erskine Sandstone or Callawa Formation of the S.W.Canning Basin and possibly Parda Formation (Lindner & Drew, 1958).
TRIASSIC	ȾRb	Blina Shale	100'±	Grey micaceous shale and fine sandstone	<u>Isaura</u> abundant	-	Blina Shale of Fitzroy Basin
PERMIAN	Ph	Hardman Member	100'±	Poorly sorted medium-grained sandstone	Pelecypods, gastropods, conulariids.		
	Pr	Condren Sandstone Member	150'+	Sandstone and shale, and some fine conglomerate.	Abundant plant and wood remains.	Water	Plant-bearing bed, Liveringa Formation, Fitzroy Basin.
	Pj	Lightjack Member	300'±	Micaceous shale, sandstone and quartz-greywacke	Pelecypods, some brachiopods.	-	Triwhite Sandstone of S.W. Canning Basin.
	Pn	Noonkanbah Formation	200'±	Micaceous shale, and sandstone.	Abundant marine fossils	-	Dora Shale of S.W.Canning Basin
	Pg	Grant Formation	200'±	Poorly sorted coarse sandstone with occasional rounded quartz pebbles. Some conglomerate. Probably fluvioglacial.	Fossil plants and wood	Water	Braeside Tillite and Paterson Formation of S.W.Canning Basin, Lyons Group of Carnarvon Basin.
				ANGULAR UNCONFORMITY			
UPPER DEVONIAN	Dui		10' exposed	Blue grey limestone with much secondary calcite.	-	Limestone	?Bugle Gap Limestone of Fitzroy Basin.
	Dum		50'±	Oligomictic conglomerate, probably torrential.	-	-	?Sparke Conglomerate of Fitzroy Basin.
				? ?			
ORDOVICIAN	O	Undifferentiated	250'+	Sandstone with minor beds of conglomerate.	Trilobite remains on Billiluna Sheet.		?Prices Creek Group of Fitzroy Basin
				ANGULAR UNCONFORMITY			
UPPER? PROTEROZOIC	Bu	Undifferentiated	?	Shale, sandstone and some dolomite	-	-	Possibly part equivalent of Mt.Frank Shale(Maddox,1941).
	Bun	Kearney Beds	2000'+	Silicified flaggy and massive sandstone and conglomerate with dips up to 75°.	-	-	Part of Kimberley Plateau succession.
				ANGULAR UNCONFORMITY			
LOWER PROTEROZOIC	Bℓg	Granite	-	Granite and granitized sediments with quartz and pegmatite veins.	-	-	Granite of Lamboo Complex and Lewis Granite of the Lewis Range.
	Bℓh	Halls Creek Metamorphics	-	Quartzite, slate, laminated claystone and fine quartz greywacke. Intruded by granite and cut by numerous quartz veins.		Metallic deposits?	Probably part equivalent of Lower Proterozoic of S.W. Canning Basin.

Lower Proterozoic

Halls Creek Metamorphics: The Halls Creek Metamorphics (Traves, 1956) crop out mainly north of Christmas Creek and in the Bulka Hills, Christmas Creek cuts through ridges of these steeply dipping rocks. Just north of Christmas Creek, at Kai Ki yard, claystone and sandstone beds two inches thick alternate rhythmically. Quartz veins ranging from one quarter inch to one foot wide cut the metamorphics, which are overlain unconformably here by probable Upper Proterozoic Mt.Frank Shales (Maddox, 1941).

Granite: The granite intrudes the Halls Creek Metamorphics and is probably contemporaneous with granitic rocks of the Lamboo Complex and the Lewis Granite (Casey and Wells, 1958 MS) of the Lewis Range. The largest outcrops of the granite on this Sheet are near the headwaters of Christmas Creek: most of this area has been mapped by photo-pattern only.

Lit-par-lit injection is visible south of Kai Ki Yard at M36, and many of the quartzites in this area show signs of granitization: they are recrystallized, and cut by ramifying vuggy quartz veins.

?Upper Proterozoic

Kearney Beds: The Kearney Beds (Casey and Wells, 1958 MS.) are named from the Kearney Range on the adjoining Lucas 4-mile Sheet. The beds crop out in the Cummins Range and were referred to as Archaean by Reeves (1949). However, they strike eastward, towards the Billiluna Sheet, where similar rocks overlie the Halls Creek Metamorphics. A specimen collected by Veevers in 1957 from M57, near a fault zone, consists of pink and white silicified fine sandstone with small ramifying quartz veins.

Undifferentiated Upper Proterozoic shale, sandstone, and dolomite occur to the north of M38, where they dip at about 10° to the north-west. The Mt.Frank Shale of Maddox (1941) may be included in this sequence.

?Ordovician

One or two very small outcrops of possible Ordovician rocks have been mapped in and west of the Cummins Range; one of these (M58) was visited by Veevers in 1957. The outcrops are similar in photo-pattern to possible Ordovician rocks cropping out on the Billiluna Sheet to the east, which contain trilobite fragments. A specimen collected at M58 is a pink, possibly feldspathic, medium-grained sandstone. The outcrop is flanked to the north and south by rocks of the Kearney Beds.

Upper Devonian

Limestone: A small outcrop of mottled limestone at M38 on Christmas Creek may be equivalent to the Bugle Gap Limestone (Guppy et al., 1958) of the Fitzroy Basin. There is no fossil evidence for the age of the rock, but the limestone from Pinnacle Spring (Mt.Ramsay Sheet) trends in this direction. It appears to overlie Upper Proterozoic shale and Lower Proterozoic granite to the north and east.

Conglomerate: A conglomerate overlies Precambrian metamorphics in the Christmas Creek area, close to the limestone. It crops out only as a debris of pebbles scattered over the surface of the ground. The distribution of the conglomerate suggests that it overlies the limestone and probably overlapped on to the Precambrian rocks. It is unsorted, but contains well rounded pebbles and cobbles half an inch to six inches in diameter; quartzite constitute 90% of the phenoclasts. The conglomerate is not bedded, but there is no evidence of glaciation and it is most probably torrential in origin.

Permian

Permian marine and freshwater sediments are more widespread than any other rocks on the Sheet. They are much more deformed than those of the same age near the centre and in the southern half of the basin. Of the Permian rocks exposed in the Fitzroy Basin, the Poole Sandstone has not been identified in this part of the basin; all other formations are distinguishable.

The Liveringa Formation has been divided into three members on the basis of lithology and floral and faunal content.

Grant Formation: Only small scattered outcrops of the Grant Formation occur on the Sheet, chiefly near Mt.Bannerman and around Bulka Hills. The massive resistant rock and its prominent jointing produce a characteristically rough terrain.

Small outcrops of medium and coarse-grained ferruginous sandstone with wood remains, to the east of Mt.Bannerman, probably belong to the Grant Formation. Pebbles up to three inches across are common. A similar sandstone showing contorted structures, and containing lenses of conglomerate with angular or sub-rounded pebbles from one half to two inches in diameter, crops out at Shiddi Pool. North of Bulka Hills at M43, probable Grant Formation outcrops contain subangular pebbles of quartz sandstone, micaceous sandstone, quartz-mica schist, quartz, and quartzite, from one half to eight inches across. Wood remains occur in a medium to coarse grained sandstone of the Grant Formation at M45 (on the Mt.Ramsay Sheet), where it is probably faulted against the Noonkanbah Formation.

At Mt.Bannerman the Condren Sandstone Member overlies outcrops of the Grant Formation.

The correlation with the Grant Formation is based on the presence of many pebbles of varying rock types in the conglomerates, the sparkling quartz grains giving a characteristic texture, and the presence of wood fragments. The formation is possibly fluvioglacial. Its average thickness is, perhaps, about 500 feet, but outcrops and bores penetrating the formation show a remarkable variation in thickness.

Noonkanbah Formation: The Noonkanbah Formation underlies rubble-covered plains or black-soil flats, and unweathered solid outcrop is rare even in large areas of dissected Permian sediments. Large plains near Lakes Jones, Betty and Lonergan, and west of Mt.Bannerman, are underlain by ferruginous shale of the Noonkanbah Formation, or of the Lightjack Member. Scattered small outcrops of shale here are overlain by thin deposits of sand or black soil. At M8 well bedded and laminated micaceous shale and sandstone with worm trails crop out. At M45 (Mt. Ramsay Sheet) brown and white, well bedded, laminated, fine micaceous sandstone and shale of the Noonkanbah Formation dipping south-west are faulted against the Grant Formation. South of this outcrop Noonkanbah sediments are probably overlain by isolated masses of the Condren Sandstone Member.

Many other scattered outcrops of the formation were seen in widely separated localities, but no reliable estimate could be made of its thickness. No identifiable fossils were found. Trend-lines which produce a characteristic photo-pattern are commonly visible on the clay-soil flats, and together with the soil type and topography have enabled the formation to be identified.

Liveringa Formation: The Lightjack Member (Guppy et al., 1958) occurs at the base of the Liveringa Formation, and is named from the type section as Lightjack Hill (Noonkanbah Sheet). Several incomplete sections occur near Christmas Creek. About a mile north-east of astrofix N21 a quartz greywacke contains Stutchburia cf. muderongensis Dickins 1956, and other poorly preserved pelecypods and gastropods. At M55 micaceous fine-grained quartz greywacke yielded an assemblage typical of the Lightjack Member (Dickins, 1958). Indeterminate fossils were found in well spoil of micaceous ripple-marked calcareous shale at M49.

On the southern half of the Mt.Bannerman Sheet scattered outcrops of ferruginous shale and fine sandstone occur beneath the sand plains and the black-soil flats. They are equivalent either to the Lightjack Member or the Noonkanbah Formation, which are often hard to distinguish as they have a similar lithology and mode of outcrop.

As far as can be ascertained contacts with the underlying Noonkanbah Formation are conformable, but regional mapping suggests a slight unconformity with the overlying Condren Sandstone Member.

The Condren Sandstone Member (Casey and Wells, 1958 MS.) mostly caps mesas or forms isolated pinnacles and, uncommonly low rises. The sandstone is nearly all massive, light in colour and texture, and easily recognized on the aerial photographs. The member contains abundant plant remains.

At Mt.Bannerman (M5), in a section 150 feet thick, plant stems, leaves, and seeds are preserved in a fine-grained, friable sandstone. White (1957) has identified leaf impressions referable to Glossopteris cf.indica and a seed of Carpolithus type. Plant fossils have also been found at M6, M18, M23, M24, M30 and M47.

At McDonald Spring 60 feet of the Condren Sandstone Member overlies 50 feet of the Lightjack Member with no evidence of any unconformity between them. Photo interpretation elsewhere however, suggests that there may be a slight unconformity between the two. South of Black Rocks at M27 a dark ferruginous medium to coarse-grained sandstone crops out. The sandstone contains some shaly lenses and fine beds of conglomerate as well as indeterminable plant remains.

The Condren Sandstone Member was laid down in shallow water: pebbles are common, the sediments are current-bedded, and plant fossils are numerous in many sections.

Two solitary outcrops of the Hardman Member (Guppy et al. 1958) are present at Boundary Hill in the north-west of the Sheet. The sediments consist of mottled white and grey medium-grained flaggy sandstone which is poorly sorted. The total thickness at M50 is 60 feet. ?Allorisma sp., Aulosteges cf. faibridgei Coleman, and ?Paraconularia sp. were identified by Dickins (1958). Aulosteges fairbridgei is a marker fossil for the Hardman Member.

No contacts of the Hardman Member with older or younger members or formations are visible at Boundary Hill.

Mesozoic

Blina Shale: The Blina Shale (Brunnschweiler, 1954) is defined in the Fitzroy Basin as the basal Triassic unit, unconformably overlying the Liveringa Formation. On the Mt. Bannerman Sheet outcrops are poor - usually only as scattered pieces of shale on the surface or rarely as small scarps a few feet high - and lie mostly on the margin of the large plains underlain by the Noonkanbah Formation or Lightjack Member in the central part of the Sheet. No exposed sections are more than 100 feet thick. Most contain Isaura ("Esthnia") in abundance; Brunnschweiler (1954) assigns the unit to the Upper Triassic because of the presence of Isaura.

Culvida Sandstone (Casey & Wells, 1958 MS). Several small outcrops referable to the Culvida Sandstone occur to the south of Black Rocks. Plant fossils in similar rocks on the northern part of the adjoining Cornish Sheet indicate an Upper Triassic or Lower Jurassic age (White, 1957) for the Culvida Sandstone. This formation may be equivalent in part to the Erskine Sandstone (Brunnschweiler, 1954) of the Fitzroy Basin; though some doubt has recently been thrown on the age of the Erskine Sandstone by plant fossils recently collected from Myroodah Ridge and the Erskine Range which indicate a Permian age (White, 1958).

Tertiary

Laterite and pisolitic ironstone: Dissected remnants of a thick laterite peneplain lie on the Precambrian rocks north of Christmas Creek. At M37 the laterite overlies almost vertical schists and interbedded sandstone. Pebbles, derived from the neighbouring ?Devonian conglomerate, are numerous in the section of laterite exposed at M39 and M41, on the southern edge of the Mt.Ramsay Sheet north-west of M38.

A laterite profile is not well developed on any of the desert breakaways and generally consists only of a resistant capping of pisolitic ironstone on the Permian and Mesozoic mesas.

Lawford Beds (Casey & Wells, 1958 MS.). Lacustrine deposits are exposed in the Lawford Creek area. They consist of massive calcareous and siliceous sediments, and overlie Precambrian rocks on the banks of Christmas Creek, five miles downstream from Kai Ki yard, near M38, and at M40 on the Mt. Ramsay Sheet. At M41 at Lawford Creek on the Mt.Ramsay Sheet the Lawford Beds overlie laterite, and for this reason may be tentatively correlated with the Oakover Beds (Maitland, 1904) of the South-western Canning Basin, which may have been laid down in the same pluvial cycle.

Quaternary

Recent deposits include aeolian sand; travertine, caliche, and evaporites; river alluvium, gravels, and sand; and alluvial black soil. Aeolian sand is the most widespread and covers large tracts of the desert as sand plains or piled into seif dunes. The red or orange colour of the sand is due to a thin coating of hematite on the grain surfaces. The sand is medium to fine grained and subangular to subrounded.

Small deposits of travertine occur in interdune areas. The alluvial gravels, sand, and black soil are distributed thinly in large stream valleys or on open plains.

STRUCTURE

The Mt.Bannerman Sheet includes parts of two major structural units; the Canning Basin and the Kimberley Block. The boundary between the two is shown in Figure 1.

The Kimberly Block (Guppy et al., 1958).

The south-eastern edge of the Kimberley Block occupies the northern part of the Mt.Bannerman Sheet, east of longitude 126° 25'. It contains mainly Precambrian rocks (sediments, metamorphics, and igneous rocks) and is probably one of the main sources of supply of the terrigenous sediments of the Canning Basin.

The folds and faults trend mainly east-west; several large faults parallel to the southern margin of the Precambrian rocks may have influenced the shape of the Canning Basin. The metamorphics are strongly folded and near vertical dips are common, but the Upper Proterozoic rocks dip at only moderate angles, generally about 20^{o} except near large faults.

The Canning Basin (Traves, Casey & Wells, 1956).

The Canning Basin includes a large area of mainly arenaceous sediments resting on a floor of Precambrian rocks, probably mainly metamorphic and igneous. It is divided into a number of smaller basins by subsurface basement ridges indicated by gravity and aeromagnetic surveys and confirmed by drilling in areas outside this Sheet. Only one of these ridges has been named; this is the Broome Ridge, running east from Broome to Dampier Downs and then south-eastward to the vicinity of Godfrey Tank, which establishes the southern limit of the Fitzroy Basin (Guppy et al., 1958).

The Fitzroy Basin extends through the Mt.Bannerman Sheet; the Broome Ridge passes south-west of the Sheet and is indicated by a large anomaly on the aeromagnetic profile near the south-west corner. The Palaeozoic sediments of the Fitzroy Basin rest on the Precambrian rocks with an angular unconformity.

The reconnaissance gravity map of the Mt.Bannerman Sheet shows a large relatively positive anomaly extending from the northern margin of the sheet at Long.126^{o}25'E., through Bulka Hills to the southern margin at Long.126^{o}40'E. Many small faults lie along the west side of this anomaly, which is probably the continuation of an anomaly of similar magnitude north-east of the Pinnacle "Fault". West of this positive anomaly is a broad negative anomaly, which, on the basis of the correlation between thickness of sediment and gravity anomaly elsewhere in the Fitzroy Basin, may indicate a thick sedimentary sequence, perhaps of the order of 15,000 feet. East of the north-south positive anomaly the gravity contours follow the structural trend of the Precambrian which is echoed in a long negative anomaly that coincides with the easternmost extent of Permian sediments and may indicate an Upper Proterozoic-Palaeozoic basin.

Considering the geology and the gravity distribution on this Sheet and the surrounding Sheets it is likely that the west side of the north-south positive gravity anomaly is the hinge line of Palaeozoic sedimentation (the "Lonergan Hinge") between a shelf area with thin sediments of sandstone-limestone lithology, disconformities, and little tectonic disturbance, to the east, and a trough or basin with thick sediments of shale-greywacke lithology, few disconformities, and greater tectonic disturbance. This concept is shown in section C-D of the map, but of course is not established.

Although no folds were established by direct measurements of dip, photo-interpretation indicates an anticline south of Dean Hill, with its crest broken by a fault; broad south-pitching folds west and south-west of Lake Betty, whose axes trend south-south-east; a south-pitching anticline, disrupted by axial faults, trending in the same direction south of Lake Lonergan and an anticline trending south-east, whose axis lies a little to the east of Lake Doman.

Faults in the Palaeozoic sediments are most abundant west of the Lonergan Hinge. Most of the faults trend north-north-west. Their dip is unknown; stratigraphic displacements indicate throws of less than 200 feet.

ECONOMIC GEOLOGY

Petroleum Prospects: The sediments of the Fitzroy Basin on the Mt.Bannerman Sheet have much the same prospects of containing petroleum pools as those farther to the north-west, because the lithologies, sequence, structure, and geological history are likely to be similar in the two areas.

Ordovician calcareous petroleum source-beds containing trace petroleum crop out at Prices Creek (Guppy et al., 1958), twenty miles north-north-west of the north-west corner of the Sheet. Other possible source-beds are; possible Ordovician sandstone in the Cummins Range area, Devonian calcareous beds about twenty miles north of the north-west corner of the Sheet, and the Permian Noonkanbah Formation.

Reservoir rocks are known in the Ordovician, Devonian, and Permian elsewhere in the Fitzroy Basin and probably extend on to this Sheet area.

The Lonergan Hinge (Fig.1) may include areas of closed anticlines and Ordovician and Devonian organic reefs may have developed along it. If, as seems likely, the Lonergan Hinge divides the shelf-type sedimentation from the trough, it is a very attractive area for petroleum exploration, combining drainage from a thick sequence probably containing many source-bed formations with structural relief and the likelihood of reservoir rocks. The anticlines indicated elsewhere on the Sheet are not as attractive: those to the west are less likely to have reservoir beds, those to the east are less likely to be in contact with source beds and are less likely to have cap rocks developed.

Water. As very little of the area is used for cattle-raising there is little demand on underground water resources. Surface water occurs chiefly as semi-permanent pools in the creeks, or small rock-holes. Numerous springs in Permian sediments south of Christmas Creek are probably controlled by small faults. Their water is alkaline, but can be used for watering stock.

Three wells along a subsidiary stock route between Christmas Creek Station and Godfreys Tank give ample supplies of water. Well No.1 has excellent water, at a depth of 46 feet. In the desert area good supplies of water are generally present at depths from 20 to 80 feet and may yield from 200 to 2,000 gallons per hour.

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