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BUREAU OF MINERAL RESOURCES GEOLOGY AND GEOPHYSICS.

RECORDS.

1962/56

THE GEOLOGY OF THE AVON DOWNS 1:250,000 SHEET AREA NORTHERN TERRITORY

by

M.A. Randal and G.A. Brown.

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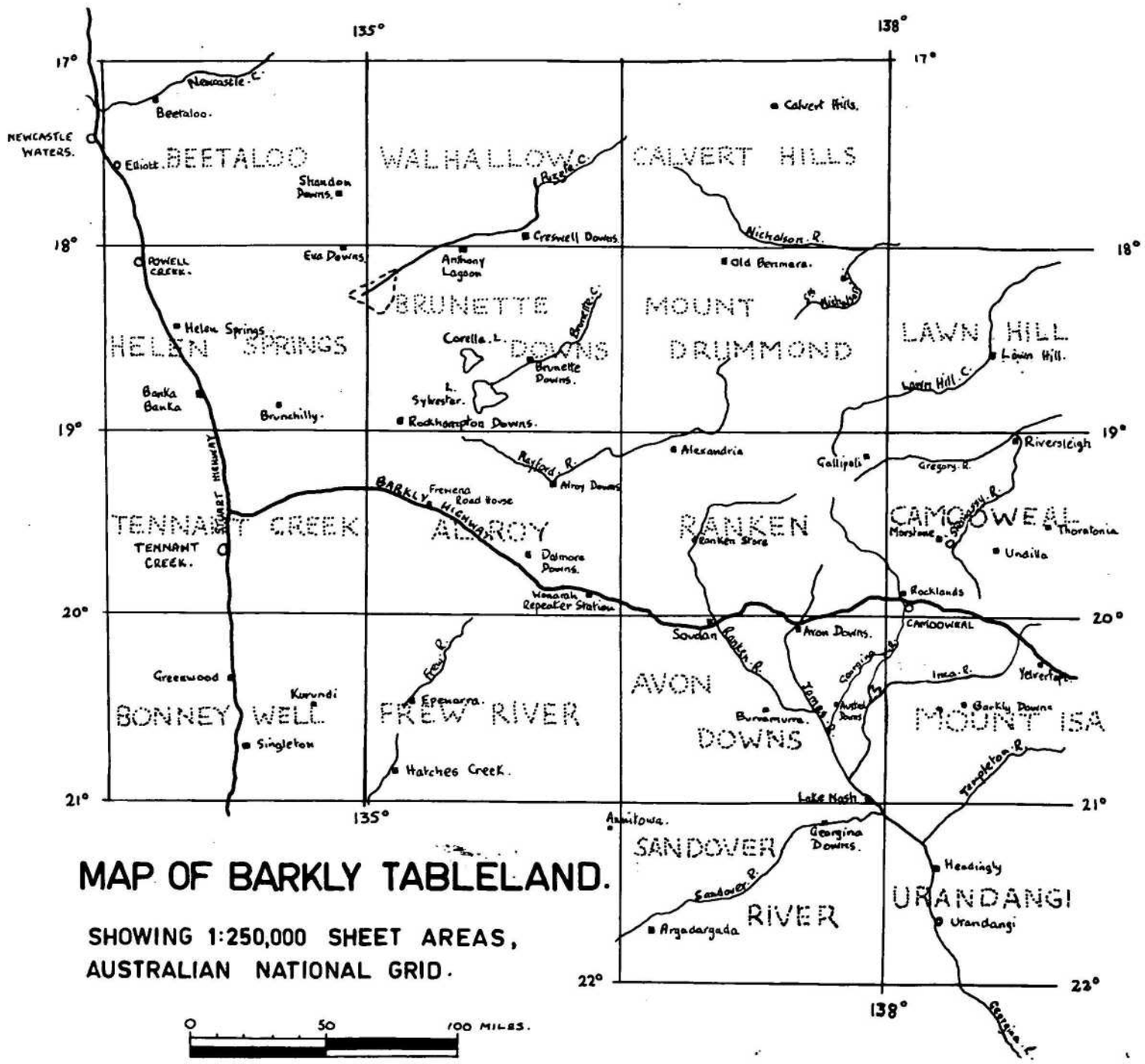
FIG. 1.



MAP OF BARKLY TABLELAND.

SHOWING 1:250,000 SHEET AREAS, AUSTRALIAN NATIONAL GRID.

0 50 100 MILES.

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To accompany Records 1962/49, 55, 56, 61.

NT/8

SUMMARY

The Bureau of Mineral Resources mapped the Avon Downs and Ranken Sheet areas in 1961, and re-examined the western part of the Camooweal Sheet area; these areas which make up the north-eastern part of the Georgina Basin also form the eastern part of the Barkly Tableland (Fig. 1). The geology of the Ranken and Camooweal Sheet areas is discussed in other records - Randal and Brown (1962a and b) and Brown (1962).

The lack of outcrops and few exposed contacts in this area make stratigraphic mapping difficult and the results conjectural; an analysis of the water bore logs has provided little help. Apparent structures which show as air photo patterns are not visible on the ground.

White, cavernous crystalline dolomite crops out as scattered blocks and boulders in the eastern part of the area; it contains chert nodules and bands and is lithologically similar to dolomite rocks near Camooweal; no fossils have been found in the dolomite and its stratigraphic and structural position is not clearly understood.

Siliceous shale, limestone, chert and fine sandstone forms a scree over hills in the northwest of the area. These sediments, which make up the Middle Cambrian Wonarah Beds, may be continuous with the Burton Beds on the Ranken Sheet area, and the Sandover Beds on the Sandover River Sheet area. No reliable regional dips were seen in these beds and their relationship with the fossiliferous Ranken Limestone to the east is based on their fossil content only. The Ranken Limestone is probably a lens in the Wonarah Beds, but its relationship with the Camooweal Dolomite is uncertain.

Mesozoic rocks form remnants in the northern part of the area, and the Tertiary Austral Downs Limestone forms a thin veneer on the Lower Palaeozoic carbonate rocks in the east.

INTRODUCTION

Location

The Avon Downs Sheet area lies in the Northern Territory of Australia between longitudes 136°30'E and 138°00'E and latitudes 20°S and 21°S; its eastern boundary is the Queensland-Northern Territory border; the area is served by the town of Camooweal, 10 miles to the north-east. The bitumen-sealed Barkly Highway from Mount Isa to Tennant Creek crosses the northern boundary of the area, and from it access is gained to numerous bore tracks and stock routes.

Location - continued:

Parts of six cattle stations occupy the area - Austral Downs (including Burramurra), Soudan (part of Alexandria), Avon Downs, Georgina Downs, Lake Nash and Rocklands. Rocklands Homestead lies north-east of the Sheet area and Georgina Downs Homestead is south-west of Lake Nash (Fig. 1); a police station is located at Lake Nash. Habitation is generally restricted to east of the Soudan-Lake Nash stock route; west of the stock route the country is largely semi-desert.

Previous Work

Since H. Y. L. Brown (1895) discovered Cambrian trilobites at Alexandria, geologists have passed through the area en route to fossil localities and mining centres in adjoining areas. Brief comments on the rock types were recorded but no systematic mapping was undertaken. References to these trips are made in "The Geology of the Ranken 1:250,000 Sheet area" (Randal & Brown, 1962b). The Avon Downs Sheet area contains part of the Barkly Tableland, which has been studied by Dr. A. A. Öpik on several occasions between 1948 and 1954. The results of this work are contained in a number of unpublished records which are the basis of the Bureau of Mineral Resources Bulletin No. 49 by A. A. Öpik (1957). M. A. Condon (1961) visited the area briefly in 1960 and examined the anticline at Lake Nash and the rocks near Soudan Homestead. The Avon Downs Sheet area was included in the photo-geological project on the Georgina Basin carried out by Shell Oil Coy (Mulder, 1961).

Air Photographs and Maps

The Avon Downs Sheet area is covered by vertical air-photographs, flown by the Royal Australian Air Force in 1947 at a scale of 1:46,500; these photographs are not clear and many bores and tracks have been put in since the photos were flown. The Division of National Mapping published the Avon Downs Sheet in the 4-mile Topographic Series in 1952; it was compiled from the 1947 photography with astrofix ground control. Ground parties from the Division revisited the area in 1958, and with the aid of spot photography, compiled the new cultural detail. This additional detail has been incorporated in the photo-scale compilations of the separate one-mile areas. The new compilation for the Sheet area has not yet been published.

PHYSIOGRAPHY

Two distinct physiographic divisions are separated by a line drawn from west of Soudan to south-east of Lake Nash. Gently undulating downs country lies east of this line, and is drained by the Georgina River and its main tributaries, the Ranken and James Rivers. A semi-desert area lies west of the line, and it extends from the Sandover River northwards to the Barkly Highway, and from the Ranken River westwards to the Davenport Ranges and Tennant Creek.

Figure 2. Boundary between desert country and the Sandover River Flood Plain; west of Lake Nash.
The photo is taken looking south from a [illegible] or 2500 feet. (G4453)

Figure 3. Low rises with dolomite slabs.
Desert country south of Soudan; taken from 1500 feet. (G4455)

The downs country lies in the Georgina Drainage Basin (C.S.I.R.O., 1954) which forms part of the large internal drainage basin centred on Lake Eyre. The downs consist of clayey black soil which supports a good growth of mitchell grass and some swamp flinders grass. Low sandy or stony rises are common and red clayey soil occurs in small patches. Gidyea scrub frequently occurs near watercourses, some stands of eucalypts occur along the major watercourses and blue-bush swamps are common. The streams are generally confined to a single channel but, in places, the larger rivers are braided, particularly the Georgina River, north of Austral Downs Homestead. The streams flow for a few months of the year only; for the rest of the year, water remains only in widely spaced waterholes, few of which are permanent. The area lies between the 10" and 15" isohyets; Avon Downs Homestead averages 13" rainfall per year.

The semi-desert area has no apparent surface drainage. Run-off on the northern slopes of the hills in the north-western part of the area flows northwards towards the Barkly Internal Drainage Basin (Randal and Brown, 1962 ; on the southern side the run-off is concentrated into small short gullies which disappear into the sand; no major streams are present. A number of small blue-bush swamps and clay-pans probably act as foci for the drainage during brief seasonal flooding. The desert area consists of red sand with some patches of pisolitic gravel on low rises; sand dunes, about 10 feet high, occur in the south-western part and they trend north-west. Only a few slabs of white dolomite show through the sand. (Figures 2 and 3.)

The relief in the Avon Downs Sheet area is about 500 feet; the altitude ranges from 550 feet at Lake Nash Homestead to 1050 feet on the hills around Barry Caves. The gradient of the major watercourses is about three feet per mile.

STRATIGRAPHY

General Considerations

Stratigraphic information is difficult to obtain because the outcrops are poor, and there are few exposed contacts. Large areas are covered with black soil and red sand with floaters of dolomite, and gravel formed of chert and rare sandstone and pisolitic ironstone pebbles. Forty water bores are in the area, but few drillers' logs have descriptions of rock-types. Even these logs are inadequate for stratigraphic interpretation. However, an interpretation of some of these logs may be reliable if they are compared with some future geologically controlled bore. A number of these logs are shown on Plate 1.

It is difficult to formalise rock units because of the lack of stratigraphic information; consequently some units are described by the informal term "beds", while others are not named at all. The Camooweal Dolomite is retained with the formational rank implied by Öpik (1957 and 1960); subsurface work on the dolomite rocks may show a need for redefinition of this unit and the restricting of its areal extent. Öpik (1957) used the tentative terms "Wonarah beds" and "Ranken limestone" with the lithological term in lower case letters; these units are now referred to as Wonarah Beds and Ranken Limestone, which was Öpik's original intention. (pers. comm.)

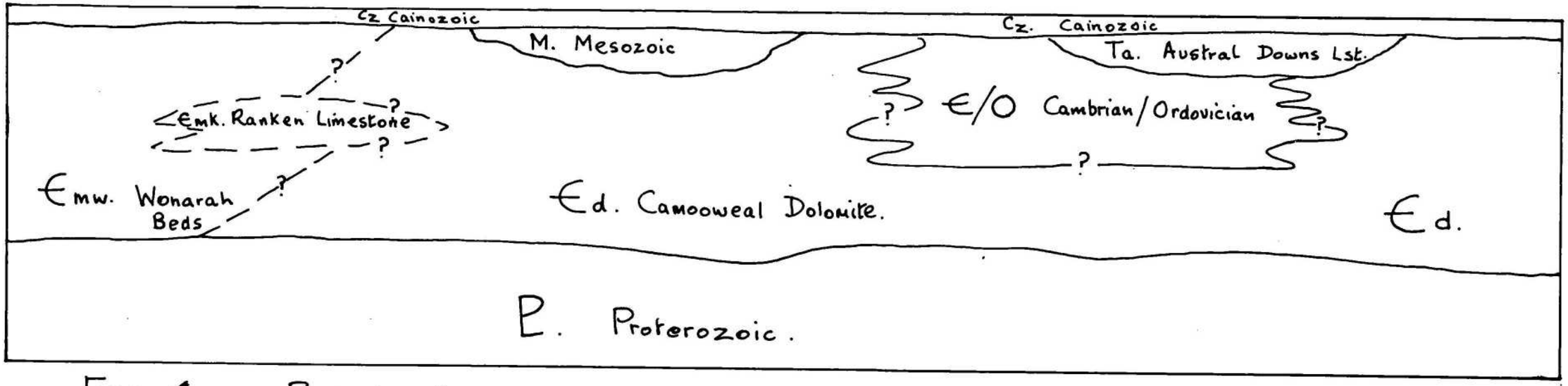

FIG. 4. Probable Relationships of Units — Avon Downs Sheet Area. (Diagrammatic, not to scale.)

To accompany Record 1962/56

Bureau of Mineral Resources, Geology and Geophysics

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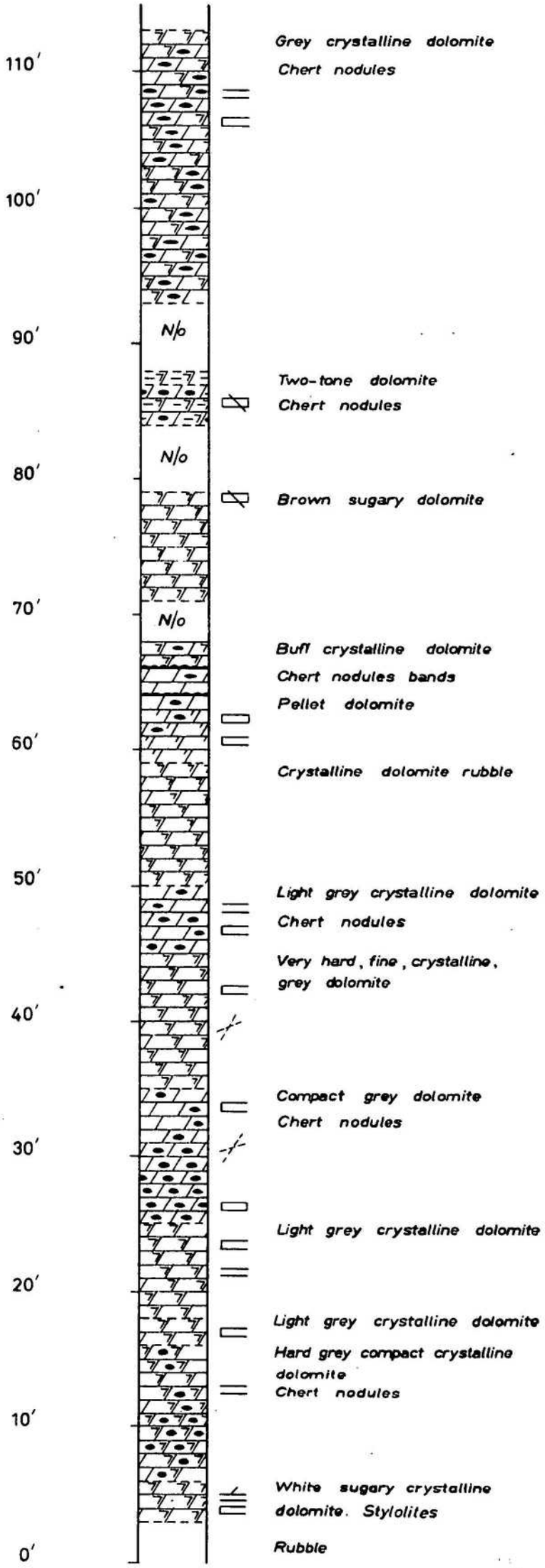
Fig. 5

SECTION IN

CAMOOWEAL DOLOMITE (?)

LAKE NASH ANTICLINE



Bureau of Mineral Resources, Geology and Geophysics.

To accompany Record No 1962/56.

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The probable stratigraphic relationships of these units are shown in Figure 4.

PALAEOZOIC

Camooweal Dolomite

In the eastern part of the Avon Downs Sheet area, a cavernous white crystalline dolomite with chert bands and nodules crops out as scattered blocks and boulders. The rocks are lithologically similar to the dolomite near Camooweal and have been included in the Camooweal Dolomite (Opik, 1954). No fossils have been found in situ, but fossiliferous (Middle and Upper Cambrian) chert and limestone fragments are scattered over the surface. The age of the dolomite is not clear; rocks which previously have been included in the Camooweal Dolomite have different relationships with Middle Cambrian rocks in other areas (Randal and Brown, 1962a and b). The thickness of the Camooweal Dolomite is not known; bore logs from the Ranken Sheet area to the north suggest it is at least 800 feet.

The name Camooweal Dolomite was first published in 1956 (Opik, 1957). The Camooweal Dolomite as outlined by Opik included rocks which had been called Georgina Limestone (Whitehouse, 1931) and Barkly Group (Noakes, 1951 and Noakes & Traves, 1954). A detailed historical account of the nomenclature is given in Randal & Brown (1962a). Opik (1957) disagreed with the previous nomenclature on the grounds that it referred to fossiliferous Cambrian rocks whereas the dolomite at Camooweal was unfossiliferous and, in his opinion, pre-Middle Cambrian. There is now some doubt if all the rocks included in the Camooweal Dolomite are in fact pre-Middle Cambrian. However, Opik's nomenclature is retained.

The type area for the Camooweal Dolomite is around Camooweal township in Queensland, ten miles north-east of this Sheet area (Opik, 1954); no type section is described.

The Camooweal Dolomite crops out in the northern and eastern parts of the Avon Downs Sheet area; it extends northwards onto the Ranken and Camooweal Sheets, eastwards onto the Mount Isa Sheet and southeastwards onto the Urandangi Sheet. Outcrops of dolomite near Lake Nash, in the southern part of the Sheet area, extend southwards onto the Sandover River Sheet. These outcrops are tentatively regarded as Camooweal Dolomite; future mapping may provide more definite information on their stratigraphic position.

The best exposures of the Camooweal Dolomite in this area are in the north near Cattle and Happy Creeks, and in the south near Lake Nash Homestead, where over a hundred feet of section is exposed (Figure 5). Good outcrops occur in the Ranken River, downstream from Soudan Homestead. Elsewhere outcrop is scarce, and it occurs only as boulders and blocks scattered on the black soil plains. The plains are covered with mitchell grass and are the main topographic expression not only of the Camooweal Dolomite, but of other carbonate rocks in the area. Consequently, any attempt to photo-interpret the extent of the Camooweal Dolomite by topographic expression could be misleading.

Figure 6. Sinkhole, 45 feet deep, in Camooweal Dolomite, south-east of Avon Downs. (G4442)

Outcrops are so few in this Sheet area that a detailed description of the unit can be done only with reference to outcrops in adjoining areas. A number of sections from the Camooweal area are described in Randal and Brown (1962a). The section exposed in the anticline at Lake Nash is shown in Figure 5. The dolomite is mainly a laminated white crystalline rock with chert bands and nodules. It is cavernous and variable in colour - white, cream, brown, buff. Massive white and mottled rocks are more coarsely crystalline and porous than the white laminated and dark ones. Usually the massive white dolomite is sugary and even friable. Pellet dolomite is rarely present; intraformational conglomerates occur in the Ranken Sheet area but not on this Sheet. Bedding varies from thin to very thick. In places quartz sandstone boulders are scattered amongst boulders of the dolomite and may represent sandstone beds within the unit. Sandstone beds are known in the Urandangi Sheet area, and sandstone beds have been recorded from water bores in the Ranken Sheet (Randal & Brown, 1962b). Sinkholes are common in the Camooweal Dolomite. In a sinkhole on Avon Downs Station (Figure 6) forty-five feet of hard buff crystalline dolomite contains thin interbeds of soft, marly dolomite.

The structure of the Camooweal Dolomite is uncertain. Good exposures are rare and are nearly always flat lying. Except near Lake Nash, even moderate folding appears to be absent, and the few shallow dips recorded may be depositional.

Well bedded crystalline dolomite is folded into a domal anticline, east of the Georgina River between Gidya Creek and Lake Nash Homestead. The dolomite contains numerous chert bands and nodules, and is similar to both the Camooweal Dolomite and the Lower Ordovician Ninmaroo Formation. No fossils have been found in the exposed section of 110 feet (Figure 3), but the scree contains rocks which have the appearance of silicified coquinites. Quartz sandstone boulders also have been found in the scree, but not in situ.

The anticline is about eight miles east-west and four miles north-south, and occurs as a group of hills up to 220 feet high. The westward extension crops out in the banks of the Georgina River. The trend of the anticline is easier to trace on air-photographs than on the ground, where numerous rolls obscure the shallow (probably less than 2^{o}) regional dip. Condon (1961) suggests the anticline may be closed in the Ordovician. Because of the similarity between outcrops of the Camooweal Dolomite and the Ninmaroo Formation, it is difficult to establish the age of the rocks exposed here, and it is suggested that the anticline should be a target for deep stratigraphic drilling to determine the lithological sequence.

The area of the Camooweal Dolomite was included in Whitehouse's Georgina Limestone (1931) of Middle Cambrian age; Noakes and Traves (1954) introduced the term Barkly Group for these rocks. Opik disputed the Middle Cambrian age for the white crystalline dolomite which covered, in discontinuous outcrop, large areas of the Barkly Tableland; he describes "the non-conformable overlap of Cambrian sediments on the Camooweal Dolomite and the presence of areal unconformities" (Opik, 1954). Chert and limestone boulders with Middle and Upper Cambrian fossils are found over the surface of the Camooweal Dolomite. Opik (1957 and pers.comm.) considers these may be remnants of a younger Cambrian

sequence once in superposition on the Camooweal Dolomite, but now eroded. Opik (op. cit.) considers that the lower Middle Cambrian Ranken Limestone overlies the Camooweal Dolomite in the Ranken River area. However, during the 1961 survey no stratigraphic relationships between the two could be determined with certainty. On the Ranken Sheet there is some evidence that outcrops of dolomite in the Ranken River area may be lateral equivalents of the Ranken Limestone.

In the Mount Drummond Sheet area to the north, rocks which have been called Camooweal Dolomite overlie the Middle Cambrian Currant Bush Limestone (Smith & Roberts, 1960); on the Camooweal Sheet area, the Camooweal Dolomite interfingers in some places with the Middle Cambrian Age Creek Formation (Randal and Brown, 1962a). These relationships cannot be inferred elsewhere in the region because of the lack of continuous outcrop. Therefore, even though some parts of the Camooweal Dolomite are Middle Cambrian or younger, the question of some pre-Middle Cambrian Camooweal Dolomite is still unresolved. South of the Avon Downs Sheet area dolomite rocks are common in the Upper Cambrian and the Ordovician. Lithologically these rocks are similar to the dolomite in the Camooweal area and produce similar patterns on air-photographs. Consequently Mulder (1961) was forced to adopt an arbitrary boundary between the Cambrian-Ordovician rocks and the Camooweal Dolomite. The dolomite may not be a single unit, the scattered outcrops may represent a number of resistant beds in a varied sequence; or alternatively, the dolomite may be the result of a diachronous environment.

The thickness of the Dolomite is not exactly known; however, bore logs in the Ranken Sheet area suggest it is over 800 feet (Randal & Brown, 1962b).

Some information on the depositional environment of the Camooweal Dolomite is available from adjoining areas (Randal & Brown, 1962a; Brown, 1962); it was laid down in shallow quiet seas, either as a calcium carbonate, or as a dolomite mud, or possibly as a mixture of the two; evaporation and precipitation of carbonates continued for some time, as shown by the massive bedding in some areas. Slump rolls in chert nodules and bands suggest minor movement during deposition. Sedimentation was probably slow, which allowed thick beds of internally laminate sediments to build up. As the sedimentation, and probably the subsidence, was slow, the sediments remained at the interface long enough to be completely dolomitised and lose all trace of sedimentary features.

Ranken Limestone

Fragmented crystalline limestone and chert, which occur in the valley of the Ranken River, have been named by Opik (1957) the Ranken Limestone. The limestone is richly fossiliferous and appears to intertongue with the Wonarah Beds to the west; its relationship with the Camooweal Dolomite to the east is not clear. The thickness of the Ranken Limestone is not known, but it is probably less than a few hundred feet (Randal & Brown, 1962b).

The fossiliferous limestone near Soudan Homestead was described by Opik (1957) as the Ranken Limestone.

Figure 7. Sinkhole in Wonarah Beds, 1 mile north of Bore No. 7A. The measured section is shown on Page 8. (G4436)

The type area for the Ranken Limestone is in and about the valley of the Ranken River between Soudan Homestead and Bore 17 Alexandria, ten miles south of Ranken Police Station; there are no type sections. The rocks occur as scattered slabs and large blocks in black soil downs, and as gravel-strewn plains along the Ranken River.

The Ranken Limestone contains oolitic, fragmental and crystalline limestone, silicified limestone, chert and some dolomite; the rocks are richly fossiliferous. Bedding, often poorly developed, ranges from thin to medium. The Ranken Limestone crops out mainly on the Ranken Sheet area to the north, where more information about the unit is obtained. (Randal & Brown, 1962b).

The stratigraphic position of the Ranken Limestone is not clear from outcrop mapping. Condon (1961) considers the limestone probably overlies the Wonarah Beds to the west and grades eastward into dolomite; he suggested the succession was dipping gently to the east. However, the dolomite, the limestone, and the Wonarah Beds have not been seen in contact; several miles of black soil separate outcrops of the Wonarah Beds from the Ranken Limestone. No reliable dips have been seen in the field. Öpik (1957) maintains the Ranken Limestone intertongues with the Wonarah Beds and stratigraphically is a lens in it. On fossil evidence Öpik (1957 and pers. comm.) considers it is impossible for the Ranken Limestone to overlie the top of the Wonarah Beds. Lenses of limestone are known in outcrop in the Wonarah Beds, and they may occur in the subsurface as evidenced by a large sinkhole (Figure 7).

The relationship of the Ranken Limestone with the Camooweal Dolomite is not certain. Condon (1961) considered the Ranken Limestone graded upwards into the dolomite on the east side of the Ranken River. Fossiliferous dolomite does occur in this area (Randal & Brown, 1962b) but its continuity with the Camooweal Dolomite is not proved. Öpik (1957) shows the Ranken Limestone unconformable on the Camooweal Dolomite. No evidence was found to prove or disprove this interpretation.

Sedimentary features in the Ranken Limestone suggest it is a shore-line deposit (Öpik, 1957). The limestone is essentially a fragmented coquinite with shell-in-shell structures and ripple marks.

The age of the Ranken Limestone is lower Middle Cambrian. Minor reworking of the limestone occurred during the upper Middle Cambrian, as shown by upper Middle Cambrian fossils at a locality north of Soudan (Öpik, 1957).

Wonarah Beds

The Wonarah Beds occupy the western part of the Avon Downs Sheet area, where they crop out as rubble covered rises; from photogeological patterns, they probably extend south of the Barkly Highway to the Sandover River area. The fossiliferous chert, siliceous shale and limestone may be continuous with other Middle Cambrian rocks in the Barkly Tableland; they are deeply lateritised with a lateritic capping up to thirty feet thick (Figure 8). The Wonarah Beds are at least five hundred feet thick.

Figure 8. Laterite capping (siliceous zone) on Wonarah Beds, near Barry Caves. (G4454)

Wonarah Beds were first used by A.A. Öpik (1957) to describe outcrops of Cambrian rocks along the Barkly Highway, west of Soudan Homestead. The rocks had been included in the Alroy Downs Beds (David, 1932) and subsequently in the Barkly Group (Noakes and Traves, 1954).

The sequence is named after the Wonarah Telegraph Repeater Station (long. 136°20'E, lat. 19°54'S) on the Barkly Highway in the Alroy Sheet area (Figure 1); there is no type section.

The Wonarah Beds crop out in the western part of the Sheet area. They extend onto the Alroy, Frew River, and Ranken Sheet areas. Mulder (1961) has traced these rocks by photogeological patterns to near the Sandover River south of the Sheet area. The Wonarah Beds may be continuous with the Middle Cambrian Sandover Beds (Öpik, 1957).

The Wonarah Beds are largely covered by sandy plains and low rubble covered rises; the area is locally referred to as "desert", and extends from Frewena in the west to Annitowa in the south, and Burramurra in the east. Between Soudan and Wonarah the rocks crop out as rubble covered hills 250 feet high. These hills probably were protected from deeper erosion by the hard lateritic capping.

The Wonarah Beds consist of fossiliferous siltstone, chert, silicified shale and silicified oolitic limestone; Condon (1961) reports leached dololutite and chert replacing dolomite. Outcrops in situ are rare; rubble covered rises are common. The rocks are lateritised and remnants of the mottled and pallid zones cap the outcrops in the area near Barry Caves (Figure 8). Detrital pisolites form a deposit twenty feet thick in a sinkhole near Bore 7A, west of Soudan Homestead. (Figure 7).

The 68-foot section at Barry Caves is, from the top:

12 feet	Silicified brecciated billy
1 foot	Quartz pebble conglomerate
20 feet	Ferruginous, red, and white, fine-grained quartz sandstone, and siltstone.
35 feet	Rubble.

The 65-foot section in the sinkhole near Bore 7A is, from the top:

20 feet	Pisolitic ironstone gravel
20 feet	Interbedded chert and siltstone
15 feet	Bedded chert, some siltstone
10 feet	Yellow, red and white, laminated siltstone.

No fossils have been found at Barry Caves, but the lithology is similar to the rocks in the sinkhole in which the trilobite Xystridura has been found. The large sinkhole may be related to a limestone not far below, which, if this is the case, may be a continuation of the Ranken Limestone. Bore 7B, which is two miles north of the sinkhole, was drilled to 365 feet as a dry hole; numerous chips of limestone occur in the spoil.

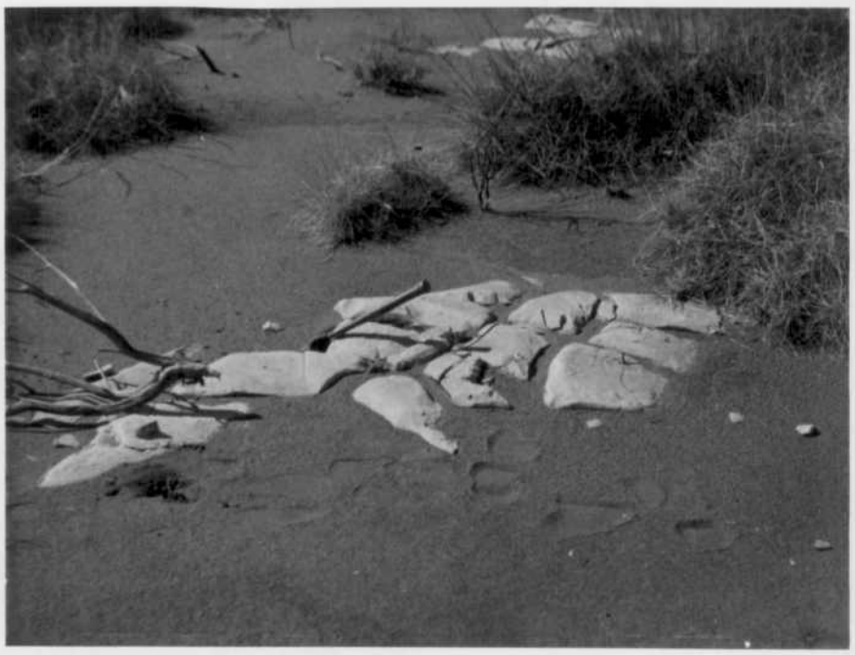

Figure 9. Outcrop of dolomite in desert country. 20 miles north-east of Annitowa Homestead. (M146)

The structure of the Wonarah Beds is not evident from field mapping. Fourteen miles east of Wonarah Telegraph Station the rocks dip 3° south-west; east of Barry Caves, they dip at low angles to the south-east. Mulder (1961) has shown dips of varying directions on his photo-geological map of Avon Downs; it is not certain which dips have regional significance. The relationship between the Wonarah Beds and the Ranken Limestone has been discussed previously. The stratigraphic range of the Wonarah Beds is shown on a chart by Öpik (1959) as extending both above and below the range of the Ranken Limestone.

The Wonarah Beds are lower Middle Cambrian, and are time equivalents of other rocks in the Barkly Region - the Gum Ridge Formation (Ivanac 1954) to the west, the Burton Beds to the north, and the Sandover Beds to the south-west. The thickness of the Wonarah Beds is not known but is at least five hundred feet; a bore at Wonarah was drilled to 450 feet without any change in lithology. A single aeromagnetic profile indicated basement at 800 feet below ground level near the Wonarah Telegraph Station, but this thickness could include rocks older than the Wonarah Beds.

Undifferentiated Cambrian and Ordovician

Finely crystalline, grey-white, dolomite crops out as pavements (Figures 3, 9) in the south-western and southern parts of the Sheet area. The country forms part of the desert area, and was crossed briefly in a helicopter. The photogeological patterns of these rocks are similar to the Camooweal Dolomite, the lower Ordovician Ninmaroo Formation and Tomahawk Beds (Smith et al, 1961). Sandstone and siltstone rubble occur, but it is so thoroughly lateritised that no original features remain. Chert rubble is common. No fossils have been found and no boundary with the Camooweal Dolomite can be interpreted. The stratigraphic position of these rocks may be determined after the Sandover River Sheet area is mapped.

MESOZOIC

Rocks of Mesozoic age form a thin veneer over Palaeozoic rocks in the northern part of the Avon Downs Sheet area. They occur along the Barkly Highway, east of Soudan Homestead, and extend northwards onto the Ranken Sheet area.

Quartz sandstone and pebble conglomerate boulders are common on low rubble covered rises; residual sand covers most of the area of outcrop.

The rocks are similar to Mesozoic rocks near Cresswell Downs (Figure 1.) and between Camooweal and Yelvertoft. Opik (pers. comm.) has found poorly preserved plant remains in these rocks.

CAINOZOIC

Austral Downs Limestone

Tertiary nodular limestone crops out in the central and the south-eastern parts of the Sheet area. Noakes (1951) named the unit Austral Downs Limestone and noted the similarity between it and the Brunette Limestone to the north (Noakes & Traves, 1954). The rocks are composed of lime and

Figure 10. Outcrop of Austral Downs Limestone; Long Bora Waterhole, Ranken River. (G4434)

silica leached from older rocks, and deposited in a lacustrine environment. It is probably less than 75 feet thick.

Noakes (1951) used Austral Downs Limestone to describe lacustrine limestone in the valley of the Georgina River, between Lake Nash Homestead and Carandotta Homestead. The name was again used by Noakes and Traves (1954) in the report on the Barkly Survey carried out by C.S.I.R.O. in 19.7-48. Traves (1955), when describing Tertiary limestone in the Ord-Victoria Region, briefly referred to the Austral Limestone of the Barkly Tableland, with a footnote stating the name was unpublished but had been approved by the Queensland Committee on Stratigraphic Nomenclature. However, the Queensland Lexicon *(195?) refers to these rocks as Austral Downs Limestone, and Noakes et al (1959) retain this form.

The unit is named from Austral Downs Homestead (long. 137°53'E, lat. 20°30'S); no type section has been described from this area, but Paten (1961) gives a representative 30-foot section from Pituri Creek near Glenormiston Homestead, south of Urandangi as:

15 feet	Chalcedony and siliceous limestone, silica increasing towards top.
5 feet	White fragmental limestone with minor chalcedony.
5 feet	White limestone with some ferruginous sandy detritus.
5 feet	Ferruginous detritus, calcareous matrix, some travertine.

The Austral Downs Limestone crops out in and about the valley of the Georgina River and along the lower reaches of the Ranken River. It extends eastward onto the Mount Isa Sheet area, and southwards onto the Sandover River and Urandangi Sheet areas.

The topography is mainly grassy downs with some areas of scrub covered rubble strewn plains. Near Burramurra the unit underlies sandy desert country.

Outcrops occur as scattered boulders in the black soil; pavements and cliffs are common in the watercourses (Figure 10).

The lithology of the formation is mainly a skeletal white crystalline or amorphous nodular limestone. Chalcedonic nodules and bands are common and frequently have textures similar to the limestone. Slumping and break-up of unconsolidated sediments has produced intraformational conglomerate and sedimentary breccia. Traces of manganese dioxide occur as dendritic smears; rare quartz grains are present. Bedding is poorly developed and the large outcrops have a massive appearance.

The Austral Downs Limestone forms a thin cover on the older carbonate rocks, which frequently protrude as inliers. It has not been seen overlying the Mesozoic rocks.

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* Compiled by E. M. Smith and others; shown in References as Smith, E.M., et al, 1958.

The formation is probably a time and lithological equivalent of the Tertiary Noranside Limestone near Boulia, and the Horse Creek Formation near Springvale (Paten, 1961), and the Brunette Limestone in the Ranken Sheet area (Randal and Brown, 1962b). No fossils have been found in the formation in the Avon Downs Sheet area; however, south of Urandangi near Roxburgh Downs, Paten (1961) has reported the forams Rotalina and Globigerina; Charophyte stems, gyrogonites and ostracods have been found at Carandotta. Paten (1961) considers the unit is late Tertiary, Noakes (1956) places it in the Miocene.

The Austral Downs Limestone, like similar deposits in the Northern Territory and Queensland, is generally confined to the broad valleys of the major watercourses. It is a lacustrine to brackish water deposit laid down in locally developed lakes formed by the temporary damming of the streams. It appears to have been derived from silica and carbonates which were leached from the older rocks during lateritisation. Some lateritic detritus is known at the base of the formation (Paten, 1961).

The maximum exposed thickness in the Avon Downs Sheet area is at Dead Dog Waterhole on the Georgina River, where 45 feet of white, nodular, limestone with chert smears, nodules and bands crops out as massive blocks on the sloping bank of the river. Paten (1961) records a maximum thickness of 55 feet near Aroota Bore, south-east of Marqua Homestead.

GEOLOGICAL HISTORY

The area contains many rocks of doubtful stratigraphic position; it is therefore not possible properly to evaluate the geological history and structure. Sedimentation occurred to the north and to the east of this area during Upper Proterozoic time and extensions of these rocks may form the basement in the Avon Downs Sheet area; Upper Proterozoic rocks crop out on the Mount Isa and Ranken Sheet areas (Figure 1).

Early Middle Cambrian seas transgressed the area and essentially carbonate rocks were deposited in the eastern part of the area; fine sandstones and siltstones were deposited in the west. The thickness of the Cambrian sediments in the south is not known but near Wonarah and Soudan it is about 800 feet.

Upper Middle Cambrian fossils in the fragmented upper beds of the Ranken Limestone suggests a late Middle Cambrian ingression, presumably from the east (Öpik, 1957). This may have been followed by the deposition, in the south, of carbonates and sandstones during the Cambrian or Ordovician.

In the Mesozoic the area was again partly submerged, isolated lakes developed in the north and arenaceous sediments were deposited in them. This was probably contemporaneous with the widespread Mesozoic transgression over large parts of Australia.

Differential warping proceeded during the late Mesozoic or Tertiary with the development of fresh or brackish water lakes. Lateritisation proceeded on the higher ground between the lakes, and silica and lime leached from the rocks were deposited in the lakes and submerged river valleys. Slight rejuvenation of the streams has produced the present cycle of erosion.

ECONOMIC GEOLOGY

Petroleum Prospects

No reliable assessment can be made of the oil prospects until the structural and stratigraphic problems are resolved by adequate subsurface work. Stratigraphic drilling and geophysical surveys are essential in this area as further surface mapping is not likely to solve the problems.

Fossiliferous, fine-grained, marine Middle Cambrian sediments in the western part of the Sheet area, and in surrounding Sheet areas may provide source beds; bituminous beds have been reported from some bores in the Barkly Region and some of the silty limestones have yielded residual hydrocarbons on toluene extraction tests. The Camooweal Dolomite and associated dolomites could form reservoirs for oil or gas; the large quantity of sub-artesian water produced from these rocks is proof of their porosity. Some of the beds in the Camooweal Dolomite are very hard and compact, and drillers logs frequently record "very tight rock" and "close rock"; these rocks might form a cap to any deep reservoir beds. However, the structure and the lithological sequence of these potential source, reservoir and cap rocks are not well known, and it is doubtful if further surface mapping will be of any help.

The thickness of the Cambrian rocks in this area must be known before the oil prospects can be assessed. No water bores have penetrated the full thickness of Cambrian sediments in this area, but on the Ranken Sheet area to the north, a bore reached Upper Proterozoic sediments at 1760 feet (Randal and Brown, 1962b). The aeromagnetic survey between Tennant Creek and Cloncurry gives 800 feet as the depth to magnetic basement near Soudan Homestead and Wonarah Telegraph Station (Jewell, 1962).

Although a magnetometer survey is probably the best and most economical method, the effect of Upper Proterozoic sediments on the calculations to magnetic basement is a problem to be overcome. It is not certain what effect these sediments will have, or how extensive they will be in the subsurface. They crop out in the northern part of the Ranken Sheet area and near Barkly Downs in the central western part of the Mount Isa Sheet area. Traverses in these areas may be necessary to determine the magnetic characteristics of these sediments. If these rocks do have magnetic effects, then the interpretation of basement as far as oil search is concerned will be easier.

The disadvantage of gravity methods is that in many areas the density of the sediment (dolomite) is greater than that of the underlying basement (sandstone and schist); however, gravity would give the trend of basement features. Gravity surveys have been carried out on the Sandover River Sheet area (Barlow, in preparation) and depending on their results it may be worthwhile to continue the survey northwards into the Avon Downs Sheet area. Seismic work is difficult to carry out successfully in an area of mainly carbonate rocks and a great deal of costly experimentation will probably be necessary before interpretable results are obtained. However, rocks other than carbonates occur in the Wonarah Beds and in the undifferentiated Cambrian/Ordovician in the south, and seismic work may prove to be helpful in these areas.

Stratigraphic drilling should be tried before any seismic or even gravity work is undertaken, and a number of drilling sites are suggested at this stage, on the understanding that they may be better positioned if any magnetometer results become available.

A deep stratigraphic bore, probably to 2,500 feet, on the Lake Nash Anticline would give accurate information on the lithological sequence of the carbonate rocks. The rocks are mainly crystalline dolomite and cherty dolomite; they are similar to both the dolomite rocks near Camooweal and the dolomite rocks in the Ninmaroo Formation to the south. The stratigraphic position of these rocks and the depth to basement, both necessary information, may be obtained from this hole.

Shallow drilling to about 500 feet should be undertaken in the Ranken Limestone and the Wonarah Beds to obtain information on their relationships to the Camooweal Dolomite. (Randal & Brown, 1969). Shallow holes in the southern part of the area will give lithological information on the undifferentiated Cambrian/Ordovician rocks which are rarely seen in outcrop. A shallow hole to about 800 feet in the north-eastern part of the area would show the true lithology of the Camooweal Dolomite, closer to the type area and would serve as a guide for the interpretation of the drillers' logs of water bores in this area.

Water Resources

Surface water resources in the Avon Downs area are inadequate for the present level of cattle stocking. None of the watercourses are perennial and few waterholes are permanent because of the low rainfall, low relief and high evaporation. Consequently, the development of the cattle industry in this area is dependent on underground water.

Within the Avon Downs Sheet area there are over forty known water bores; most are in good working order. Very few of the non-working or abandoned bores have failed because of hydrological reasons. When station paddocks are changed, bores are often no longer required, and are temporarily abandoned; in other cases bores are damaged through silting up or mechanical breakdown. Some bores have not been completed because of technical difficulties.

The quality of the sub-artesian water is variable, but most of the water is fit for human and stock consumption. Few chemical analyses are available but the waters are known to contain varying amounts of calcium, magnesium, sulphates, chlorides and carbonates.

So far it has not been possible to determine the type and number of aquifers in the region; drillers' logs give scanty lithological descriptions and little information about structure is available from surface mapping. Most bores in the dolomite areas have provided a good supply of water from aquifers between 330 and 605 feet above sea level. The water pressure surface (standing water level) ranges from 485 to 666 feet above sea level. The yield of most bores is determined largely by the capacity of the pumping equipment; most have been tested at 2000 g.p.h.

The hydrology of the Avon Downs area cannot be dealt with as a separate entity; it must be considered in relation to the surrounding areas of the Barkly Tableland. The problem is discussed in a progress report on the Hydrology of the Eastern Barkly Tableland (Randal, 1962).

Building Materials

A great deal of use has been made of the dolomite rocks of the area for minor building purposes. Dolomite slabs have been used for pathways and pavement floors for out-buildings around homesteads. Heavier slabs have been used for mounting bore equipment and as foundations for cattle troughs and over-shoot dams. Heavy blocks of dolomite have been used in the construction of small bridges and culverts along the Barkly Highway.

Abundant supplies of gravel are available in the vicinity of the James River; the gravel is composed mainly of chert and silicified carbonate rocks and is often naturally sorted into sizes from pebbles to large cobbles. It is used for repair works on the bitumen sealed Barkly Highway. There are no occurrences of good sand; the ferruginous, and often silty sand, of the desert area is of doubtful value for building purposes. Limestone for calcining is available near Soudan but quarrying operations may be difficult because of siliceous interbeds.

No metal deposits have been reported in this area, but galena occurs in the Camooweal Dolomite in adjoining areas.

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/ This publication is undated, but contains material published in 1957.

APPENDIX

Fossil Lists

Fossil lists from each locality are not yet prepared. A resumé of the forms found in the Wonarah Beds and the Ranken Limestone (Öpik, 1957) is given below.

Wonarah Beds

"Xystridura" browni
Xystridura sp.
Pagetia significans
Oryctocephalus
ptychoparids
Peronopsis sp.
Helcionella
brachiopods.

No Queensland species appear, but the fauna of the Burton Beds is well represented.

Ranken Limestone

Kootenia
Asaphiscus
Peronopsis
Archeocyathus
Biconulites
Hyolithes
Helcionella
Cymbionites
Peridionites
Eocystis
Acrothele
Lingulella
Bohemiella
Nisuia (?)

INTERPRETATION OF DRILLER'S LOGS IN THE AVON DOWNS SHEET AREA.

Plate 1

136°30' 137°00' 30' 138°00'
20°00' 15' 30' 45' 21°00'

N

0 FEET
50
100

0 5 10 MILES

KEY.

- ● SUB ARTESIAN BORE.
- 720' HEIGHT ABOVE SEA LEVEL.
- −397' FIGURES ON L.H.S. REFER TO DEPTH BELOW COLLAR.
- 323'+ FIGURES ON R.H.S. REFER TO HEIGHT ABOVE SEA LEVEL.
- W. LEVEL OF AQUIFER.
- S.W.L. STANDING WATER LEVEL.
- T. IN COLUMNS INDICATES CONSOLIDATED CLAY & SAND.
- CAVE.
- IRONSTONE.

AVON DOWNS No 35
● 720'

35' Black & Red Clay.
White & Grey Limestone
110' Hard limestone with boulders.
170' 550' S.W.L. Grey & Blue Limestones with caves.
290' 420'W. Blue limestone
396'W. with ribbonstone and caves.
366' Black limestone.
−397' 323'+

KILGOUR BORE.
● 765'

14' Alluvium.
Yellow limestone & flint
114' 119' Flint.
Yellow limestone.
511'W.
−298' 467'+

SHAKESPEARE BORE.
● 688'

8' Soil
24' Shale (white & yellow).
58' Red limestone with boulders and ribbonstone
Yellow rock & limestone with boulders & ribbonstone.
120' 135' Red rubble & small boulders.
150' S.W.L. 538'W. Silty limestone.
179' 508' N. Grey limestone.
−184' 504'+

YELLOW BORE No 7.
● 670'

Clay & Shale.
Chert 44' 55'
Shale & Clay. 72'
White limestone 82'
Red Shale & clay. 98'
White & yellow limestone 118'
Yellow Shale. 124'
White limestone 142'
Drift sand 148'
Limestone −172' 539'W. 527' S.W.L. 504'W. 498'+

BLUE BUSH BORE
● 640'

15' 30' Yellow clay. Sandy Shale.
Pipe Clay & Rubble.
83' 86' White flint.
Yellow wash, rubble & boulders.
102' White flint and hard rock.
117' 128' 578' S.W.L. 508'W. Sand rock. Flint & quartz boulders
138' Sand rock.
167' 175' 479'W. Dolomite & ribbonstone limestone. Flint rock.
−178' 462'+

YELLOW BORE No 8.
● 680'

6' Soil
21' White Shale.
Rotten white rock.
Red gravel.
Yellow limestone.
Flint.
Limestone with caves.
110' Boulders.
Limestone.
136' 537'W. Sandstone, ironstone.
150' 534 S.W.L. Shale
167' Sandstone < Drift Sand
519'
469'
−219' 460'+ White pipe clay & and Sand.
Sand rock.

Bureau of Mineral Resources, Geology and Geophysics. April 1962

To accompany Record 1962/56 & 61

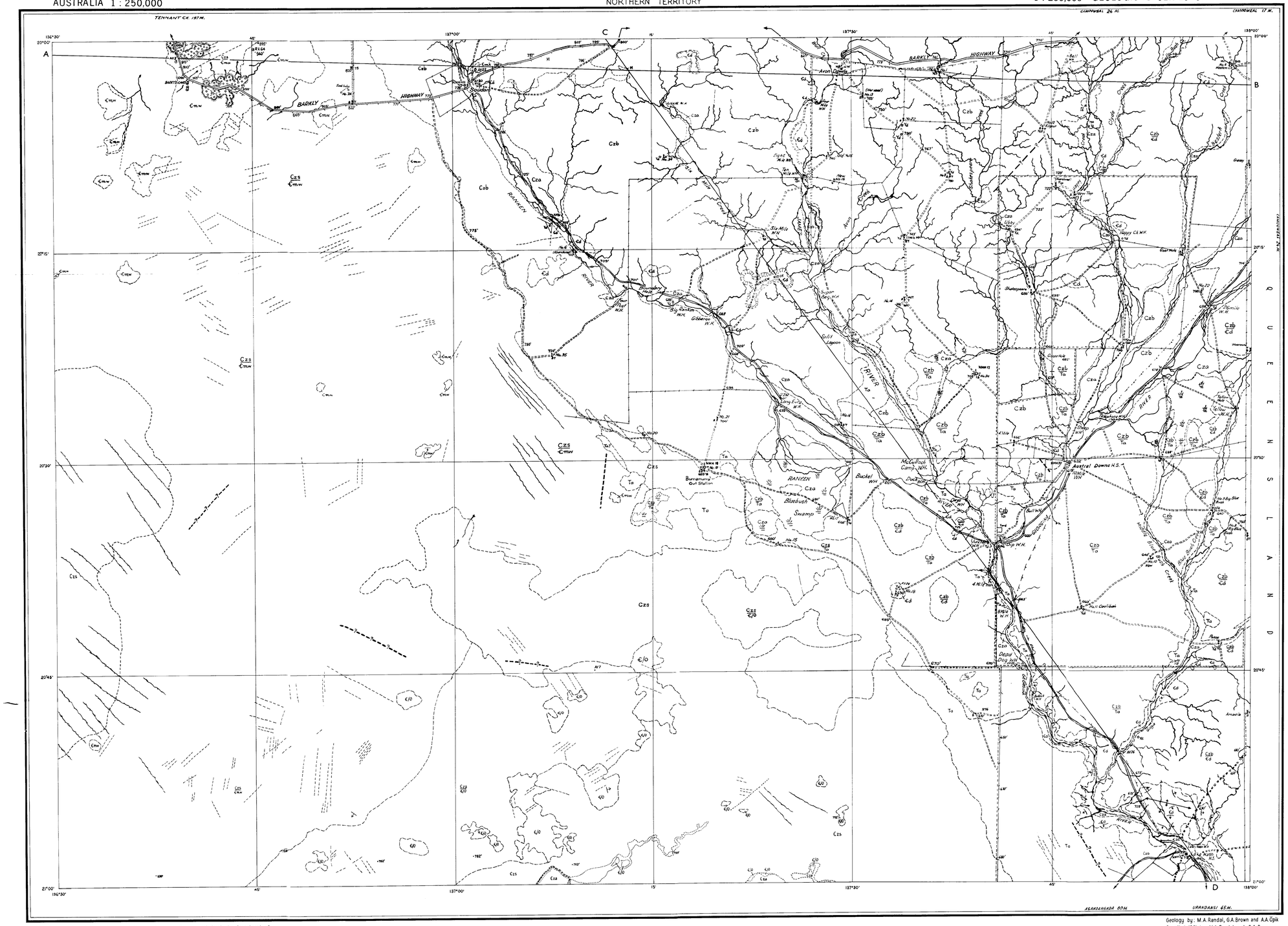
F 53/4/2

AUSTRALIA 1 : 250,000

AVON DOWNS
NORTHERN TERRITORY

1 : 250,000 GEOLOGICAL SERIES SHEET SF 53-4

PRELIMINARY EDITION, 1962 Plate 2
SUBJECT TO AMENDMENT



Reference

CAINOZOIC			Czb	Alluvium and gravel
			Czb	Black soil, clayey soils, minor sand and gravel
			Czs	Residual sand, ferruginous sand and lateritic pellets. Minor black soil and gravel
				Laterite
	Tertiary	Austral Downs Limestone	Ta	White nodular limestone and dolomite, some chert
MESOZOIC		Undifferentiated	M	Quartz sandstone, silicified in part, some pebble conglomerate
PALAEOZOIC	Cambrian – Ordovician	Undifferentiated	€/0	Mainly dolomite, some quartz sandstone
	Middle Cambrian	Wonarah Beds	€mw	Fossiliferous silicified limestone, siltstone, chert, silicified shale, quartz sandstone
		Ranken Limestone	€mk	Fossiliferous oolitic and crystalline limestone some chert nodules
	Cambrian	Camooweal Dolomite	€d	White crystalline dolomite with chert nodules and bands. Some dolarenite and marly interbeds. Minor quartz sandstone lenses

- Geological boundary, position approximate
- Strike and dip of strata
- Horizontal bedding
- Dip < 15°
- Bedding trend lines
- Joints
- Anticlinal fold axis
- Fault concealed
- Fault inferred

(Air photo interpretation)

- Macro fossil locality
- AV 51 Specimen locality and reference number
- •770 Barometric spot height in feet
- Road
- Vehicle track
- Fence
- Telephone line
- HS Homestead
- Yd Yard
- Landing ground
- W.H. Waterhole
- B Water bore
- Abandoned water bore
- Windpump
- T Tank
- Sand dunes
- Astro station

Compiled and issued by the Bureau of Mineral Resources, Geology and Geophysics, Department of National Development. Topographic base compiled by the Division of National Mapping, Department of National Development. Aerial photography by the Royal Australian Air Force; complete vertical coverage at 1:146,500 scale. Transverse Mercator Projection.

INDEX TO ADJOINING SHEETS

Showing Magnetic Declination

ALROY	RANKEN	CAMOOWEAL
FREW RIVER	AVON DOWNS	MT. ISA
ELKEDRA	SANDOVER RIVER	URANDANGI

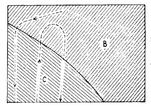
ANNUAL CHANGE 1·0°E

Scale 1 : 250,000

5 0 5 10 15 MILES

5 0 5 10 15 20 25 KILOMETRES

GEOLOGICAL RELIABILITY DIAGRAM



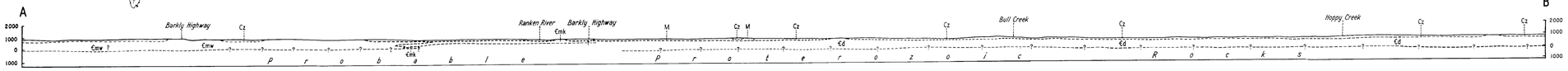
B Detailed reconnoissance - numerous traverses with air-photo interpretation
C Air-photo interpretation
⟶ Helicopter traverses

Geology by: M.A. Randal, G.A. Brown and A.A. Öpik
Compiled 1961 by: M.A. Randal and G.A. Brown
Drawn by: P.J. Brown and G. Matveev

Sections

SCALE (V/H = 1)

A-B



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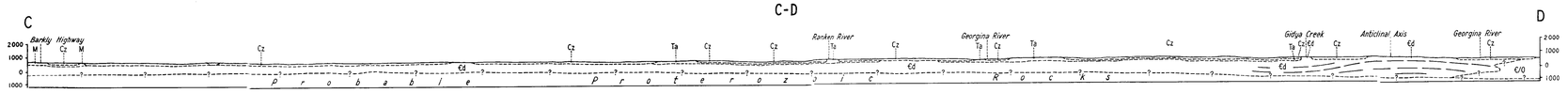

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