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RECORDS 1966/47

GEOLOGY OF THE WISO BASIN, NORTHERN TERRITORY

by

E.N. Milligan, K.G.Smith, R.A.H. Nichols and H.F. Doutch.

The information contained in this report has been obtained by the Department of National Development, as part of the policy of the Commonwealth Government, to assist in the exploration and development of mineral resources. It may not be published in any form or used in a company prospectus without the permission in writing of the Director, Bureau of Mineral Resources, Geology and Geophysics.

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IN SEPARATE FOLDER

THE GEOLOGY OF THE WISO BASIN

SUMMARY

The Wiso Basin occupies about 40,000 square miles between Tennant Creek and Tanami in the Northern Territory. Most of this area is desert, and little was known of its geology before 1965, when a field party from the Bureau of Mineral Resources made a reconnaissance survey and also drilled 10 scout holes. The Bureau also conducted, by contract, a reconnaissance gravity survey in 1965.

The Basin is bounded by the Carpentarian Mount Winnecke Sandstone in the west, by Precambrian arenites, low grade schists, and intrusives in the south-west, by Archaean meta-quartzite, amphibolite, schist and gneiss (Arunta Complex) intruded by granite, pegmatite and quartz, in the south, and by Lower Proterozoic arenites (Hatches Creek Group, Tomkinson Creek Beds and Warramunga Group) in the east. Cretaceous rocks are known to crop out at the northern margin of the basin, but this area has not been mapped.

The sedimentary rocks of the Wiso Basin are of Lower and Middle Palaeozoic age, however, the youngest rocks in most of the Basin are of lower-Middle Cambrian age. In the southern half of the Basin (the Lander Trough), Lower to Middle Ordovician dolomite and sandstone is overlain unconformably by Devonian sandstone. The relationship between the Cambrian and Ordovician rocks is unknown.

The following Palaeozoic rock units were mapped (The ages the units are referred to are the ages of a limited number of fossil assemblages, and indicate only a limited time range for the unit):-

<u>Dulcie Sandstone</u> (?Upper Devonian) - 60 feet. Argillaceous, poorly sorted sandstone and some clean friable quartz sandstone of probably fresh water origin. No fossils. Outcrops limited to the southern part of the Basin. Unconformably overlies Hanson River Beds.

<u>Hanson River Beds</u> (Lower? - Middle Ordovician) - 500 feet estimated. Bioclastic quartzose dolarenite, quartzose microcrystalline dolomite, fine-medium grained sandstone. Often richly fossiliferous, with brachiopods, trilobites, nautiloids and conodonts. Outcrop limited to the southern part of the Basin.

Undifferentiated Lower Palaeozoic rocks - 50 feet. Dark and light grey microcrystalline dolomite, pink quartzose microcrystalline limestones, dolomitic siltstone with halite casts. Outcrop limited to south-west part of the Basin. Overlain unconformably by Dulcie Sandstone.

Merrina Beds (lower Middle Cambrian) - 450 feet+. Crystalline dolomite overlain by dolomitic claystone, siltstone, and fine grained sandstone with thin dolomite beds, overlain in turn, by medium to coarse grain, cross-bedded sandstone. Fossils uncommon - Biconulites, phosphatic brachiopods, trilobites, Chancelloria and Girvanella. Crops out sporadically over northern three-quarters of the Basin; penetrated by all ten Wiso scout-holes.

Montejinni Limestone (lower Middle Cambrian) - 20 feet+. Crystalline dolomite, silty microcrystalline dolomite and limestone, and rare dolomitic siltstone. Fossils - phosphatic brachiopods, Biconulites and eocrinoid plates. Crops out in the central north-west of the Basin and extends north for over 70 miles. Overlain conformably by the upper part of the Merrina Beds.

Antrim Plateau Volcanics (?Lower Cambrian) - 50 feet+. Basaltic flows, agglomerate and tuff cropping out in the north-west corner of the area.

Tentative structural and stratigraphic comparisons made with the neighbouring Georgina Basin, and consideration of the geophysical evidence, indicates that thicknesses of sedimentary rocks in the Lander Trough may be of the order of 10,000 feet or more. A few thousand feet of this is likely to be Adelaidean to Lower Cambrian in age.

Ten scout-holes were drilled across the northern part of the area; the maximum depth was 600 feet. Supplies of water (ranging from 1100 to 3000 parts per million total dissolved salts) of 800 to 6000 gallons per hour were obtained at depths from 100 to 200 feet from aquifers in Middle Cambrian vughy dolomite and friable sandstone, and in ?Tertiary sand, in the northern half of GREEN SWAMP WELL 1:250,000 sheet area.

The probable extent, age, thickness, nature of potential source, reservoir and trap rock, and the environmental-tectonic history of the Lander Trough indicates that this area could be prospective for commercial accumulations of hydrocarbons.

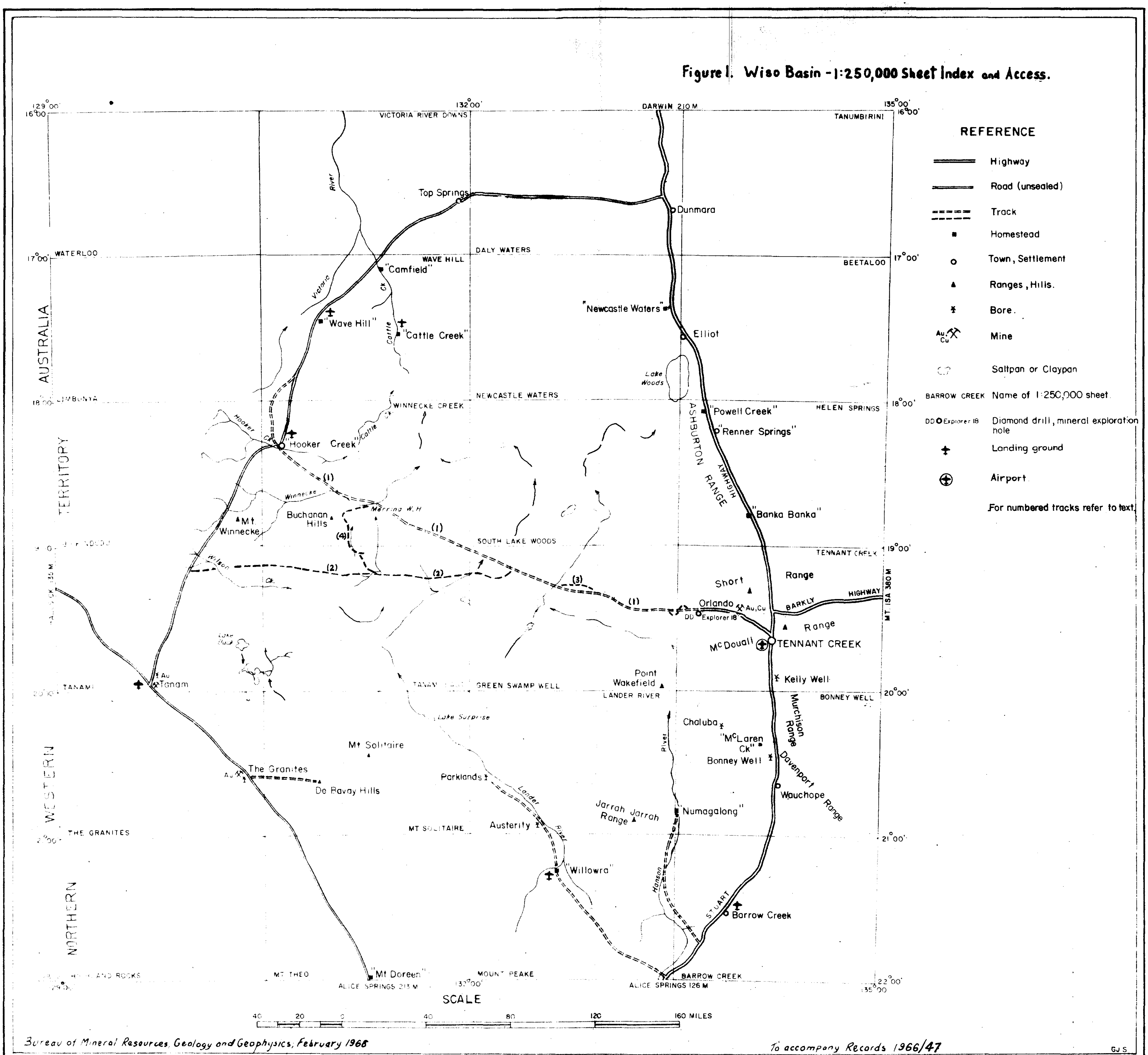


Figure I. Wiso Basin - 1:250,000 Sheet Index and Access.
REFERENCE
Highway
Road (unsealed)
Track
Homestead
Town, Settlement
Ranges, Hills.
Bore.
Mine
Saltpan or Claypan
BARROW CREEK Name of 1:250,000 sheet.
Diamond drill, mineral exploration hole
Landing ground
Airport
For numbered tracks refer to text.
VICTORIA RIVER DOWNS
TANUMBIRINI
WATERLOO
WAVE HILL
DALY WATERS
BEETALOO
NEWCASTLE WATERS
WINNECKE CREEK
HELEN SPRINGS
SOUTH LAKE WOODS
TENNANT CREEK
GREEN SWAMP WELL
LANDER RIVER
BONNEY WELL
THE GRANITES
MT SOLITAIRE
MT THEO
MOUNT PEAKE
BARROW CREEK
DARWIN 210 M
ALICE SPRINGS 213 M
ALICE SPRINGS 126 M
MT ISA 380 M
Top Springs
Dunmara
"Camfield"
"Wave Hill"
"Cattle Creek"
"Newcastle Waters"
Elliot
Lake Woods
"Powell Creek"
"Renner Springs"
ASHBURTON RANGE
HIGHWAY
"Hooker Creek"
"Banka Banka"
Mt. Winnecke
Buchanan Hills
Short Range
Orlando
Explorer 18
BARKLY HIGHWAY
Range
McDouall
TENNANT CREEK
Kelly Well
Point Wakefield
Tanami
Chaluba
"McLaren Ck"
Bonney Well
Murchison Range
Davenport Range
Wauchope
Mt Solitaire
The Granites
De Bavay Hills
Parklands
Lander River
Jarrah Jarrah Range
"Numagalong"
Austerity
"Willowra"
STUART
Barrow Creek
"Mt Doreen"
Lake Surprise
AUSTRALIA
TERRITORY
WESTERN
NORTHERN
SCALE
160 MILES
Bureau of Mineral Resources, Geology and Geophysics, February 1968
To accompany Records 1966/47
GJS

A thin bed of phosphatic pellet dolomite in the Hanson River Beds yielding 10.8 per cent P2O5 is apparently a concentrated pellet deposit and may be limited in extent and very variable in phosphate content.

INTRODUCTION

Location

The area mapped[1] is approximately 40,000 square miles and includes six 1:250,000 Sheet areas, namely Winnecke Creek, Tanami East, Mt. Solitaire, Lander River, Green Swamp Well and South Lake Woods[2], and small areas on Bonney Well and Tanami (fig.1).

Reasons for Survey

In 1962, the results of a B.M.R. aeromagnetic traverse from Gordon Downs to Tennant Creek indicated a depth to magnetic basement of 6,000 feet below sea-level on GREEN SWAMP WELL with a gradual decrease to the known Precambrian margins to the east and west. In 1963, Smith (1963) made two helicopter traverses over GREEN SWAMP WELL and recorded low outcrops of horizontal sandstone with interbedded siltstone and chert. He also examined the air photos of the area and produced a sketch map. He indicated (loc.cit.p.4) that similar outcrops to those on GREEN SWAMP WELL occurred on TANAMI EAST, LANDER RIVER, WINNECKE CREEK, and SOUTH LAKE WOODS; volcanics and steeply dipping Precambrian rocks cropped out on parts of TANAMI EAST. His map (loc.cit.fig.2) indicated possible Upper Proterozoic rocks in north east LANDER RIVER. Following this, a proposal for a programme of shallow drilling in the northern half of the area, and a mapping programme to be done by helicopter was made. The occurrence of Upper Cambrian rocks in a B.M.R. core hole (Grg.18), approximately half way between the Wiso Basin and the Georgina Basin was not considered significant as it was expected that the Upper Cambrian in that area would be a thin cover over basement.

[1] Hereafter referred to as ... the area.

[2] Subsequent reference to 1:250,000 Sheet areas is signified by using capital letters for the geographical prefixes, e.g. WINNECKE CREEK, TANAMI EAST, etc.

Access and Communications

A formed road from Hooker Creek via Top Springs to the Stuart Highway, crosses the extreme north-west of the area. The Hall's Creek - Alice Springs (via Tanami) road crosses the south-west sector of the area, and two station tracks give access to the extreme south of the area, from the Stuart Highway, via Numagalong and Willowra Stations. Other vehicle tracks, useful for navigation by four-wheel drive vehicles are (figure 1):-

(1) from Tennant Creek west-north-west to Hooker Creek Native Welfare settlement, following partly the vehicle tracks of a Department of Interior Survey traverse and partly a track blazed by the staff of the Hooker Creek Native Welfare Settlement. This track has been deeply rutted in places by drilling vehicles;

(2) the Department of Interior Survey tracks which run from the Tanami-Hooker Creek road to its junction with track (1). These tracks have been used by Wongela Geophysical Toyotas and Land Rovers but are less well defined than track (1);

(3) B.M.R. tracks bypassing heavy sand on track (1). The tracks were formed by Land Rovers, Toyotas, and a G.M.C. 'Blitz';

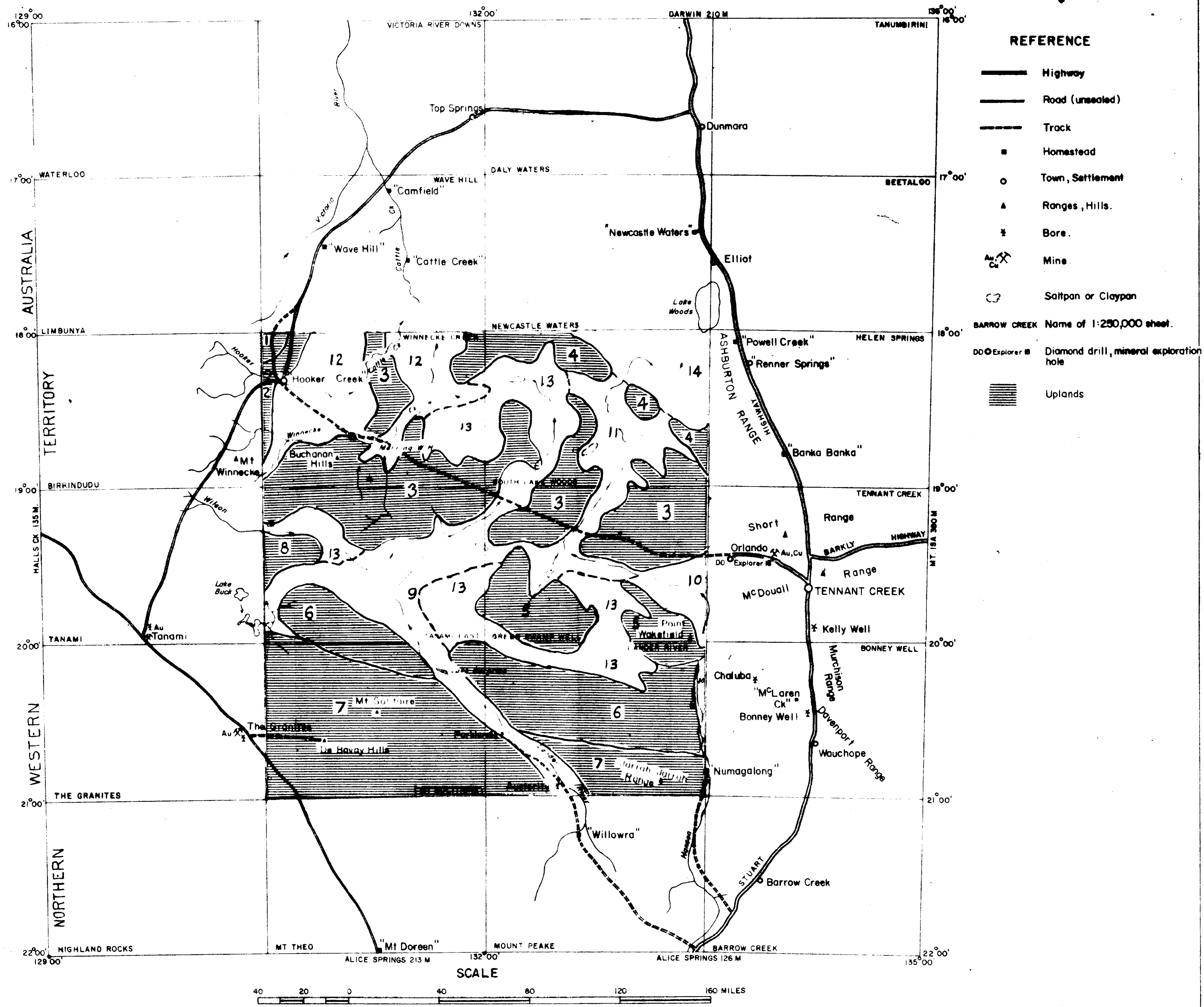
(4) B.M.R. tracks from Merrina Waterhole to track (2). The northern section is dragged in part and used by drilling vehicles as far as the branch off to scout hole T.E.1. The remaining section has been used only by Land Rovers and is indistinct.

Cross country access over most of the area is reasonably good, especially on the gravel rises where vegetation is minimal. However, patches of irregular sandhills surround most of the gravel hill areas; these may extend for some miles and reduce progress to under 3 miles per hour.

Fig. 2.

Wiso Basin - Physiographic Divisions

(for explanation - see text)



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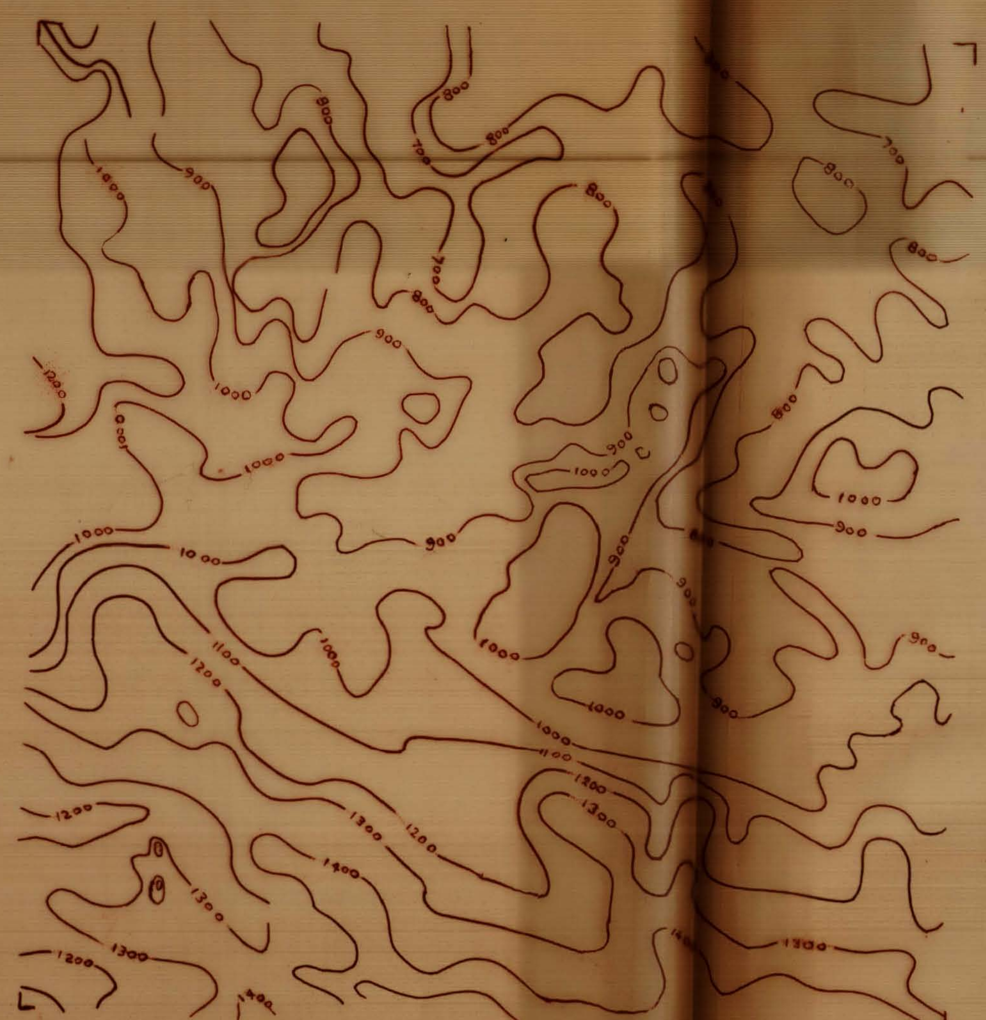


900'

Contour interval 100'; compiled from Gravity Survey elevations on 7mile grid.

Physiography

The following physiographic regions are recognised (fig. 2):-

1. Basalt plateaux country. Basaltic lava flows form a typical lava plateau in the extreme north-west of the area. Dissection of this plateau is slight on WINNECKE CREEK but more extensive further north.

2. Hooker Creek Uplands, north-west of Hooker Creek, comprise a gently undulating sand plain with low rises capped by sandy pisolitic laterite gravel.

3. Winnecke Tableland. (Chewings, 1928). This tableland occupies over 10,000 square miles in the northern part of the area. The altitude ranges from 850 feet in the north to 1,000 feet in the south and 1,200 feet in the south-west. The slopes of most of the tableland are covered by aeolian sand. The higher rises are capped by pisolitic laterite gravel. (In some low lying areas linear parallel sand dunes are still preserved.) In the north-east of GREEN SWAMP WELL and on WINNECKE CREEK, the eastern slopes of the valleys are flanked by scarps up to 60 feet high of pisolitic laterite capped sandstone; the western slopes are sand covered. The Buchanan Hills (fig. 3) and a few isolated mesas some 25 miles east are completely ringed by scarps.

4. Renehan Ridge - Dixon Ridge System is a broad belt of high country trending north-west across the north-eastern sector of SOUTH LAKE WOODS. The eastern hills comprise parallel quartzite ridges up to 900 feet in altitude, alternating with narrow stony alluvial fans and broader plains of aeolian and colluvial sand. The remainder of the Ridge System comprises broad, flat topped sandstone and pisolitic laterite hills with low scarps (rarely up to 60 feet high), which range in elevation from 750 to 850 feet.

5. Point Wakefield Ridge System (south-east GREEN SWAMP WELL) is formed of low sandstone plateaux ranging in elevation from 1,100 feet in the west to 950 feet in the east, capped by pisolitic laterite. Scarps up to 60 feet high occur near the Hanson River; low irregular scarps with scattered alluvial fans along their margins occur along the northern flanks of the Ridge System. The southern and western flanks are partially or wholly covered with aeolian sand.

6. Lander Plateau trends west-north-west across the area. The altitude of the plateau ranges from 1,100 to 1,300 feet. The slope of the northern flank falls off within 2 miles to under 900 feet. Irregular and reticulate dunes, with some mobile sand patches are the highest dunes in the area (up to 125 feet high) and cover most of the outcrop (figure 4), which in places forms steep sandstone scarps or low dolomite hills. The latter are dissected by soil filled valleys with entrenched creeks. At the eastern end of the Lander Plateau, very low shale and dolomite hills and mesas are capped in places by Tertiary limestone and chalcedony.

7. Hanson - Lander Plains (Mabbutt, 1965) are mostly sand covered in the east; only a few tors of crystalline rocks and ridges of reef quartz rise above the sand. In the south and west, broad areas of mulga covered plains with very low rocky rises and few high hills occur.

8. Wilson Creek Plateau (west TANAMI EAST) is a sand covered area bordered by very low (30 feet maximum) scarps of laterite, one of which is continuous for ten miles.

9. Lander River Flood Plain varies from one to three miles wide in its middle reaches and broadens considerably in its lower reaches, showing the effect of large scale ponding, e.g. Lake Surprise. Later ponding on a smaller scale is caused by encroachment of sand dunes.

10. Hanson River Flood Plain is similar to that of the Lander River in the south, but sand encroachment has virtually obliterated the lower flood plain. Extensive sinkhole development is indicated by circular depressions in the thinner sand cover.

11. GREEN SWAMP WELL - SOUTH LAKE WOODS Drainage System comprises numerous disconnected claypans and short irregular drainage channels that trend west-north-west and east-north-east.

12. Winnecke Creek - Cattle Creek Plains comprise broad flat or gently undulating lowland sand plain dissected by the Winnecke Creek and Hooker Creek - Cattle Creek drainage channels. These channels vary from sandy creeks incised in alluvium to broad silt flats with intermittent water holes occupying areas of pisolitic laterite outcrop.

13. Lowland Dunefields occur south-west of Point Wakefield, between the Hanson and Lander Rivers, and in the lower plains of the Wilson, Hooker and Winnecke Creeks. The dunes are

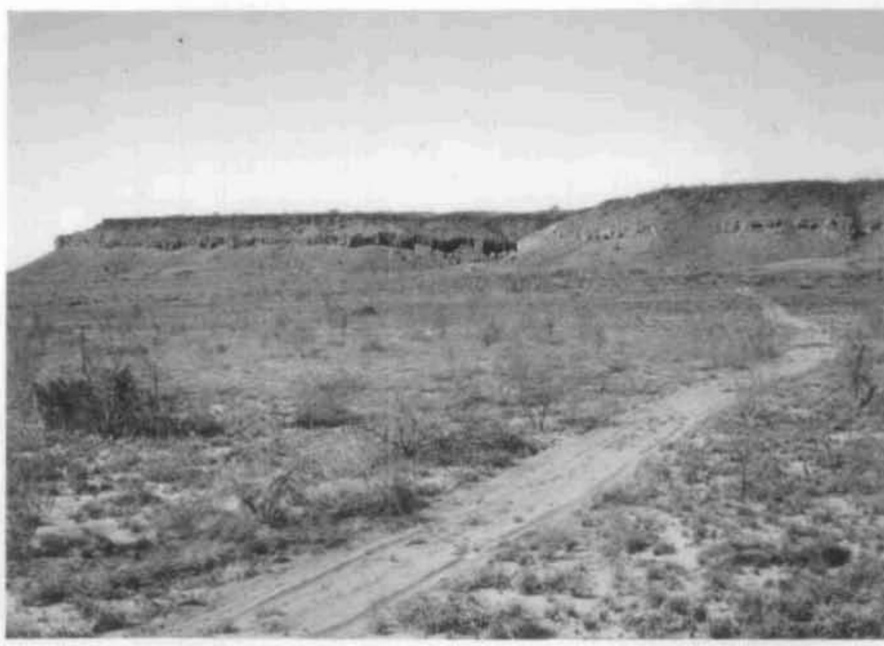
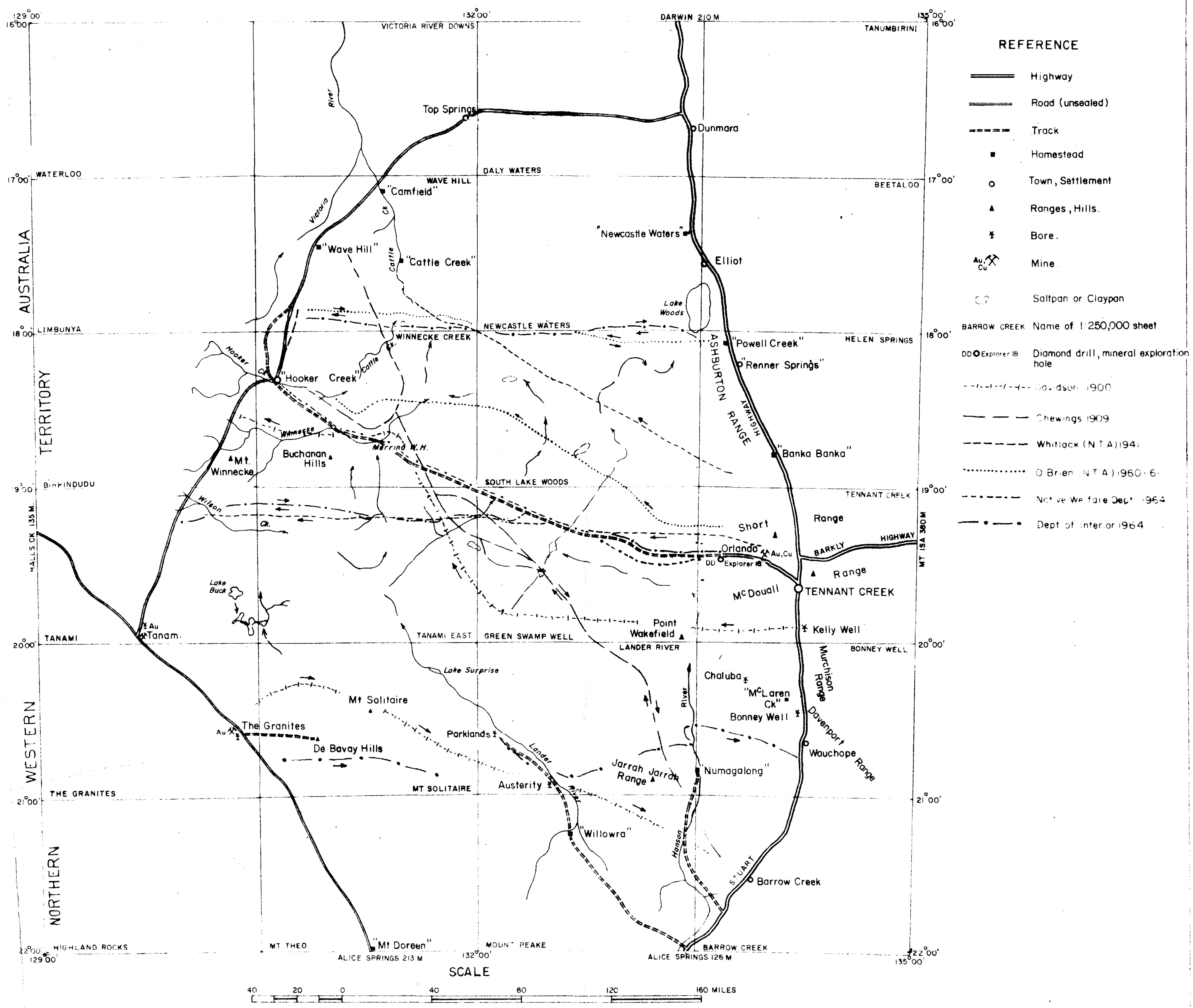


Figure 3. Buchanan Hills, WINNECKE CREEK, showing scarp formation at base of deep weathering profile. Dark band at top of hill is 40 feet of pisolitic laterite. Neg. No. G/8753.

Figure 4. High (over 80') irregular sand dunes, Lander Plateau, north-east MOUNT SOLITAIRE. Neg. No. G/8757.

Figure 5. Wiso Basin-Routes of Surface Geological Topographic and Land Surveys.



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To accompany Records 1966/47

parallel and linear, with broad, flat, sandy swales. In the Hooker Creek, Winnecke Creek, and Wilson Creek areas, the dunes are low and widely spaced (1½ miles or more apart); in the south-eastern areas, the dunes are higher (up to 20 feet) and broader, with defined crests, and with correspondingly narrow swales (seldom more than ½ mile apart). Irregular dunes and sand hills fringe the eastern margins of the more extensive areas of outcrop.

14. Lake Woods Plains comprises undulating sand plain with low parallel dunes bordering plains of old lake deposits.

Vegetation

Spinifex and occasionally acacias provide the vegetation cover over most of the area, although thick stands of a spindly wattle cover some sandhill areas. Mulga stands are restricted to local areas in the south and south-west. Thick turpentine scrub occurs only in the northern areas. Teatree and blue bush are common in the GREEN SWAMP WELL - SOUTH LAKE WOODS Drainage System. Tall eucalypts line drainage channels in the area, and are scattered over the floodouts of the larger creeks and rivers.

Previous Investigations

A number of surveyors, but only two geologists, had previously crossed the area (figure 5). The first was Davidson (1905), who in 1900 traversed from Kelly Well, on the Stuart Highway, to Western Australia and returned to Barrow Creek. He made passing references to ferruginous sandstone and ironstone conglomerate (almost certainly pisolitic laterite), and described and figured a section at Buchanan Hills of 50 feet of conglomerate capping 200 feet of sandstone and limestone. He also recorded granite and 'iron saturated' schist from the southern part of the area.

In 1909, Chewings (1928, 1931) was commissioned to sink a series of wells for a proposed stock route from Barrow Creek to Wave Hill. He observed the Devonian sandstone in the northern part of LANDER RIVER. He noted (loc. cit. 1931, p.323) that the sandstone was '... much disturbed and fractured in places though its general position was more or less horizontal.' He suggested the sandstone was Palaeozoic and possibly Cambrian. He also described the sandstone and shale of the northern part of the area and considered it to be a distinct formation which he named the Winnecke Creek Tableland Formation (now named the Merrina Beds). He considered the Formation to be younger than the sandstone on LANDER RIVER due to its apparent superficial nature, '... in no case, notwithstanding that the Tableland Formation covers such extensive areas of country, did it appear to have had any great vertical dimensions' (1931, p.9).

He also examined the Middle Cambrian limestone and siltstone (Montejinni Limestone) where it underlies the Winnecke Tableland Formation (Merrina Beds) in the extreme north of WINNECKE CREEK. Because of the folding in the beds (actually slump folding), he believed them to be unconformable under the essentially flat Winnecke Tableland Formation, and probably correlatives of Devonian limestone in Western Australia.

Wade (1924), published a map which included the western part of the area. He erroneously showed granite outcrops at 131° east and 18° 30' south. The basis for this was probably the map of the Northern Territory (Winnecke, 1898), referred to by Davidson (1905,p.70) as showing metalliferous, high mountain ranges in the vicinity of Buchanan Hills.

In 1937, Hossfeld (1938a) made a brief reference to scattered outcrops of potentially metalliferous rocks between The Granites and Tennant Creek. In 1937, he also sampled auriferous reefs in an area 35 miles south of Tennant Creek and 10 miles west of the Stuart Highway, and named this area the Wiso Area (Hossfeld, 1938b). Later, (1954, p.134) he used the name Wiso Tableland for '... the large unmapped area bounded by Newcastle Waters, Wave Hill, The Granites and Barrow Creek, believed to be underlain by Cambrian sediments'. He presumed a northwards continuation of these sediments joining the Buldiva (Daly River) Basin, the whole constituting the Buldiva - Wiso Basin.

In 1940, J. Whitlock, a Northern Territory Administration surveyor, dragged two tracks across the area, and in 1960 and 1961 V. O'Brien, also of the N.T.A., traversed the area in search of grazing country (figure 5). He named some physiographic features on SOUTH LAKE WOODS including Renehan Ridges and Dixon Ridge.

In 1959, Phillips (1959) flew over the Tanami Desert and recorded outcrops of more or less flat lying sandstone in the south of TANAMI EAST, and crystalline rock further south.

In 1963, Smith (1963), made two helicopter traverses into the eastern part of the area and recorded low outcrops of horizontal sandstone interbedded with siltstone and chert.

In 1960, the Geophysical Branch of the B.M.R. ran airborne magnetometer and radiometric traverses which covered the eastern third of GREEN SWAMP WELL (Spence, 1962). The magnetic intensity was found to be of low relief. Also the Tomkinson Creek Beds were found to be effectively non-magnetic in this area. In 1962, one aeromagnetic traverse (unpublished B.M.R. map) from Gordon Downs to Tennant Creek passed across the northern part of GREEN SWAMP WELL. Interpretation of the results showed that the maximum depth to basement was of the order of 6,000 feet below sea level in the central northern part of GREEN SWAMP WELL.

In 1964, Aero Service Limited flew an aeromagnetic survey over the Wiso Basin area for Exoil Oil Company Limited (Zarzavatjian and Hartman, 1964). The depth to basement estimations were possibly affected by interference patterns from minor magnetic horizons.

A photo-interpretation of the area was prepared by the photogeological section of the B.M.R. (Rivereau and Perry, 1965).

In 1965, Wongela Geophysical carried out a helicopter gravity survey which included the Wiso Basin, under contract to the B.M.R. (Flavelle, 1965). Preparatory levelling was carried out by Department of Interior surveyors in 1964. An extremely large gravity minimum was located trending west-north-west across LANDER RIVER and the north-eastern part of MOUNT SOLITAIRE.

Survey methods

Officers in the field party were K.G. Smith, E.N. Milligan, R.A.H. Nichols and H.F. Doutch. The survey was carried out by helicopter traverse over a period of 33 days, and outcrops were plotted on aerial photographs at a scale of 1:46,000 and 1:50,000. The aerial photographs were taken in 1949 by the R.A.A.F. Air photo-interpretation maps were also used as guides and were provided by the photogeological section of the Bureau of Mineral Resources. Ground support was by Land Rovers and two four-wheel drive 3 ton trucks. Shallow scout-holes were drilled on an east-west to north-west line across the northern part of the area, concurrently with the helicopter survey. The scout-holes were designed to obtain geological information in areas of sand cover along most of the route surveyed by the Department of Interior. Five scout-holes were drilled on GREEN SWAMP WELL (GSW 1 - 5), one on TANAMI EAST (TE 1), and four on WINNECKE CREEK (WC 1 - 4). (figure 6). Thin sections were examined and described by R.A.H. Nichols.

Oil Permit Boundaries

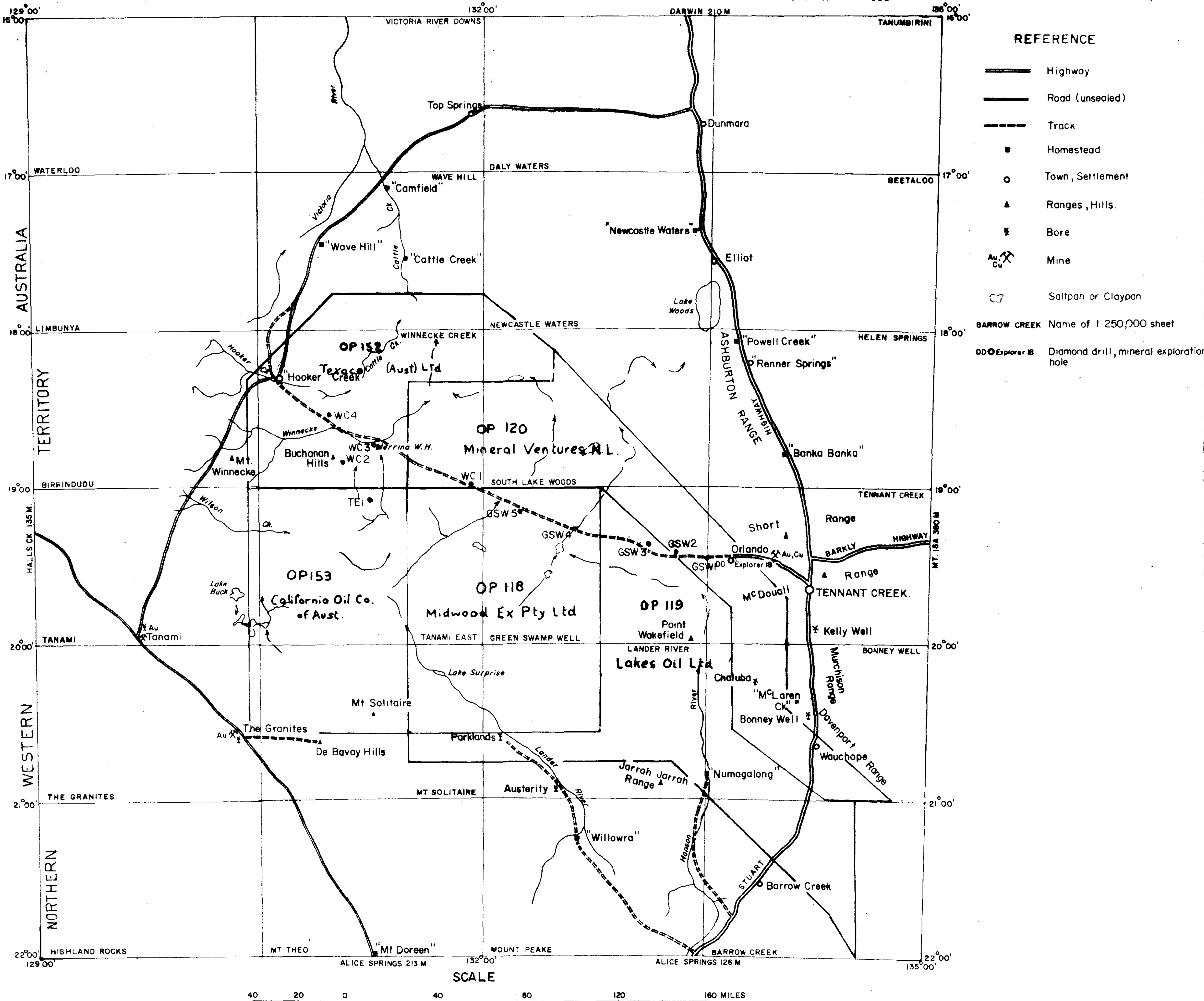
Most of the area is covered by five Oil Permits (figure 6).

Water Supplies

A number of water holes have developed in impervious pisolitic laterite on Hooker Creek and Winnecke Creek and its tributaries, and retain water for some months after heavy rain. A few in the lower reaches of Winnecke Creek may be semi-permanent. A number of claypans also hold water for some weeks after moderate falls of rain (in the order of one to two inches). Chewings (1931) obtained water from depths of six feet, near a series of native wells sunk in sandstone with a thin cover of kunkar, in the northern part of LANDER RIVER. He also obtained water from shallow depths near claypans in the southern part of the GREEN SWAMP WELL - SOUTH LAKE WOODS drainage system (B.M.R. scout hole G.S.W. 4 drilled on this drainage system, encountered a seepage of water at 21 feet).

Two bores on Willowra Station are drawing water from the Lander River basin in the extreme south of the area. One bore on Numagalong Station is drawing water from alluvium of the Hanson River basin. Hooker Creek Native Welfare Settlement has three domestic and two pastoral bores on WINNECKE CREEK. (Appendix 2).

Figure 6 Wiso Basin — Oil Permit Boundaries and location of Scout-holes



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STRATIGRAPHY

The Precambrian rocks were studied only cursorily and, following current B.M.R. practice, were divided into undifferentiated Precambrian, Archaean, Lower Proterozoic and Carpentarian. Adelaidean includes all rocks which are time correlations of the sediments in the Adelaidean Geosyncline, above the base of the Willouran Series, and below the base of the Cambrian - the tentative age of the base of the Willouran Series is 1400 million years. The Carpentarian includes all rocks which are time correlates of the sequence above the base of the Cliffdale Volcanics, and below the base of the Adelaidean, in the Carpentaria area of the Northern Territory. The age of the base of the Carpentarian is about 1800 million years. Rocks which were deposited between the top of the Archaean and the base of the Carpentarian are tentatively referred to as Lower Proterozoic.

The Palaeozoic sequence was subdivided and units were grouped into the Montijinni Limestone, Merrina Beds, Hanson River Beds, undifferentiated Lower Palaeozoic, and Dulcie Sandstone. Sandstone, grey travertinous limestone and pisolitic laterite, thought to be of Tertiary age, was not named.

The nomenclature of the sedimentary rocks described in this record follows Folk (1964).

General distribution of the stratigraphic units

The known Precambrian and Palaeozoic succession differs in the various parts of the basin; the succession is summarised below.

1. Eastern marginal area: Merrina Beds - sandstone, siltstone, claystone and chert, overlying fossiliferous Lower Middle Cambrian dolomite - unconformably overlies Tomkinson Creek Beds ortho-quartzite of probable Lower Proterozoic age. (In the subsurface, the dolomite overlies a sandstone which may be the Tomkinson Creek Beds or a younger un-named unit).

2. Central area: Merrina Beds - sandstone, siltstone and claystone with rare fossiliferous Lower Middle Cambrian dolomite interbeds were the only rocks identified.

3. Northern area: Merrina Beds - unfossiliferous sandstone, siltstone and claystone - conformably overlie fossiliferous Lower Middle Cambrian dolomite (Montejinni Limestone).

4. North-western area: ?Merrina Beds - sandstone and chert - overlie (unfossiliferous) ?Lower Cambrian Antrim Plateau Volcanics with apparent conformity.

5. Western marginal area: Merrina Beds - sandstone - unconformably overlie probable Carpentarian arenites, and intrusives of Precambrian age.

6. South-west area: Grey dolomite and red, sandy limestone, possible time correlatives of the Merrina Beds (or possibly the Ordovician Hanson River Beds) are overlain unconformably by unfossiliferous sandstone correlated with the Devonian Dulcie Sandstone of the Georgina Basin. Precambrian arenites and low grade schists crop out to the west, and apparently have fault contacts with these younger rocks.

7. Southern area: Hanson River Beds - fossiliferous sandstone and dolomite of Middle, and perhaps Lower Ordovician, age - are overlain unconformably by the Devonian Dulcie Sandstone. Gneisses similar to Arunta Complex types, intruded by quartz and pegmatites, are apparently faulted against the Dulcie Sandstone at its southern boundary. The relationship of the Hanson River Beds to the Merrina Beds is unknown. The regional dip in this area is to the south-south-west, so that the Merrina Beds may dip under the Hanson River Beds. However, nothing is known of the nature or age of the rocks between the two Formations or of the complete time range of either the Hanson River Beds or the Merrina Beds.

PRECAMBRIAN

Arunta Complex

Mawson and Madigan (1930) proposed the name Arunta Complex for the Precambrian igneous and metamorphic rocks of the MacDonnell Ranges, Central Australia, and traced their extent north to Barrow Creek, some 50 miles south-east of the area. Out-crop in the south of LANDER RIVER and in central MOUNT SOLITAIRE comprises rock types similar to those known from the Arunta Complex. These include metaquartzite, porphyroblastic biotite - quartz -

feldspar gneiss, mica schist, and hornblende - feldspar amphibolite. No age determinations are available for the Arunta Complex, and at present the age is regarded as ?Archaean.

Warramunga Group

The Warramunga Group (Ivanac, 1954) crops out in the northern half of BONNEY WELL (Smith, Stewart and Smith, 1961). The rocks are low grade metamorphics, sandstone, greywacke siltstone, shale, red and black banded chert and rhyolite. They are intruded by basic igneus rocks, acid porphyry and microcline granite. The age of the Group is Lower Proterozoic.

Hatches Creek Group

The Hatches Creek Group crops out in most of the eastern half of BONNEY WELL and trends north-west into the western half (Smith, Stewart and Smith, 1961). The rocks are mainly thin to medium bedded, medium to coarse grained, silty, silicified quartz sandstone intruded by basic igneus rocks, quartz - feldspar porphyry and other acid and intermediate rocks, and by granite. The age of the Group is Lower Proterozoic (Walpole and Smith, 1961).

Tomkinson Creek Beds

The Tomkinson Creek Beds (Randal, Brown and Doutch, 1966) crop out in two areas:

(i) near the central eastern margin of SOUTH LAKE WOODS; and

(ii) in the south-eastern corner of SOUTH LAKE WOODS, and north-eastern corner of GREEN SWAMP WELL (continuing onto north-western TENNANT CREEK).

(i) The rocks in this area are medium to coarse grained quartz sandstones.

(ii) Similar rocks with pebbly and cobbly beds crop out on the western side of the northern extremity of this area. Here, they are separated by a north-west trending fault from probably younger, fine to medium grained quartz sandstone. In the southern part of this area (on TENNANT CREEK), higher beds in this sequence contain clay and silt flakes and blebs. Ripple marks are common; some beds are silicified. The same broad stratigraphic succession occurs on HELEN SPRINGS (Randal, Brown and Doutch, 1966). The two areas form part of a limb of a major north-west trending syncline disrupted by many normal faults, causing repetition of the beds in the southern area. Lithological similarities suggest a correlation with the Hatches Creek Group, and hence, a Lower Proterozoic age (K.G. Smith, pers. comm.).

Mount Winnecke Sandstone

Traves (1955) described poorly sorted, coarse-grained sandstone and fine conglomerate with pebbles of quartz, chert and greenstone, cropping out on BIRINDUDU; he named these rocks the Mount Winnecke Sandstone. Over 140 feet of similar sandstone crops out in a hill at the north-west margin of TANAMI EAST, 30 miles south-east of Mount Winnecke. It is identified as Mount Winnecke Sandstone. The structure of the outcrop is a peri-syncline with its long axis striking at 360°; dips range from 5 to 12 degrees.

The rock is cross bedded with alternating dark grey and lighter purple - grey laminae. In hand specimen the rock is a coarse, siliceous, lithic, quartz sandstone with sub-rounded, poorly sorted, quartz grains, and rounded, red grains of ?jasper and black ?tourmaline grains. The cement is siliceous; the time of silicification cannot be determined. The age is probably Carpentarian (Dunn 1965).

Undifferentiated Precambrian rocks.

These include steeply dipping greywacke and low grade schist in the south-west corner of TANAMI EAST, highly ferruginised arenites and low grade schist at DeBavay Hills, MOUNT SOLITAIRE and various intrusive rocks, for example, quartz - biotite-feldspar granite, quartz - feldspar - biotite granite, quartz - feldspar - hornblende - biotite granite, fine and coarse grained biotite - feldspar pegmatite, mica - tourmaline - quartz pegmatite, garnet and muscovite bearing aplite and tourmaline and muscovite bearing reef quartz. The larger quartz reefs apparently have a preferred orientation of west - north - west in the eastern part of the area, and north - west in the western part of the area, that is, approximately paralleling the basin margin.

Some of the pegmatites on MOUNT SOLITAIRE may be sources of muscovite, and they warrant investigation if future supplies of Australian mica are sought. The most prospective area is about 20 miles east-north-east of MOUNT SOLITAIRE and is accessible by four-wheel drive vehicles. In this area, numerous quartz-feldspar-tourmaline-muscovite pegmatites are concordant with ?Archaean schist; muscovite is abundant in books measuring 6 inches by 4 inches, and most of the pegmatites are zoned with prominent quartz cores. The width of the pegmatites ranges from 1 foot to 50 feet, and length ranges from 30 to 200 feet. The largest pegmatite was about 120 feet long and 50 feet wide.

Another area where numerous pegmatites crop out is about 30 miles east of MOUNT SOLITAIRE. In this area, quartz-feldspar-tourmaline-muscovite pegmatites occur as veins in granite. Muscovite is abundant in the pegmatites, but the books are small. The pegmatites strike at 320 degrees, and are 1 foot to 3 feet wide and up to 300 feet long.

PALAEOZOIC

Antrim Plateau Volcanics

David (1932) defined the Antrim Plateau Volcanics. They consist of basalt flows and some agglomerate tuffs. According to Traves (1955) they unconformably overlie Upper Proterozoic sedimentary rocks and appear to be conformably overlain by Middle Cambrian sedimentary rocks.

Montejinni Limestone

Traves (1955) mapped and named the Montejinni Limestone. A section at Montejinni Homestead, 150 miles north of Hooker Creek, consists of 40 feet of thick bedded to massive, fine to coarse crystalline limestone, with abundant chert nodules, overlain by 20 to 40 feet of thick bedded, finely crystalline limestone with rare chert nodules. Traves mapped the extention of the limestone to within 15 miles of WINNECKE CREEK. The only fossils found were abundant Girvanella.

Thin to medium bedded quartzose microcrystalline limestone and dolomitic micaceous quartz siltstone and fine to medium crystalline dolomite, cropping out in the north and north-east part of WINNECKE CREEK, are mapped as Montejinni Limestone. Outcrop is scattered and is seldom more than 10 feet thick. In the upper reaches of Cattle Creek these rocks crop out in topographic depressions below low scarps of Merrina Beds sandstone and siltstone.

Two samples were examined and described as follows:

WB 9. Quartzose micrite

Hand specimen: grey-brown with light brown and tan mottling, dark grey manganese? spots, some layering, small pin-hole vughs, hard.

Thin section (fig. 7): Grains. 10-20%, quartz silt, approximately 50 microns in size, sub angular, lath shaped, clear, well sorted; clay minerals or mica flakes; discontinuous patches and layers of quartz and mica silt alternate with calcilutite. Some limonite staining.

Matrix. 80-90%, cryptocrystalline to microcrystalline calcite, partly recrystallised, and unwinnowed.

Origin. Accumulated in low energy conditions, possibly in a sheltered or protected part of a lagoon; periodic storms may account for transport and deposition of silt and clay. Calcilutite may have formed by precipitation, abrasion of fossils, or from transport from adjacent areas (Cloud, 1962).

WB 10. (Fig. 8). Quartzose micrite.

As above; but with 40-50% quartz silt, well sorted, scattered throughout calcilutite matrix; rare mica or clay minerals; rare feldspar. This type may represent a deposit formed under more turbulent conditions. Phosphatic brachiopods, echinoderm fragments and Biconulites are common in some of the more silty, microcrystalline limestone beds.

Age: The fossils have been examined by Dr. A.A. Öpik, Canberra, and by C. Gatehouse (B.M.R.). An Acrothele Linnarsson, 1876, of upper Lower to middle Middle Cambrian aspect is present along with Biconulites s.l. and eocrinoid plates. The age of this fauna is most likely to be lower Middle Cambrian (pers. comm., C. Gatehouse).

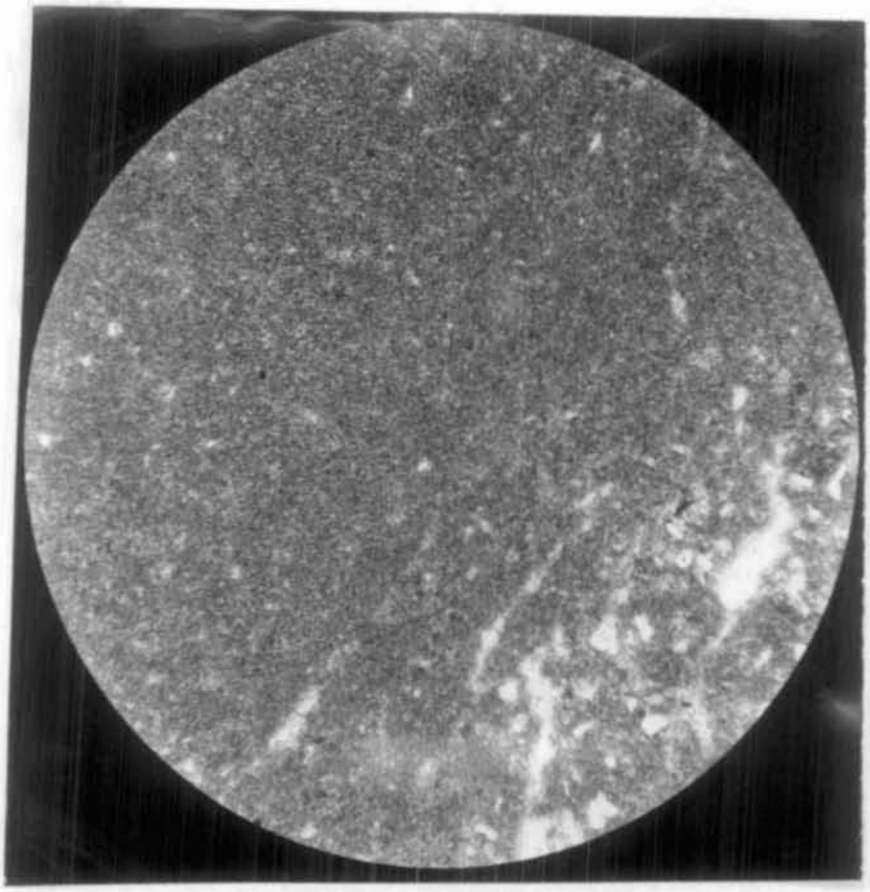


Fig. 7 Microcrystalline limestone (X30); Montejinni Limestone. Sample No. WB9. Negative No. G/8749.

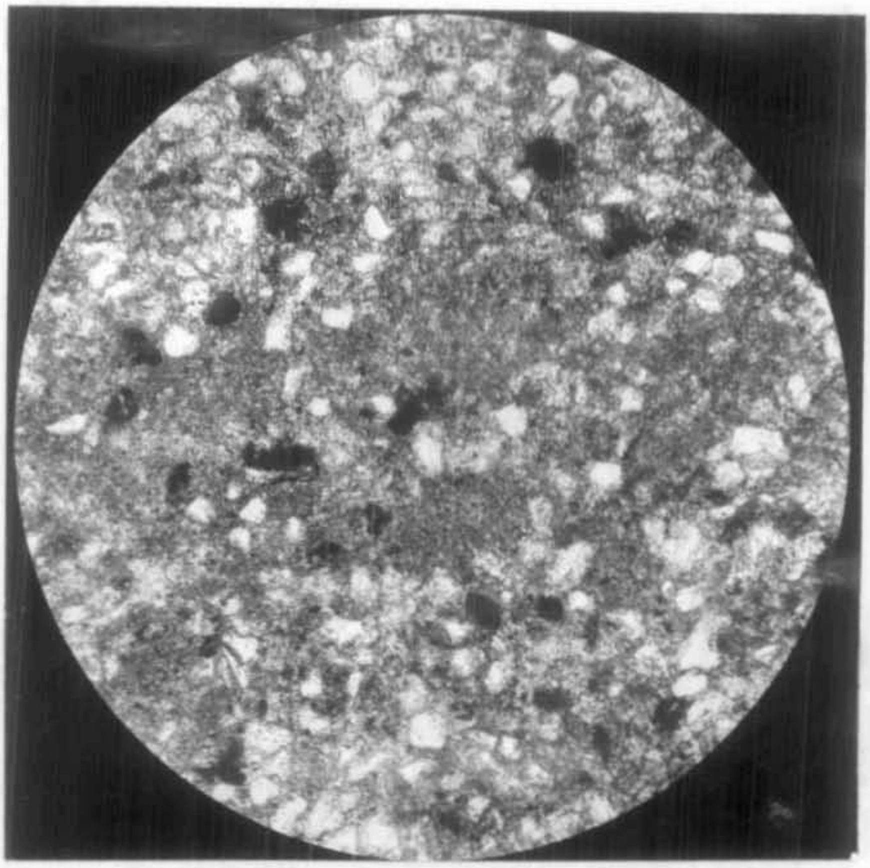


Fig. 8 Quartzose microcrystalline limestone (X40); Montejinni Limestone. Sample No. WB10 Neg. No. G/8739.

Fig. 9 Cross-lamination in fine grained dolomitic sandstone, Merrina Beds, 1 mile east of Buchanan Hills, WINNECKE CREEK. Neg. No. G/8752.

Fig. 10 ?Girvanella in algal dolomite, Merrina Beds. Sample No. WB1, 4 miles east of Buchanan Hills. Neg. No. G/8755.

Merrina Beds (New Name)

The Merrina Beds are named from Merrina Waterhole on Winnecke Creek where scout hole W.C.3 penetrated 132 feet of siltstone and claystone of the Merrina Beds.

The Merrina Beds crop out sporadically in GREEN SWAMP WELL, SOUTH LAKE WOODS, WINNECKE CREEK and TANAMI EAST. Most outcrops are small in extent and thickness and many have been strongly ferruginised. The best outcrops are in the south-east and north-east of GREEN SWAMP WELL and in the south of WINNECKE CREEK, bordering the valleys of Winnecke Creek and its tributaries. Rock types range from medium-bedded, cross-bedded, poorly-sorted, granular sandstones to algal dolomite; all the rocks were deposited in shallow water.

The areas of better outcrop visited were:-

WINNECKE CREEK

Buchanan Hills: The lower part of the section was not measured, however, the following approximate thicknesses were observed:

Top:	40 feet;	pisolitic laterite
	90 feet;	deeply weathered siltstone
	20 feet;	massive white and pink claystone with some micaceous siltstone laminae
	50 feet;	pink, red, red-brown fine grained sandstone, siltstone and claystone with rare thin argillaceous dolomite beds
	10 feet;	grey and blue grey dolomitic fine grained sandstone and siltstone, cross-laminated, with scour and fill, undulate bedding, and slump structures (fig. 9).
	50 feet;	unexposed.
	20 feet;	dolomite, mostly travertinised, one three-inch bed with common to abundant Girvanella (fig. 10), brachiopods and Biconulites.

A sample (WB 1) of the algal dolomite (figs. 10 & 11) was examined and described as follows:

WB 1 Algal dolomite

Hand specimen. Grey-brown with undulating purple layers, spherical and oval algal nodules with concentric layering around detrital nuclei; bioclastic fragments, vughy, hard.

Thin section. Grains 70%, algal nodules (pisolites or oncolites), Biconulites, brachiopod, ostracod? and Echinodermata fragments. Algal nodules, average size 2 cms., oval to spherical, anhedral, medium crystalline dolomite with dark inclusions of cryptocrystalline dolomite (relict algal layering?). No evidence of tubes or filaments.

Fossil fragments occur between algal nodules, and many shell-like fragments and possible tubes have been recrystallised by dolomitisation; others, including Echinodermata fragments, are partly or wholly replaced by microcrystalline and fibrous silica.

Matrix. 30%, the grains occur in a mosaic of microcrystalline dolomite, most crystals have inclusions of finer dolomite, giving a cloudy appearance.

Origin. The algal nodules may represent Girvanella nodules or oncoliths. It is impossible to tell if the concentric layers were composed of tubes or cryptocrystalline carbonate (Logan, Rezak, and Ginsburg, 1964). The nodules formed in shallow warm water in the photosynthetic zone, either by the growth of Girvanella around fossil fragments, possibly in mud, or by the growth of an algal mat around a detrital core, during continuous movement. (loc.cit.). Other bioclasts were probably trapped between the nodules which prevented winnowing. Dolomitisation probably occurred at a late stage in diagenesis as the crystalline mosaic obliterates most of the original textures, whereas early stage dolomitisation tends to preserve original textures.

Scout hole WC 2 penetrated additional very fine grained sandstone, siltstone and claystone below the algal dolomite horizon.

Water hole 9 miles south-east of W.C.2: The sequence comprises -

20' medium bedded, fine grained, pink and buff, micaceous sandstone, interbedded with buff siltstone, and white and purple, mottled claystone; one claystone bed

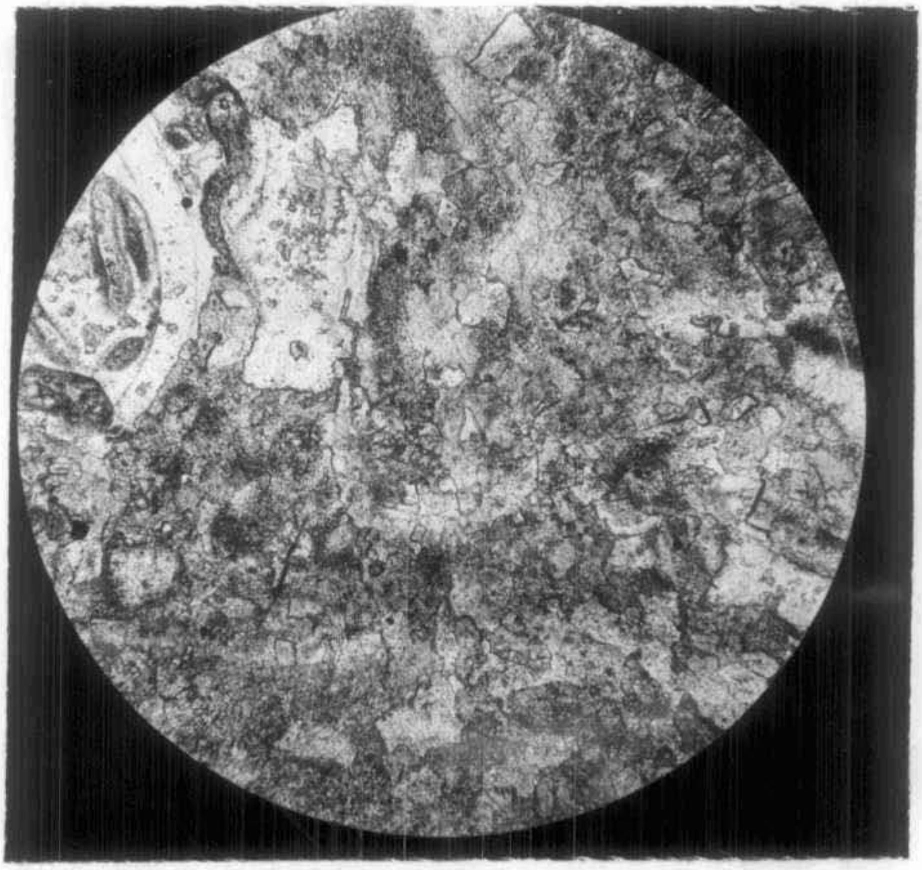


Fig. 11 Algal dolomite (Girvanella?) with bioclasts (X45), Merrina Beds. Sample No. WB1. Neg. No. G/8741

Fig. 12 Concentric ?shrinkage cracks around 'mud balls' in claystone; Merrina Beds, 10 miles south-east of Buchanan Hills. Neg. No. G8756.

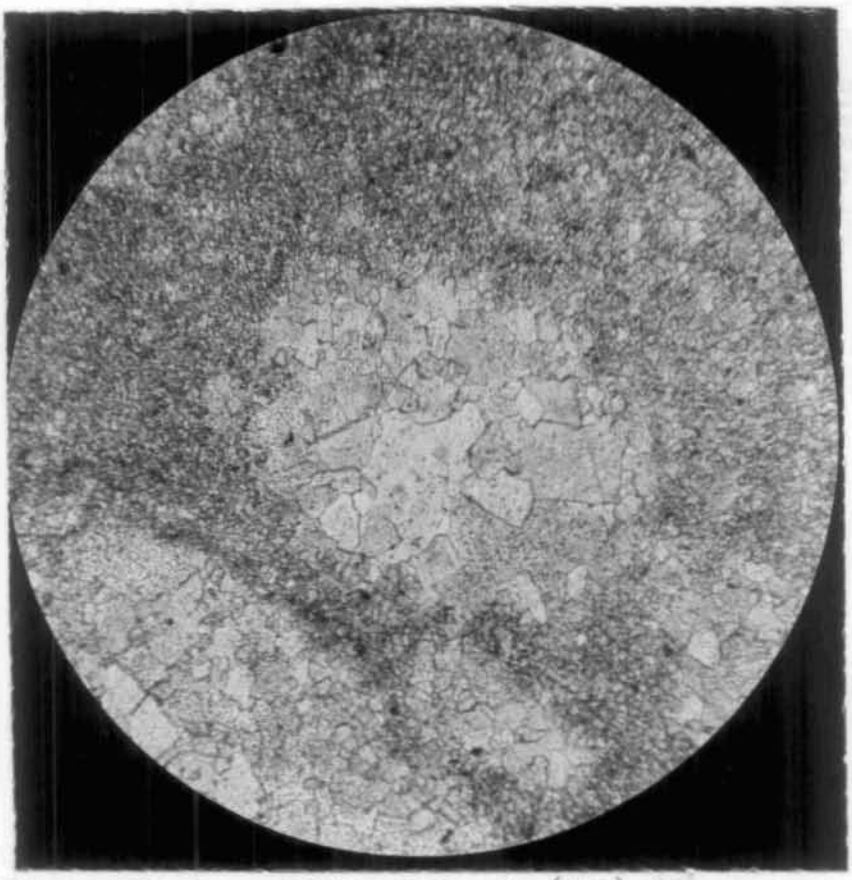


Fig. 13 Micro-medium crystalline dolomite (X45), Merrina Beds. Sample No. WB16. Neg. No. G/8743

contained 'concretions' with concentric spherical partings around 3 - 4 inch nucleii of accreted claystone fragments. (figure 12).

Head waters of Cattle Creek: (ca 840 feet above sea level). The horizontal sequence comprises,

20' of equal amounts of interbedded, buff, fine grained sandstone and claystone with muscovite rich laminae, and a 1-foot bed of pink, cross bedded, micaceous, argillaceous sandstone.

TANAMI EAST. Run 2 photo 5056 (central, north TANAMI EAST). (ca 1,220 feet above sea level):

22' medium to thick bedded, cross bedded, dark brown, medium grained sandstone with occasional clay pellets.

18' laminated, dark brown, micaceous siltstone.

SOUTH LAKE WOODS. 20 miles west-north-west of the south-east corner of the Sheet:

60' brown and white, medium grained, cross bedded sandstone with clay pellets, interbedded with brown and purple quartz siltstone with shaly, micaceous laminae and clay pellets.

14 miles south of Dixon Ridge. A dolomite cropping out in a topographic low was sampled (WB 16) and described as follows:

WB 16 Dolomite (medium crystalline).

Hand specimen. Light brown-grey, medium crystalline, hard, tight, some weathered patches (fossil fragments?) stand out.

Thin section (fig. 13). Grains, nil. Matrix, medium crystalline and microcrystalline patches, some medium crystalline patches with circular to oval outline (?fossils), and some with lath or spine-like shape.

Origin. Possibly accumulated as a carbonate mud with some bioclastic or algal remains; it was later completely recrystallised and dolomitised.

GREEN SWAMP WELL. G.S.W. 2 scout hole site.

12' Brown and white, cross-bedded, well sorted, friable, fine to medium grained sandstone with white clay and silt layers; some purple, micaceous sand laminae.

48' Ferruginised, brown and purple micaceous siltstone - claystone.

Two samples from this locality were described as follows.

WB 17 Siliceous quartz sandstone

Hand specimen. Light brown - orange, fine to medium grained quartz sandstone, porous, hard.

Thin section. (fig. 14) Grains 80%, quartz, fine grained, average size 200 microns, some 500 microns, subrounded to rounded, low sphericity, average to well sorted. Overgrowths produce angular appearance and tend to be idiomorphic. Grain on grain texture with triple points and solution contacts. Rare chert grains and vein quartz, some fractured but majority undeformed. Cement. 10% siliceous, as overgrowths, voids 10%.

Origin. Accumulated in shallow water, relatively near land and deposited by medium strength, persistent currents giving average to well-sorted and subrounded grains. This may have resulted from uplift of the land and or climatic change giving increased erosion and replacing carbonate depositional conditions.

WB 18 Ferruginous siltstone

Hand specimen. Dark brown, mottled siltstone, micaceous and ferruginous, with thin claystone lenses and patches, with slurry? structures.

Thin section. (fig. 15) Grains, 90%; 80% quartz silt, 20% ferruginous claystone fragments, irregular shaped patches, some laminated, broken layers or beds (slumped?) composed of clay minerals (some chloritic) with rare quartz silt and iron oxide. Quartz silt, angular, well sorted throughout. Matrix. 10% iron oxide and clay minerals.

Origin. Accumulated either in deep, quiet water far from land, or in shallow protected quiet water. Clay minerals were probably derived from nearby land with the silt. The rock was probably ferruginised during lateritisation. The occurrence of siltstone may imply either elevation of land with increased erosion, or cooler climatic conditions.

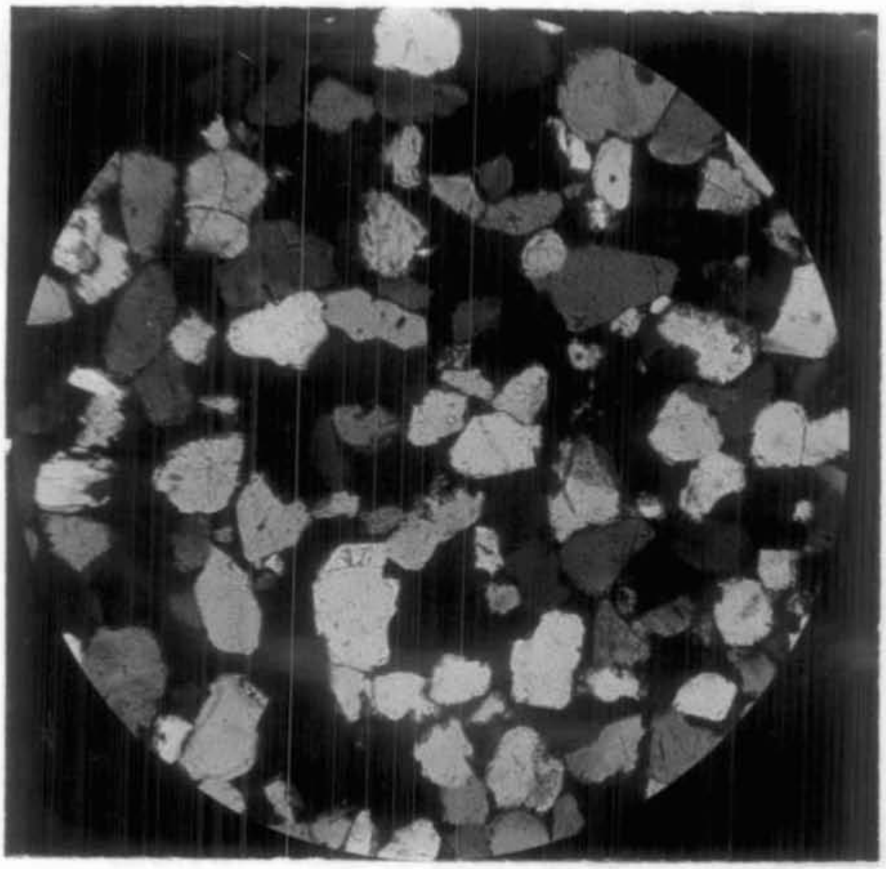


Fig. 14 Siliceous quartz sandstone, fine-medium grained (X30); Merrina Beds. Sample No. WB17. Neg. No. G/8744.

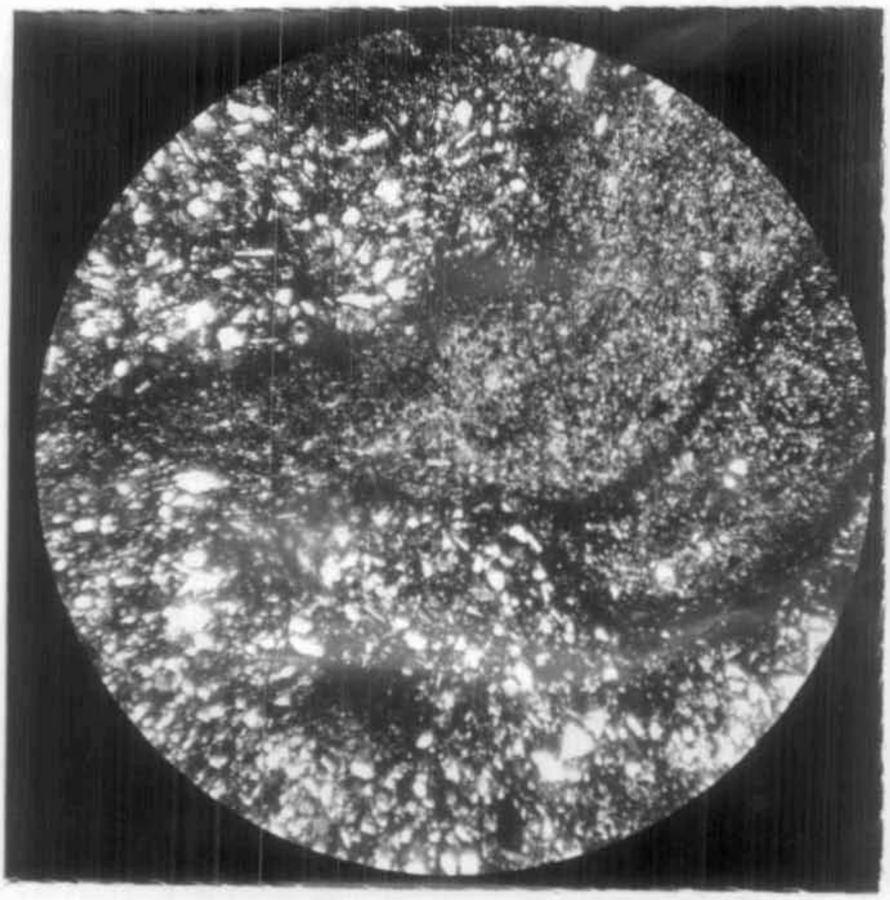


Fig. 15 Ferruginous quartz siltstone with clay/siltstone fragments? (or slumped layers) (X45); Merrina Beds. Sample No. WB18. Neg. No. G/8745.

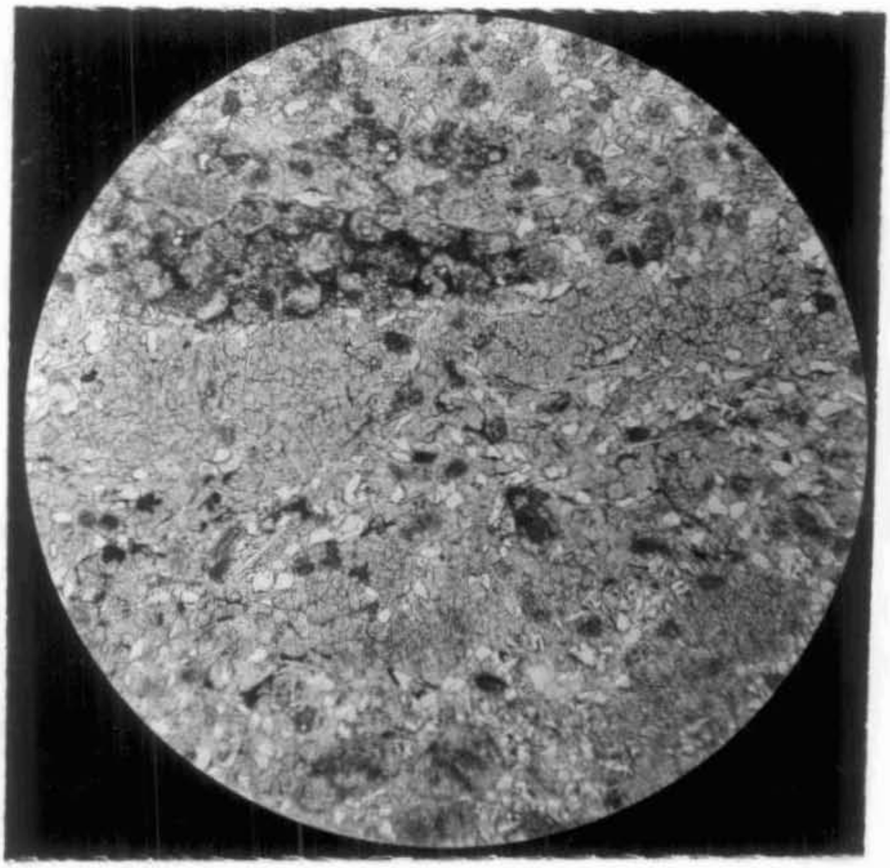


Fig. 16 Silty (quartz and mica), algal? dolomite. (X45); Merrina Beds. Sample No. WB19. Neg. No. G/8742.

Point Wakefield: 46 feet interbedded; 80% medium bedded, cross bedded medium grained, red brown micaceous, lithic feldspathic quartz sandstone; (One 15 foot interval is festoon cross bedded with dips on the cross beds up to 25 degrees; oscillation ripple marks occur infrequently) 20% purple, pink and white, shaly, micaceous, very fine grained, quartz sandstone and siltstone and claystone. Scour and fill structures occur in the sandstone and siltstone.

Run 14 photo 5187; (central south GREEN SWAMP WELL). A large sinkhole, situated approximately at latitude 19°57' S, longitude 132°32'E, is about 200 feet long, 30 feet wide and 100 feet deep. It has developed along a west-north-west trending vertical joint in flat-lying sedimentary rocks which consist of:

10' sand, red soil, laterite.
2' red, medium grained, ripple marked sandstone.
13' thin bedded, yellow-white, silty, (quartz) dolomite.
1' red sandstone (near base of above unit).

The ten feet below this are probably fine to medium grained calcareous or dolomitic rocks (suggested by rounded weathering surface and possible stalactites). A sample of the silty dolomite is described as follows:-

WB 19 Micaceous, quartzose dolomite.

Hand specimen. Light grey, light brown, microcrystalline sandy (quartzose, micaceous), partly fissile, hard. Some porosity along laminae and stylolites. Densely worm burrowed in part.

Thin section (fig. 16). Grains. 20%, quartz, mica, fossil fragments. Quartz, 90%, average size 100-150 microns, angular to sub angular, well sorted, low sphericity, in layers and scattered. Rare grain on grain texture; rare feldspar and chert grains. Mica, 5%, long thin, white mica or clay mineral laths (flakes), approximately 250 microns in length. Fossil fragments, 5%, broken algal cellular structure (possibly early Dasycladaceae) with dark cryptocrystalline dolomite walls and fibrous varieties, 50 microns thick around cells, 150 microns diameter. Other fragments are bicellular, with fibrous walls of microcrystalline dolomite (possibly early sponge forms). Matrix 80%, microcrystalline dolomite partly recrystallised to medium crystalline dolomite.

Origin. Accumulated in shallow warm water, in a carbonate rich environment, near land, with periodic currents depositing quartz, mica or clay minerals, and probably organic fragments. The presence of algal remains suggests that small algal patches existed nearby. The currents were not strong enough to winnow the sediment.

A tentative composite stratigraphic column has been constructed for the Merrina Beds in the northern part of the area, mainly from subsurface data (see section on subsurface geology). The structure of the Merrina Beds in this area is regionally flat lying. Outcrop on topographic highs (over 900 feet) is usually medium to coarse grained sandstone, at lower altitudes finer grained clastics and dolomite crops out. The exception is the siltstone/claystone sequence at Buchanan Hills. These rocks dip to the east and are therefore likely to be older than outcrop at the same topographic level further east.

The regional strike in the south-eastern part of the Basin appears to be west-north-west. The most south-easterly outcrop (and, presumably, the youngest - the altitude is approximately 1,005 feet) examined was that in central south GREEN SWAMP WELL (WB 19). The dolomite here is lithologically dissimilar to other Merrina Beds dolomites and may represent a new depositional phase after the period of widespread sandstone deposition recognised in the northern part of the area.

Age: Diagnostic fossils are rare in the Merrina Beds and have been found only in the algal dolomite at Buchanan Hills and from dolomite and chert at 160 - 200 feet in G.S.W. 1. They are Biconulites, Acrotreta and Acrothele. The association of these fossils indicates an early Middle Cambrian age. (pers. comm. A.A. Öpik, Canberra). These occurrences are in the lower part of the known Merrina Beds sequence; the age of the upper part of the Merrina Beds has not been determined. The next youngest Formation mapped is the Hanson River Beds of Ordovician age; large areas of sand cover the area between outcrops of Merrina Beds and Hanson River Beds.

Correlation with adjacent units: The lithology, fossil assemblage and age of the dolomites in the Merrina Beds indicate a close correlation with the Montejinni Limestone. The lithology of the arenite/lutite sequence has a marked resemblance to arenite and lutite with interbedded dolomite cropping out on ELKEDRA and BARROW CREEK that have been tentatively mapped as part of the Cambro-Ordovician Tomahawk Beds (Smith and Milligan, 1964).

Environment of Deposition: The abundance of dolomite 'mud', the presence of algal 'mats' and the common occurrence of crossbedding and undulate ripple marking indicates that sedimentation took place in carbonate saturated shallow (including littoral) waters, possibly penecontemporaneously enriched in magnesium. There appears to be little variation in lithology laterally across the northern part of the Basin. (Outcrop of Middle Cambrian rocks in the southern area is unknown). The vertical variation is from dolomite, up through dolomitic siltstone and claystone and very fine grained sandstone, with interbedded dolomite, to medium to coarse grained sandstone. (The amount of dolomite originally in the upper sandstone is unknown, due to deep weathering). This transition almost certainly resulted from an increase in tectonism and a lowering of parts of the sea floor, producing increased circulation and decreased salinity.

Hanson River Beds (New Name)

The Hanson River Beds crop out sporadically west of the Hanson River floodout and as far west as north-east MOUNT SOLITAIRE. Sandstone, laminated, fine-grained, red, micaceous, with some red siltstone, forms the north-eastern outcrops (on LANDER RIVER). These may be the oldest beds in the unit. Dolomite with sandstone interbeds crop out in claypans and low hills south and west of the sandstone. Samples from these outcrops are described as follows:

WB 13 Medium crystalline, bioclastic dolomite

Hand specimen. Light brown-grey, hard, tight, medium crystalline, bioclastic dolomite with rudaceous brachiopod and trilobite fragments parallel and inclined to bedding.

Thin section (fig. 17). Grains 30-40%, brachiopod shell fragments, trilobite, Echinodermata, and possibly molluscan fragments. Rare phosphate pellets (1%) of collophane with quartz silt. Most shell fragments have thin rims of iron oxide; iron oxide also occurs as inclusions scattered throughout, and concentrated along fibres near the edges of shell fragments.

Matrix 60-70%, medium crystalline dolomite, anhedral with dark inclusions and brown patches of more equant dolomite rhombs. Syntaxial replacement dolomite rims occur around Echinodermata fragments, single or several crystals have replaced shell fragments, leaving ghost structures.

Origin. Accumulated possibly as a shelly, crinoidal calcirudite (coquina), bound by calcite mud, i.e. poorly winnowed. The grains do not touch one another and were probably mud supported; subsequent dolomitisation recrystallised the matrix and partly altered the bioclasts; some bioclasts (molluscan?) were probably completely altered, and are now represented by the clear, medium crystalline dolomite patches.

WB 8a Phosphatic, medium crystalline, bioclastic dolomite.

Hand specimen. Hard, tight, light brown-grey with yellow patches, white bioclasts, 1-2 mms. long, shell fragments and crinoids, rare quartz sand.

Thin section (fig. 18) Grains 25%, rounded and well sorted crinoid, brachiopod/ostracod, and isotropic (conodont?) fragments. (1-2 mms. in size). The crinoid fragments have syntaxial replacement rims and possibly syntaxial rim cement. The replacement rims have clear outer parts and an inner part with inclusions. Rare large pellets of equigranular dolomite silt, phosphatic brachiopod fragments and phosphate pellets containing quartz sand and silt also occur. Scattered quartz sand forms 1% of the grains. Some limonite staining. Matrix 75%, anhedral dolomite, 250 microns in size, medium crystalline, apparently replacing the original mosaic, now represented by remnant areas of microcrystalline dolomite and limonite with partly serrated boundaries.

Origin. Accumulated in shallow warm water, as a bioclastic calcarenite, possibly near crinoid 'meadows'; the crinoids and brachiopods were probably transported, as they appear abraded and rounded. The phosphate pellets are either phosphatized carbonate clasts, or transported phosphate clasts from a nearby phosphate-rich sediment.

Fig. 17 Fossiliferous (shelly), microcrystalline dolomite (with trilobite frags). (X45); Hanson River Beds. Sample No. WB13, Neg. No. G/8738.

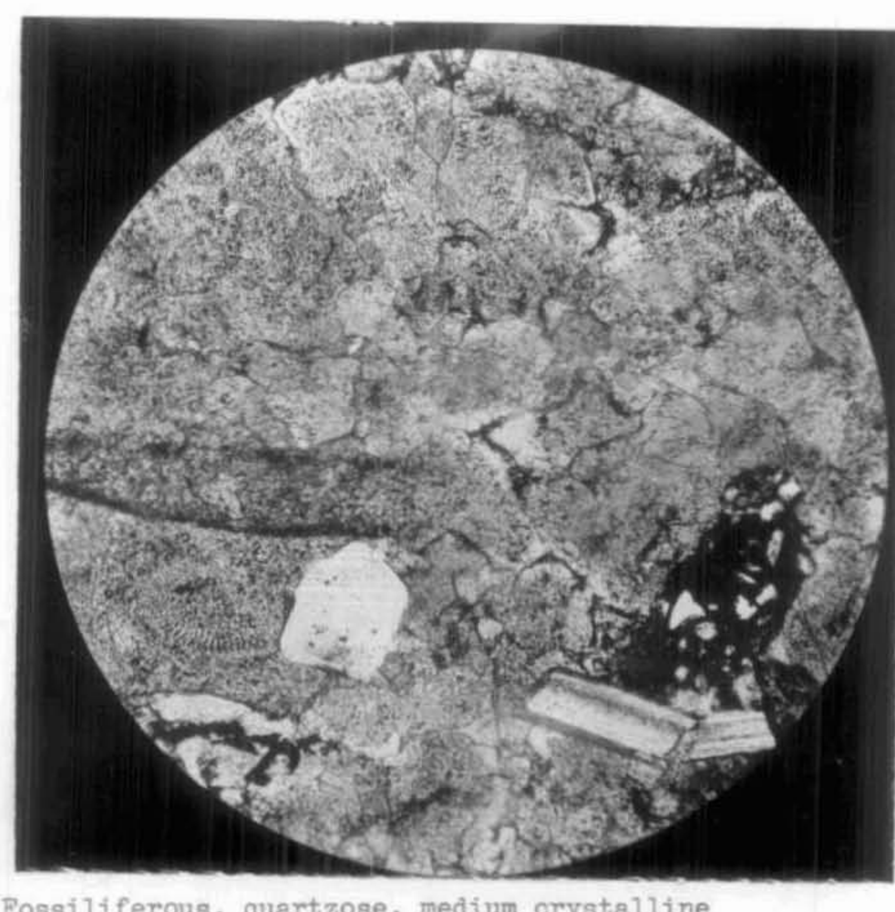


Fig. 18 Fossiliferous, quartzose, medium crystalline dolomite; rare phosphate (X30); Hanson River Beds. Sample No. WB8a. Neg. No. G/8748.

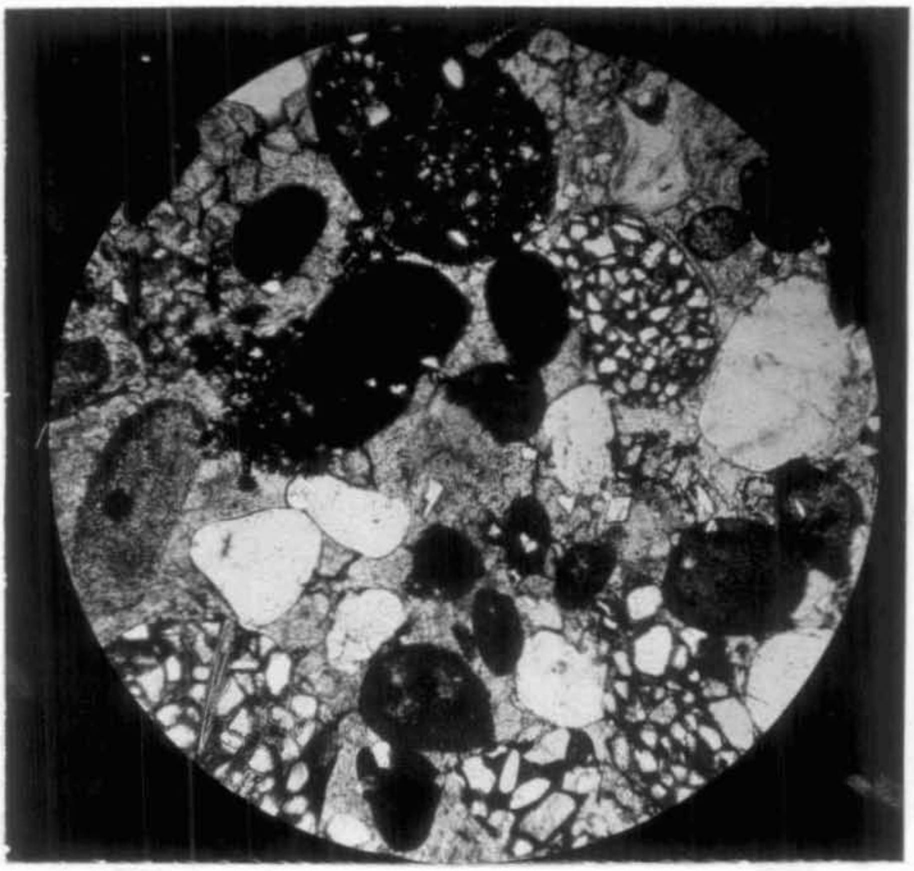


Fig. 19 Fossiliferous, quartzose, pellet-phosphate dolomite, (X45); Hanson River Beds. Sample No. WB8b. Neg. No. G/8750.

WB 8b **Quartzose, bioclastic, pellet-phosphate dolomite.**

Hand specimen. Light brown yellow, hard, clastic, calcareous dolomite with coarse, brown, arenite-size phosphate pellets, bioclasts and quartz; pellets weathered out on surface, some solution cracks.

Thin section (fig. 19) Grains 70%, phosphate clasts (50%), Echinodermata fragments (40%), quartz sand (10%).

(i) Phosphate clasts are well rounded, 1-3 mms. in size, oval to sub-spherical composed of collophane with quartz silt and rare lath apatite, compound clasts of pellets and ooliths all of collophane, collophane with quartz sand and collophane only.

(ii) Echinodermata; well rounded plates (ossicles?) of crinoids or cystids; limonite staining along internal structure.

(iii) Quartz; well rounded, well sorted quartz sand, 500 microns average diameter.

Cement 30%, dominantly syntaxial rim cement around crinoids (composed of dolomite and calcite) binding them to the phosphate pellets, and medium crystalline dolomite between some phosphate clasts.

Origin. All clasts appear derived, and have accumulated in shallow, warm water, probably near a crinoid 'meadow'. The quartz is well rounded and often sub-spherical indicating either prolonged transport or derivation from a well-sorted sandstone. The phosphate pellets may be phosphatised carbonate clasts, concretions, or eroded fragments from a phosphate-rich sediment (10% P_2O_5). It may be compared with phosphate rich rocks of the Amadeus Basin (Cook, 1966).

WB 14 **Fine grained siliceous, quartz sandstone.**

Hand specimen. Light grey with brown exterior, well sorted, fine grained, hard, porous, quartz sandstone. Some solution cracks, possibly representing dissolved fossils. Some ichno-fossils (tracks and trails); vague laminae apparent on the weathered surface.

Thin section. (fig. 20) Grains 90%, quartz, very fine grained, average diameter 100 microns, subangular to subrounded, well sorted, overgrowths of silica, grain-on-grain texture, triple points and solution boundaries. Rare green tourmaline, some clay minerals or mica (1%), possibly some apatite.

Origin. Accumulated in a shallow area, near land, under persistent current activity which permitted sorting and winnowing. Possibly periods of non-deposition allowing preservation of trails.

Quartz sandstone - thin bedded, fine grained, micaceous (muscovite), ?feldspathic, strongly silicified in part, and with richly fossiliferous lenses - forms the higher hills west of the Hanson flood out and is apparently the youngest unit in the sequence.

Fine and medium crystalline, quartzose dolomite forms low outcrop 12 miles north-east of Lake Surprise, and is described as follows.

WB 2 Quartzose dolomite (sandy, medium crystalline dolomite).

Hand specimen. Light brown - grey, hard, tight, medium crystalline, with scattered quartz sand weathered out.

Thin section. (fig. 21) Grains 10%, quartz and rare bioclasts. Quartz, subrounded to rounded, 300 - 400 microns in size, well sorted, some angularity produced by dolomite replacing quartz (or possibly overlapping boundaries) some with medium sphericity. Bioclasts, less than 1%, small fragments of Echinodermata with syntaxial over-growths, and one or two possible phosphatic brachiopod or conodont fragments; some limonite staining.

In reflected light, palimpsest pellets, clasts, ooliths or possibly Echinodermata fragments are visible, but are now all dolomitised. Matrix 90%, fine to medium crystalline dolomite, approximately 100 microns crystal size.

Origin. Accumulated in shallow warm water possibly as a bioclastic pelletal calcarenite. The quartz sand was derived from periodic currents after increased erosion due to tectonic or climatic change. Dolomitisation has destroyed the original texture, and appears to be a late stage diagenetic mosaic.

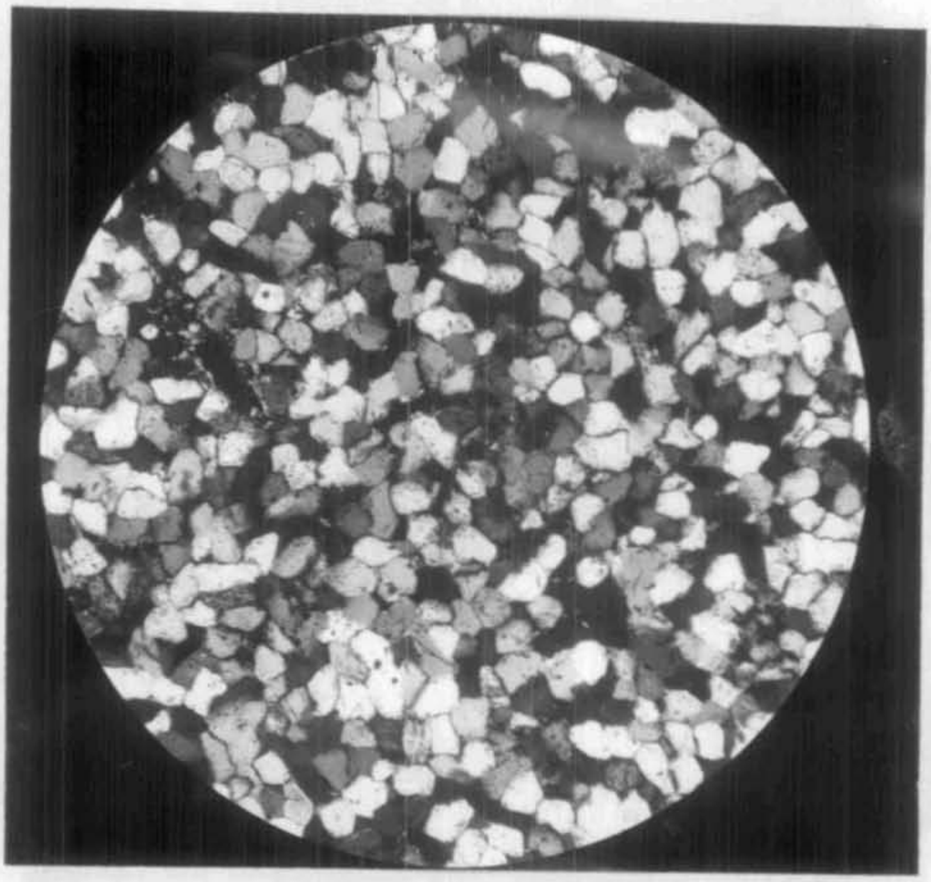


Fig. 20 Fine grained, siliceous, quartz sandstone (X30); Hanson River Beds. Sample No. WB14, Neg. No. G/8747.

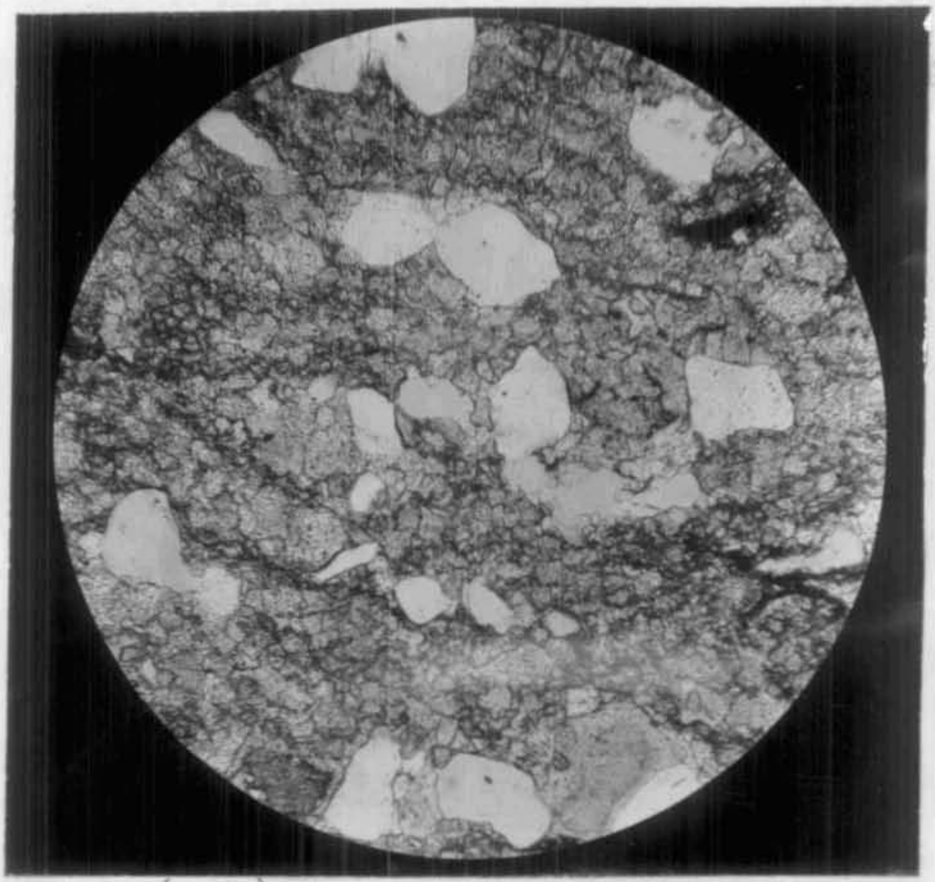


Fig. 21 Quartzose (sandy) microcrystalline dolomite (with conodonts in parts) (X30); Hanson River Beds. Sample No. WB2, Neg. No. G/8751.

Age: The macro-fossil material is poorly preserved. However, a Lower to Middle Ordovician is indicated from a preliminary examination of the material (pers. comm. J. Gilbert-Tomlinson, B.M.R., Canberra).

Conodonts from W.B.2 (north-east MOUNT SOLITAIRE) are Arenigian or younger (pers. comm. P.J. Jones, B.M.R., Canberra). Conodonts and gastropods extracted from a dolomite sample WB 13 (possibly in the middle of the exposed section) indicate a lowermost Middle Ordovician age for the rock (pers. comm. E. Druce and J. Gilbert-Tomlinson, B.M.R., Canberra).

Environment of deposition: The Hanson River Beds were shallow water sediments which accumulated under the influence of strong current action as biocalcarenite and well sorted or winnowed terriginous material. Dolomitisation appears to have been late-stage as the high magnesium content would have been inimical to the survival of the fauna. The presence of large brachiopod fragments indicates that the fossils are of local origin.

Correlation with adjacent units: The macrofossil assemblage has more affinity with Georgina Basin than Amadeus Basin forms. (pers. comm. J. Gilbert-Tomlinson). Also, the lithology and fossils in one of the sandstones resembles that of the Nora Formation in the Georgina Basin. (The nearest outcrop of the Nora Formation is 200 miles south-east of the Hanson River Beds outcrop).

Undifferentiated Lower Palaeozoic Rocks:

Unfossiliferous carbonate rock with fine grained sandstone and siltstone interbeds crop out over 400 square miles in the south-west corner of TANAMI EAST. They are unconformably overlain by Dulcie Sandstone and are strongly ferruginised for some 10 feet below the contact.

The rock types are light to dark grey calcareous and noncalcareous dololutite with occasional blue grey chert nodules, red quartzose calcilutite, and laminated micaceous (biotite and muscovite), argillaceous, fine grained quartz sandstone and siltstone with halite casts. A sample of the quartzose calcilutite is described as follows:

WB 4 Quartzose microcrystalline limestone.

Hand specimen. Light red-brown to pink, hard, tight, finely crystalline, scattered fine grained quartz sand. Rare pink claystone clasts, 8 mms diameter.

Thin section. (fig. 22) Grains 35%. Quartz 95%, echinodermata 5%; quartz angular to sub angular, 150-300 microns, average sorting, scattered; 1% feldspar (plagioclase, microcline); some ferruginous pellets; limonite rims occur around most quartz. Irregular patches, 250 microns across, of equigranular microcrystalline calcite and limonite occur throughout the sample. Matrix 65%, microcrystalline calcite, and silt-size fragments of echinodermata?. Some calcite silt in the matrix (similar to that in the irregular patches).

Origin. Deposited in warm shallow water in relatively sheltered area, allowing accumulation of calcite mud; possibly close to land source of quartz and the rare feldspar; crinoids probably transported as their life environment seems unrelated to the depositional environment.

Age: The age of the unit is unknown. It is overlain unconformably by the Devonian Dulcie Sandstone; basal contacts are unknown. Fossil evidence is meagre; a few possible Echinodermata fragments have been observed in thin section. Dark grey microcrystalline dolomites are common in the Middle Cambrian formations in the Georgina Basin, and the siltstone resembles Merrina Beds siltstone from scout hole T.E.1. The rocks could therefore be Middle Cambrian. However, microcrystalline and quartzose dolomite of the Hanson River Beds crops out 80 miles away, so the possibility of an Ordovician age cannot be dismissed.

Dulcie Sandstone

At the type locality the Formation comprises cross bedded quartz sandstone with occasional beds of siltstone and pebble conglomerate (Smith, 1965). A fresh water origin for the Formation is indicated by the presence of placoderms.

Medium to thick bedded, cross bedded, argillaceous sandstone and clean, friable quartz sandstone crops out in the northern half of LANDER RIVER, and in the south-west corner of

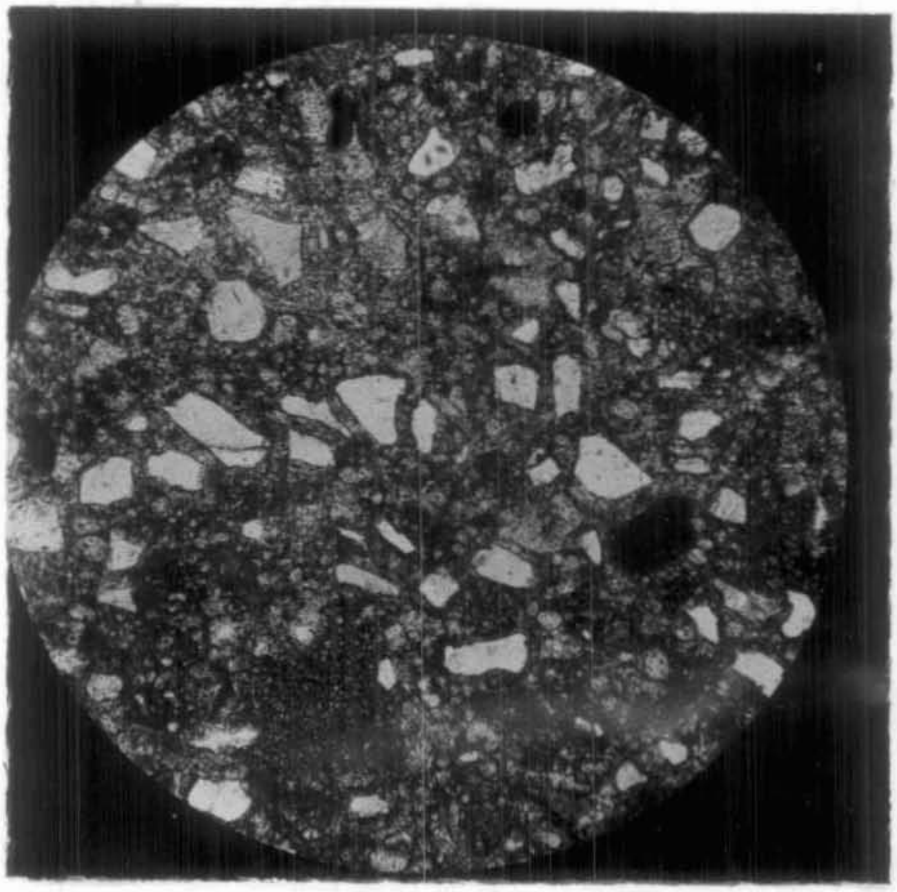


Fig. 22 Quartzose microcrystalline limestone with small? Echinodermata fragments (and halite casts in parts), (X30); Undifferentiated Lower Palaeozoic. Sample No. WB4, Neg. No. G/8740.

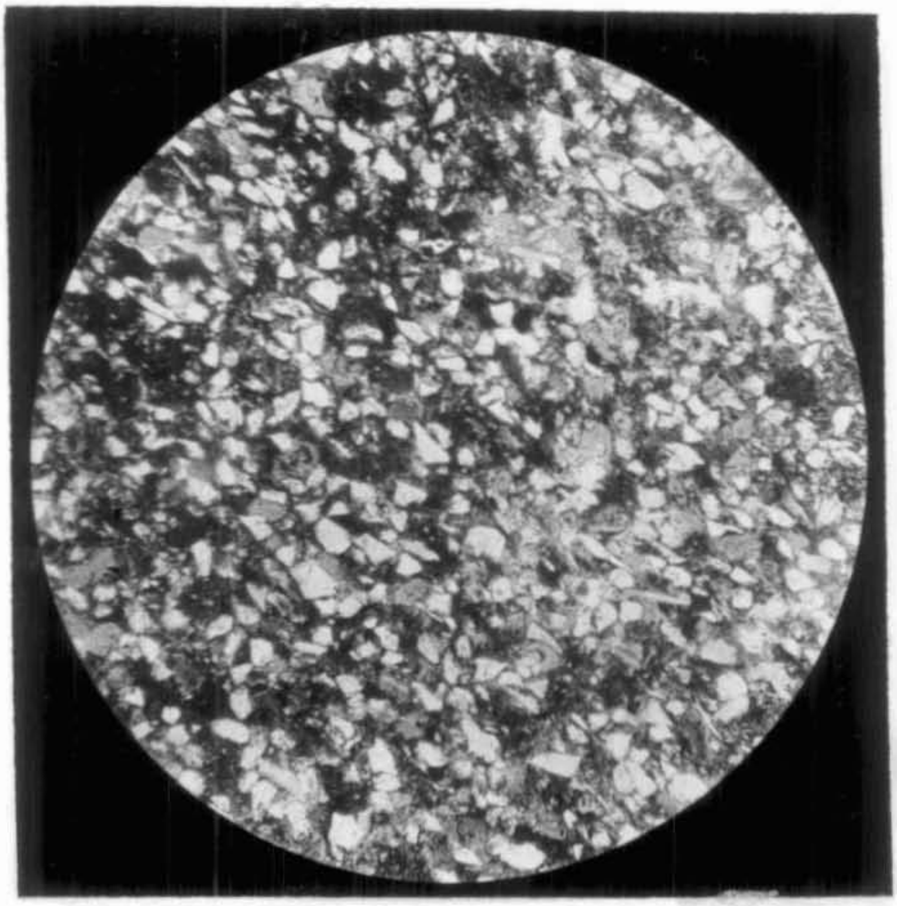


Fig. 23 Fine grained, clayey quartz sandstone, cross bedded in parts (X30); Dulcie Sandstone. Sample No. WB15, Neg. No. G/8746.

TANAMI EAST where it forms bluffs up to 60 feet high. Two samples from the Dulcie Sandstone are described as follows:

WB 15, WB 11 Argillaceous sandstone

Hand specimen. Very light brown, white and pink, clayey, fine grained quartz sandstone, partly cross bedded, porous, medium hard.

Thin section (WB 15) (Fig. 23) Grains 70-80%, quartz and clay minerals with rare chert grains and possibly altered feldspar. Quartz, angular to sub angular, 100 - 250 microns in size, partly grain on grain texture, average sorting, low sphericity, some blades of quartz, ½ - 1 mm. Chert, subrounded. Rare zircon and tourmaline. Matrix 20-30%, clay minerals and some silica and iron oxide, poorly winnowed.

Origin. Poorly sorted sand and clay accumulated in a shallow area of low energy, close to land. Periodic strong currents produced the cross bedding but did not winnow the deposit. The relative uniformity of quartz grains implies sorting in a previous environment, or during long transport.

Age: No fossils were found. However, the similar lithology and the stratigraphic position suggests that this unit is ~~[struck-out word]~~ comparable with the Dulcie Sandstone and, unless the Formation is diachronous, Devonian in age.

MESOZOIC

There are no proven Mesozoic rocks in the area, but three small outcrops in the central eastern part of LANDER RIVER are tentatively regarded as Mesozoic in age. These outcrops consist of weathered sandy siltstone with polygonal mud cracks, and white, silty, cross-bedded medium grained sandstone with abundant clay pellets and rare pebbles. The thickness ranges from 10 to 30 feet, and they overlie various units of the Hanson River Beds. The exposed sediments are unfossiliferous, but they are younger than Middle Ordovician and bear no lithological resemblance to Devonian sediments, and on regional considerations, they are best placed in the Mesozoic.

CAINOZOIC

?Tertiary:

The majority of the ?Tertiary out crops in the area are laterite and limestone.

Laterite: Pisolitic laterite, cemented and loose, crops out over most of the area, and is best developed capping the hills north of the Lander Plateau and occupying the valleys of the larger drainage channels. The maximum observed thickness was 40 feet at Buchanan Hills.

Limestone: The principal site of limestone deposition probably has been the valley of the Lander River and its flood out (figure 24), and the old valley of the Hanson River, east of its junction with the GREEN SWAMP WELL - SOUTH LAKE WOODS Drainage System i.e. south of Winnecke Tableland. The elevation of the outcrop varies between approximately 800 and 1,000 feet. Tertiary limestone crops out also in areas adjacent to basement rocks at the eastern and western margins of the area. Limestone at higher altitude occurs in the valley of the Lander River, south of the Lander Plateau. In the west, the limestone is extensively silicified. No fossils have been found; the tentative Tertiary age suggested for these rocks is based on their similarities to fossiliferous limestones on Brunette Downs, 120 miles to the north-east of the area (Lloyd, 1965).

Claystone: Weathered clay and claystone (approximately 90' thick) was penetrated by core-hole G.S.W.1. As Tertiary limestone crops out around the well site, these sediments are tentatively considered to be also Tertiary.

Sandy limestone and sandstone: Several small outcrops of pink, red and grey sandy limestone have been observed on the floors and banks of some claypans within the dune fields between localities WB6 and WB7 on LANDER RIVER. In one of these claypans, 5 feet of horizontally-bedded, pink, medium-bedded sandy limestone is overlain by 5 feet of khaki, soft, medium-grained, thin bedded sandstone: this sandstone is succeeded by 10 feet of grey, clean, friable, medium-grained quartz sandstone which is partly covered by the Quaternary red sand of a dune bordering the claypan. On LANDER RIVER, Tertiary sediments are more extensive than the 1:250,000 scale map indicates, because many of the outcrops are too small to be shown.

Fig. 24 Small scale karst topography developed in ?Tertiary travertinous limestone, Lander River Floodout 20 miles north-west of Lake Surprise, MOUNT SOLITAIRE. Neg. No. 8754.

Quaternary and Recent

Aeolian-colluvial red-brown sand covers approximately 60 - 70 per cent of the area. Much has been slightly resorted by sheet water flow after heavy rain. Apart from the drainage channels of the larger river systems, the major accumulations of alluvial deposits are at the east and western margins of the basin where the Lower Palaeozoic rocks abut against Precambrian quartzites, e.g. Lake Woods, Lake Buck. The only significant areas of Recent alluvial deposits are in the somewhat wetter, western parts of the area. Recent evaporite deposits are limited to the south-west part of the area. A sample collected from near the western border of TANAMI EAST was composed of halite (dominant) and hexahydrite.

SUBSURFACE GEOLOGY

WELL HISTORY

A series of shallow scout holes were drilled in the Wiso Basin to augment the results of surface geological mapping in areas of poor outcrop.

Ten holes were drilled in a line from Tennant Creek to Hooker Creek, with some holes offset from the general line. Access to the first well, approximately 55 miles west of Tennant Creek, was along the road from Tennant Creek, via Orlando Mine, to "Explorer 18", and thence along a line of pegs surveyed by the Department of the Interior in 1964.

The scout holes were drilled by Gorey and Cole Drillers Pty. Ltd., Alice Springs, N.T., using a Failing 1000 rig mounted on an International truck, and air-rotary methods using an Ingersol Rand compressor supplying 600 cu. ft. per minute at 80 - 100 p.s.i. Water-rotary was used on rare occasions when the water column became too great for air circulation. A Widco 1000 logging unit was provided by the Geophysical Branch of the Bureau of Mineral Resources.

Five scout holes were drilled on GREEN SWAMP WELL (G.S.W. Nos. 1 - 5); one was drilled on TANAMI EAST (T.E.1) and four were drilled on WINNECKE CREEK (W.C. Nos. 1 - 4). The total footage drilled was 2,878' 10". Summaries of each scout hole follow, and their locations are plotted on Figure 6.

GREEN SWAMP WELL NO. 1.

Location: GREEN SWAMP WELL, 54 miles west of Tennant Creek.
Commenced: 9/6/65.
Abandoned: 14/6/65.
T.D. 305' (cased as water bore)

The well penetrated:-

Sand, clay:	(0 - 91')	- Cainozoic
Dolomite & chert:	(91 - 270')	- Merrina Beds
Sandstone:	(270 - 305')	- ?Tomkinson Creek Beds.

Target depth was 600' or prior basement.
Core: 1.(147 - 147'9") recovered 7" of dolomite.
Water: struck at 119', 160' and 187'; supply by air lifting was approximately 2,000 gallons per hour (gph); standing water level (SWL) is 93'. (Analyses given in Appendix 2).
Fossils: The following fossils were examined by C. Gatehouse, B.M.R. and A.A. Öpik, Canberra:

160 - 170 feet	-	phosphatic brachiopods (indet.)
		'Helcionella'
		eocrinoid plates
		sponge spicules
190 - 200 feet	-	Acrotreta Kutorga, 1848
		Acrothele Linnarsson, 1876
		eocrinoid plates
		Chancelloriidae
		hyolithid fragments
		sponge spicules
150 - 200 feet (approx.)	-	spinose phosphatic brachiopods
		eocrinoid plates
		Chancelloriidae
		sponge spicules

Dr. A.A. Öpik made the following comment on the fossils. 'On this evidence and the presence of other fossils, the age of these samples is most probably Xystridura time of early Middle Cambrian'. The bottom sandstone is probably Lower Proterozoic Tomkinson Creek Beds. However the sandstone was much less indurated than normal for Tomkinson Creek Beds, and may be perhaps Adelaidean or younger. S.P. - resistivity and Gamma Ray logs were run.

GREEN SWAMP WELL NO. 2.

Location: Approximately 15 miles west of G.S.W.1.
Commenced: 15/6/65
Abandoned: 17/6/65
T.D. 227' 6" (abandoned)

The well penetrated:

Sand, gravel:	(0 - 2')	Quaternary
Claystone, siltstone:	(2 - 80')	Merrina Beds
Dolomitic siltstone:	(80 - 160')	Merrina Beds
Dolomite, dolomitic siltstone:	(160 - 227'6")	Merrina Beds

Target depth was approximately 200 feet.
Core: 1. (222 - 227') recovered 5' of dolomite.
Water: struck at 197 feet; supply by air lifting was approximately 800 gph; SWL was 184'7".
Fossils: Nil.
S.P. - resistivity and Gamma Ray logs were run.

GREEN SWAMP WELL NO. 3.

Location: 15 miles WNW of G.S.W. No. 2.
Commenced: 21/6/65.
Abandoned: 22/6/65.
T.D. 300' (abandoned)

The well penetrated:-

Sand, gravel:	(0 - 10')	
Sandstone/siltstone:	(10 - 98')	
Packed sand, silt, clay, thin sandstone:	(98 - 285')	(?Quaternary)
Dolomitic sandstone:	(285 - 300')	- Merrina Beds

Target depth: was 300' or prior carbonate rocks.
Core: 1 (290 - 300') recovered 9' 9" of dolomitic sandstone.
Water: struck at 280' but could not be air-lifted to the surface; S.W.L. was 275 feet.
Fossils: Nil.

S.P. - resistivity and Gamma Ray logs were run from 275 - 300'; the Gamma Ray probe was damaged in the hole, but recovered.

GREEN SWAMP WELL NO. 4.

Location: Approximately 30 miles WNW of G.S.W. No. 3.
Commenced: 23/6/65.
Abandoned: 1/7/65.
T.D. 589' 4" (partly cased as a water well)

The well penetrated:-

Clay	(0 - 1')	
Sandstone/claystone:	(1 - 40')	[redacted]
Sand, thin sandstone, rare chert:	(40 - 135')	
Sandstone, minor siltstone:	(135 - 335')	Merrina Beds
Sandstone, (& gypsum), minor dolomite:	(335 - 350')	
Sandstone (& gypsum):	(350 - 371')	
Dolomite, siltstone:	(371 - 589'4")	

Target depth: was 600'.

Core: 1 (300 - 300'4") recovered 2". Further core recovery was prevented by the inability to clear the hole of water during coring.

2 (361 - 371') recovered 10' of sandstone.

3 (585 - 589') recovered 4' of dolomite.

Water: struck from 21 feet to 145 feet (salt water at 145 feet); supplies increased from 21' until approximately 6,000 gph were air lifted;

SWL was 11 feet.

Fossils: Nil.

S.P. - resistivity logs were run from 0 - 280' prior to casing from surface to 399'; and from 300 - 589' 4".

GREEN SWAMP WELL NO. 5.

Location: 26 miles WNW of G.S.W. No. 4.
Commenced: 7/7/65.
Abandoned: 7/7/65.
T.D. 295' (abandoned)

The well penetrated:-

Sand: (0 - 10')
Sandstone: (10 - 120') - Merrina Beds

Sandstone (friable)	(120 - 240')	Merrina Beds
Dolomitic sandstone, siltstone, dolomite:	(240 - 295')	

Target depth: was 300 feet, or deeper if the section appeared to be interesting.

Core: 1 (287 - 295') recovered 7" of dolomitic, micaceous siltstone; the remainder of the core was lost in the hole.

Water: struck at 70' (seepage), and 120'; supply by air lifting was 1500 - 2000 gph; SWL was 60'.

Fossils: Nil

S.P. - resistivity logs were run to 233' only, due to rapid silting up of the hole, and only the S.P. was recorded due to a fault in the equipment.

WINNECKE CREEK NO. 1.

Location: 33 miles WNW of G.S.W. No. 5
Commenced: 9/7/65
Abandoned: 10/7/65
T.D. 173' 6" (abandoned)

The well penetrated:

Sand:	(0 - 10')	Merrina Beds
Siltstone/Claystone:	(10 - 60')	
Dolomitic siltstone/claystone, dolomite:	(60 - 173'6")	

Target depth: was approximately 300 feet.

Core: 1 (170 - 173'6") recovered 3'6" of dolomite.

Water: Air circulation was lost at 163', but no water was struck.

Fossils: Nil.

S.P. - resistivity: logs were not run.

WINNECKE CREEK NO. 2.

Location: 15 miles south-west of Merrina Water Hole (Winnecke Creek) at the base of Buchanan Hills.
Commenced: 12/7/65
Abandoned: 13/7/65
T.D.: 237'6" (abandoned)

The well penetrated:-

Silt, sand, gravel:	(0 - 40')	
Siltstone/claystone (glauconitic), dolomite:	(40 - 210')	Merrina Beds
Dolomite:	(210 - 237'6")	Merrina Beds

Target depth: 600' or prior volcanic rocks.

Core: 1 (227 - 237') recovered 7' 6" of dolomite.

Water: Seepages between 190 - 210 feet.

Fossils: 70 - 80 feet - *Lingula*; 120 - 130 feet - indet. trilobite fragments.

S.P. - Resistivity: No logs were run.

TANAMI EAST NO. 1.

Location: 23m. south-east of W.C. No. 2.

Commenced: 15/7/65.

Abandoned: 17/7/65.

T.D.: 412' (abandoned)

The well penetrated:-

Sand:	(0 - 10')	
Sandstone:	(10 - 90')	Merrina Beds
Dolomitic sandstone, siltstone/claystone:	(90 - 150')	Merrina Beds
Dolomitic siltstone, sandstone, dolomite:	(150 - 390')	Merrina Beds
Dolomite:	(390 - 412')	Merrina Beds

Target depth: approximately 300'.

Core: 1. (243'6" - 260') recovered 16'3" rare dolomite, glauconitic sandstone, siltstone and claystone.

2. (402 - 412') recovered 10' of dolomite.

Water: Nil

Fossils: 259'8" - inarticulate brachiopod fragments.

S.P. - Resistivity: No logs were run.

WINNECKE CREEK NO. 3.

Location: Merrina Water Hole, Winnecke Creek.

Commenced: 19/7/65

Abandoned: 19/7/65

T.D. 162' (abandoned)

The well penetrated:-

Laterite, sand, soil: (0 - 30')

Siltstone: (30 - 162') - Merrina Beds

The target depth was to be sufficient to identify the sequence. The sequence was too soft to core, and no water was struck.

WINNECKE CREEK NO. 4

Location: 29m. north-west of Merrina Water Hole.

Commenced: 20/7/65

Abandoned: 20/7/65

T.D. 177' (abandoned)

The well penetrated:-

Laterite, sand, clay:	(0 - 70')	Merrina Beds
Siltstone:	(70 - 148')	
Dolomite, dolomitic siltstone:	(148 - 177')	

Target depth: Antrim Plateau Volcanics

Core: 1 (175 - 177') recovered 1'3" of dolomite.

Water: Nil.

Fossils: Nil.

The hole was abandoned at 177', as funds available for the project had been spent.

The ten holes (aggregate footage of 2878'10") were drilled and 250 miles (between first and last wells) were travelled, in 41 days, with 2 days delay due to rain and 2 days due to breakdown.

Three holes, G.S.W. Nos. 1, 4 and 5, yielded good supplies of water (analyses from A.I.B. Alice Springs); one yielded a low supply (G.S.W. No. 2); and two yielded seepages (G.S.W. No. 3 and W.C. No. 2).

The hole diameters usually decreased from 8½" opening to 6¾" drilling, with 3 11/16ths bottom hole coring. Variations on the above consisted of 7⅞" following opener, and 4½", 4¼" or 5⅜" following 6¾" drilling.

Air circulation was lost in 3 wells (W.C.1, W.C.2, T.E.1); water circulation was used successfully when the standing water could not be blown out. Difficulties in lifting the water column prevented the first core recoveries in G.S.W. No. 1 and G.S.W. No.4.

Soft units prevented coring in W.C. No. 3. However, throughout the programme, cuttings and core recovery were good.

S.P. - resistivity and Gamma Ray logs were run where possible, but the project was finally abandoned when the equipment became faulty and a replacement gamma probe could not be assembled. The percentages of $CaCO_3$ and total carbonate in the sequences were calculated and plotted alongside the lithological logs (Fig. 25).

GEOLOGY:

The scout holes enabled the determination of the rock units below the surface up to depths ranging from 160 - 590' but only provided a marker horizon in one case (G.S.W. No. 1). Fossils of Cambrian age were found in two wells; present evidence indicates that essentially the same section was drilled in all core holes.

The proposed stratigraphic column which follows, is a composite one, based on a synthesis of the units penetrated in each well. The tentative correlation between wells is based on lithological comparison; the lithologies, however, may be diachronous.

COMPOSITE STRATIGRAPHIC COLUMN.

(1) Tomkinson Creek Beds (Lower Proterozoic). In the eastern part of the basin, economic basement was probably reached at 270 feet; 30' of purple, white, quartz sandstone were penetrated. This is similar to some units in the Tomkinson Creek Beds further east which dip westwards, but may also be a sandstone unit low in the Cambrian sequence. No bottom hole core was taken for dip determination as the diamond core bit appeared unsuitable for air-circulation.

(2) Merrina Beds. (Dolomite). (Middle Cambrian). Above the sandstone of the Tomkinson Creek Beds, more than 180 feet of dolomite occurs, varying from light brown-grey to dark grey in colour, predominantly microcrystalline, and partly argillaceous. Some hydrocarbon residue occurs around crystals in small veins between 210 - 230 feet. Chert fragments were also found, and one contains *Biconulites*? and trilobite fragments. This dolomite may be equivalent to the light grey microcrystalline, calcareous dolomite at the base of G.S.W. Nos. 2 and 4, W.C. No. 1 and 2, T.E. No.1 and possibly W.C. No. 4.

LITHOLOGICAL AND CALCIMETRY LOGS, SCOUT HOLES, WISO BASIN N.T.

NT/A142

TO ACCOMPANY RECORD 1966/47

D.R.W.

(3) Merrina Beds. (Siltstone and dolomite). Overlying the thin dolomite sequences at the base of G.S.W. Nos. 2 and 4, W.C. Nos 1 and 2 etc., is a sequence of interbedded dark brown siltstone and claystone, partly dolomitic, and thin beds of dolomite (G.S.W. Nos. 2, 4 and 5; W.C. Nos. 1, 2 and 4). The siltstone is quartzose, argillaceous, partly micaceous, dolomitic, ferruginous and partly current bedded; gypsum occurs in vughs in G.S.W. No. 4 and T.E. No. 1. The claystone is also ferruginous and partly micaceous, and often occurs as thin layers in the siltstone.

The dolomite interbeds are light brown to dark grey, and vary from microcrystalline (G.S.W. No. 4, core 3 and T.E. No. 1, core 2) with some gypsum in G.S.W. No. 4 and organic residue along stylolites; to microcrystalline with Echinodermata fragments (W.C. No. 1, core 1), and flocculent stromatolitic algal remains (W.C. No. 2, core 1), and microcrystalline, argillaceous and micaceous, with quartz silt, some glauconite, tourmaline and rare garnet grains (T.E. No. 1, core 1).

The maximum thickness penetrated is 250 feet. In W.C.2, a brachiopod (Lingula) and possible trilobite fragments were found in this sequence. Algal dolomite at the foot of Buchanan Hills, containing ?Girvanella 'puddings' and Middle Cambrian Biconulites occuring in an interbed in this sequence.

A variation occurs in T.E. No. 1 where thin beds of grey dolomitic and fine grained quartz sandstone are interbedded with brown dolomitic siltstone in the lower part, while the upper part comprises siltstone and rare dolomite.

(4) Merrina Beds. (quartz sandstone, sand, silt and clay). Overlying the brown siltstone and dolomite is a sequence of red-brown, white and grey quartz sandstone, partly dolomitic with one or two interbeds of brown siltstone and dolomite. The upper part is white and grey and probably represents a leached section. The upper part also contains many intervals of quartz sand, notably in G.S.W. Nos. 4 and 5, and packed sands, silt and clay in G.S.W. No. 3, between thin sandstone beds. These may represent de-cemented sandstone, siltstone and claystone in the leached zone. The sands or sandstone may become recemented (by silica) as at the top of G.S.W. Nos. 4 and 5. This section is 330 feet thick, and no fossils were found.

A variation occurs in the north-western part of the area where more claystone occurs, interbedded with sandstone and siltstone.

The drilling programme thus established that basement for prospects of economic accumulations of hydrocarbons is probably 270' below surface near the eastern edge of the basin, and that above this in the centre of the Basin there are possibly 770' of dolomite, siltstone and dolomite, and siltstone, claystone and sandstone.

CORRELATION:

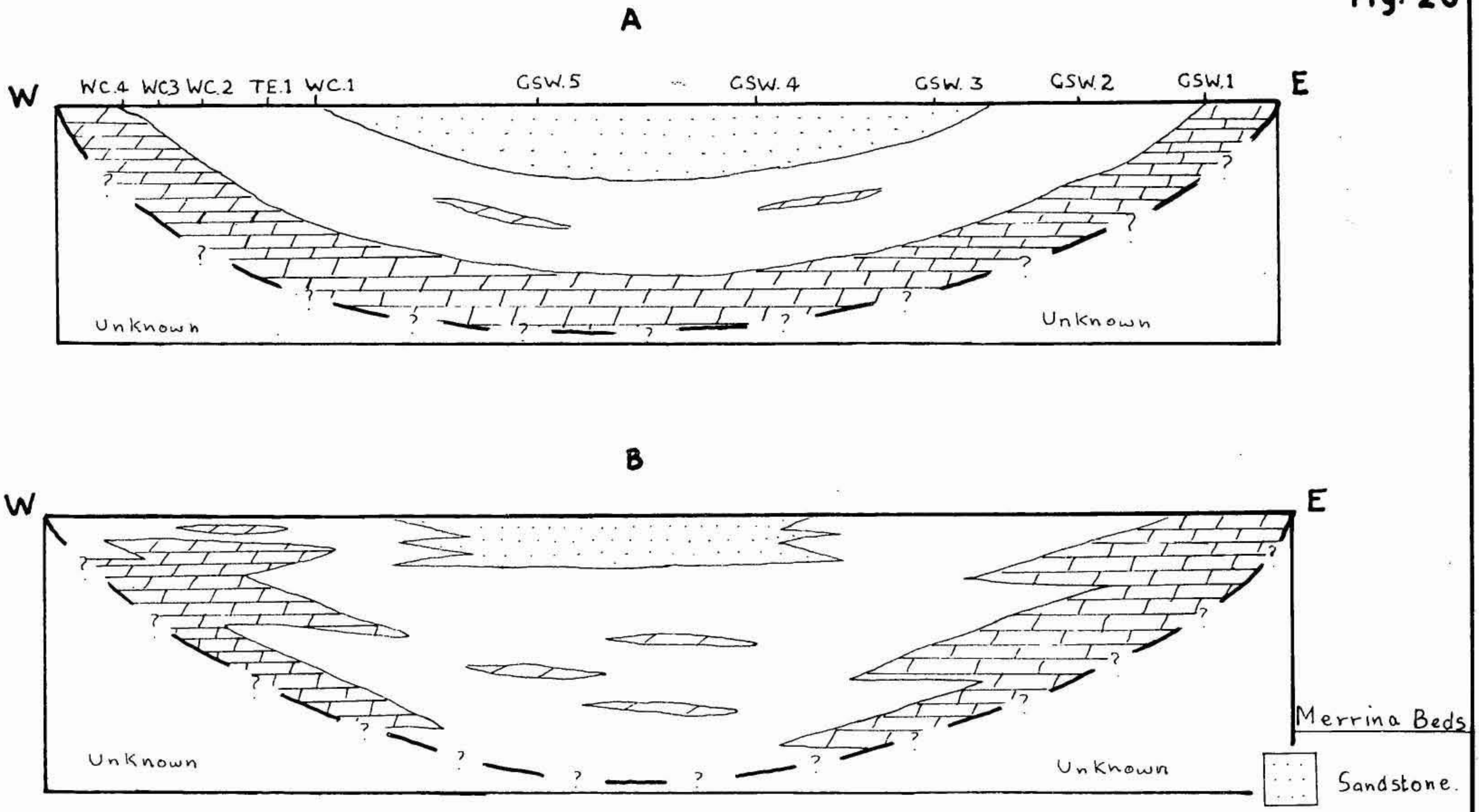
It was not possible to determine any lateral variations in the thickness of the 'basal' dolomite unit as only one well reached the base of this unit. Similarly lateral variations in the thickness of the upper sandstone unit could not be determined as the top of the unit is eroded. The interbedded siltstone, claystone and dolomite unit thickens westward from G.S.W. No. 2 to G.S.W. No. 4 and to W.C. No. 2 and T.E. No. 1, and possibly thins north-westwards to W.C. No. 1.

A study of the solid geology of the basin (Fig.28) shows that the wells were sited parallel to the regional strike and the Cambrian rocks encountered in wells are of the same general age. It appears, then, that the sediments of the three units accumulated with little variation from east to north-west (Fig. 26A). However, it is possible that these units may be wholly or partly diachronous. (Fig. 26B). The topographic, structural and palaeontological control is inadequate to determine this.

AEROMAGNETIC SURVEYS

The age of the magnetic basement is speculative. Lower Proterozoic, Carpentarian and Adelaidean sedimentary rocks underlie the known Palaeozoic succession. The results of an aeromagnetic and radiometric survey carried out on TENNANT CREEK and eastern GREEN SWAMP WELL by the B.M.R. (Spence, 1962) indicated that the Lower Proterozoic Tomkinson Creek Beds are weakly magnetic. The Mount Winnecke Sandstone is lithologically similar to the Tomkinson Creek Beds and may also be weakly magnetic. Results of aeromagnetic surveys in the Georgina Basin indicate that Adelaidean and Lower Cambrian rocks are not

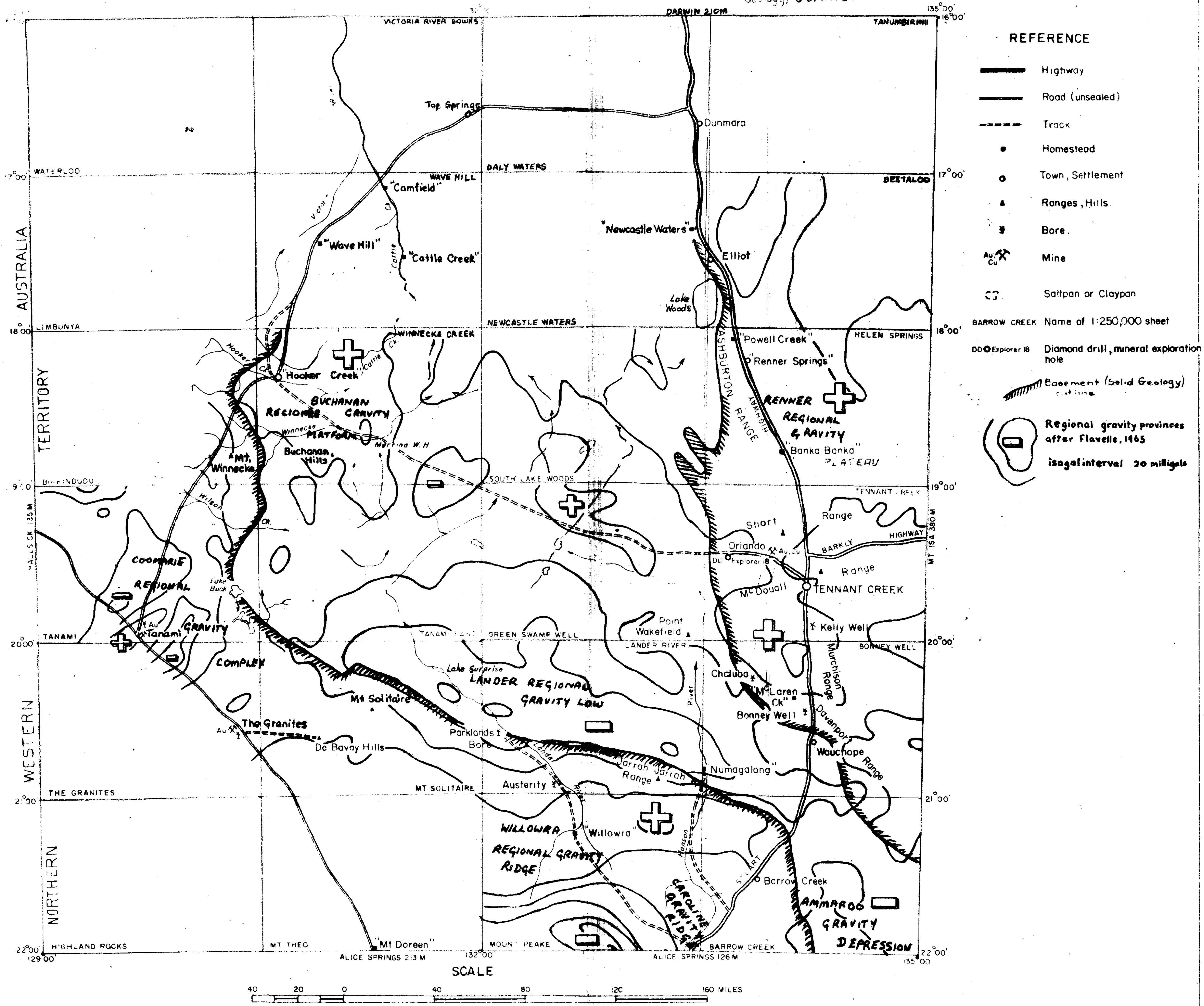
Fig. 26



ALTERNATIVE DIAGRAMMATIC CROSS SECTIONS, WISO BASIN. (NORTHERN HALF)

TO ACCOMPANY RECORD 1966/47

Figure 27 Wiso Basin - Bouguer Anomalies, Aeromagnetic Depth to Basement estimates and Basement (Solid Geology) Outline.



Bureau of Mineral Resources, Geology and Geophysics, February 1966

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GJS

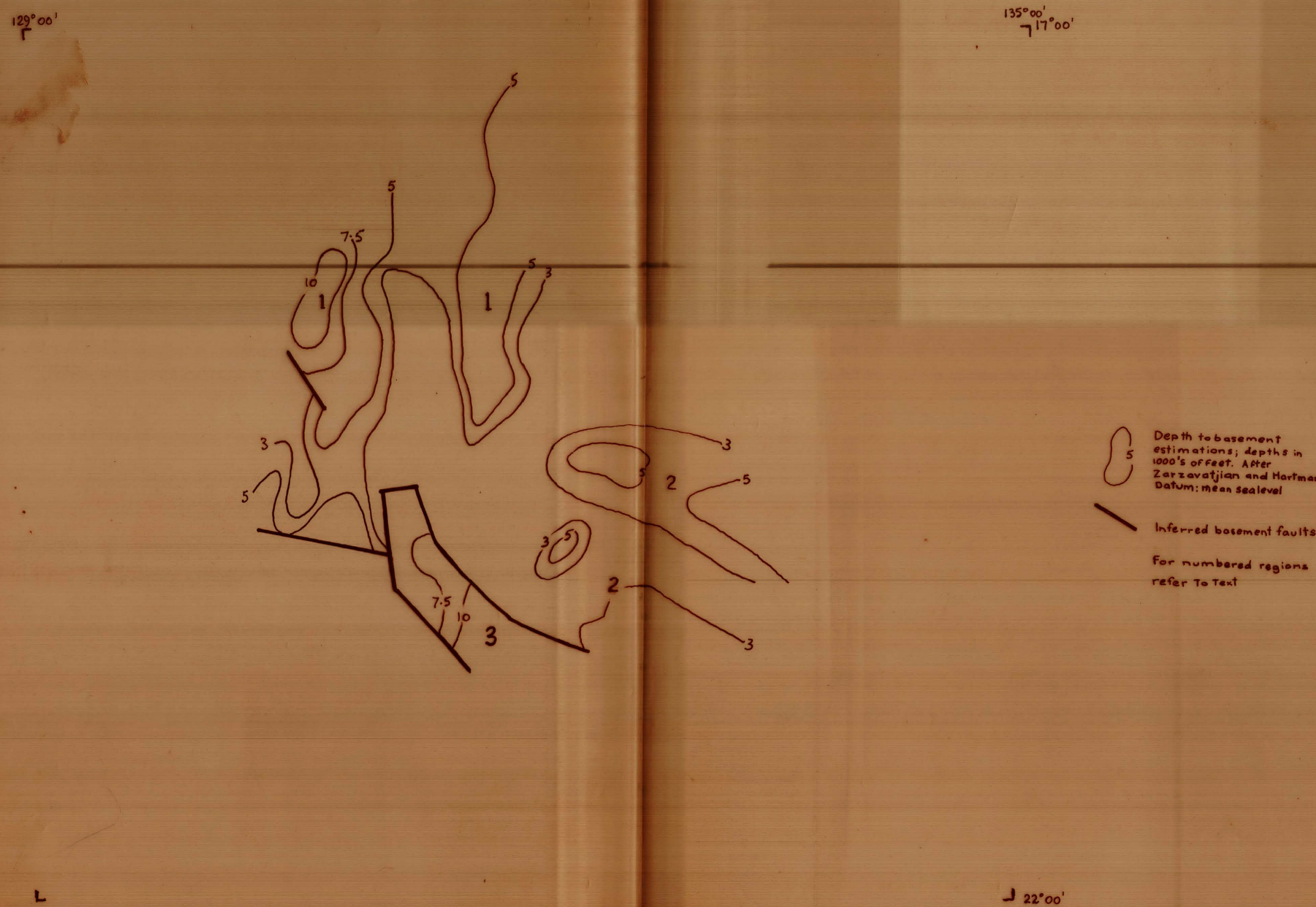
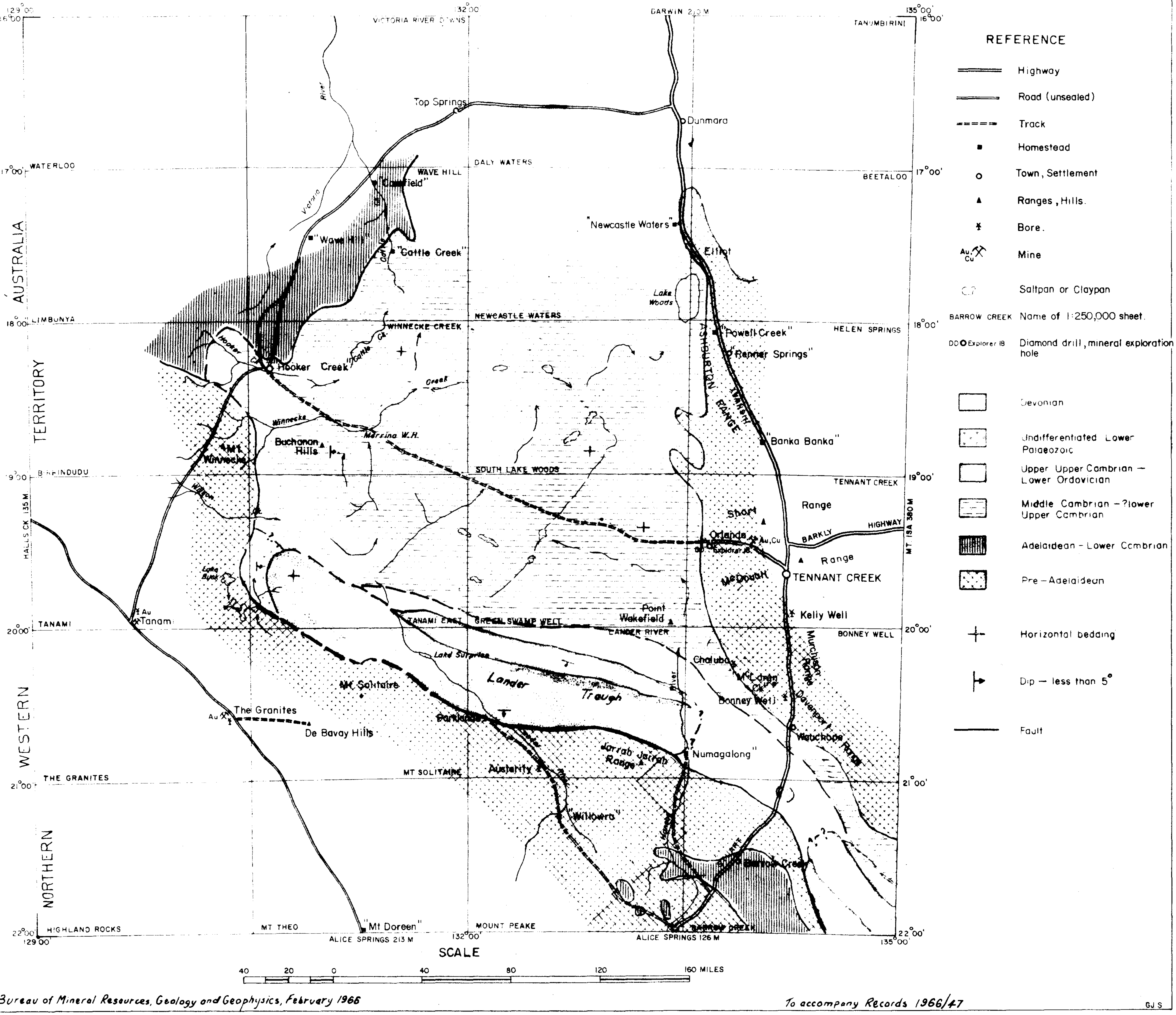

129°00'
135°00'
17°00'
22°00'
Depth to basement estimations; depths in 1000's of feet. After Zarzavatjian and Hartman
Datum: mean sealevel
Inferred basement faults
For numbered regions refer to Text

Figure 28 Wiso Basin - Solid (Pre-Tertiary) Geology and Structure.



Bureau of Mineral Resources, Geology and Geophysics, February 1966

To accompany Records 1966/47

GJS

effectively magnetic. Magnetic basement, therefore, may be considerably older than the economic basement for petroleum exploration.

Depths to basement of 6,000 feet below sea level on GREEN SWAMP WELL were estimated from the B.M.R. 1962 aeromagnetic traverse (unpublished B.M.R. files). The deepest B.M.R. core hole established that Middle Cambrian sediments were present at 100 feet above sea level near the middle of the GREEN SWAMP WELL section of the traverse.

In 1964, Aero Service Ltd., carried out an aeromagnetic survey over the area for Exoil Oil Co. Pty. Ltd. (Zarzavatjian and Hartman, 1964). A number of structural features were interpreted from depth to basement calculations (Fig. 27):

1 - Two north - south oriented depressions in the west of the area. The evidence for the easterly depression was weak. The trend of these depressions is parallel to structural trends in the Mount Winnecke Sandstone and may, in fact, be caused by the presence of this Sandstone.

2 - Two west-north-west depressions in the south-east of the area. The evidence for the southern of these was weak, but the general configuration of the Basin in this area was considered to be reliable. The trend of these depressions is oblique to the structural trend of the Tomkinson Creek Beds and may represent an underlying sequence of Adelaidean or Lower Cambrian sedimentary rocks.

3 - A prominent structural indication, interpreted as a large north-west trending graben with the southern flank intruded by dykes, is, for the most part, parallel to, although centred south of, the Lander Trough and the Lander Regional Gravity Low (Flavelle, 1965) which is probably bordered to the south by regional faults intruded by quartz and pegmatite dykes.

GRAVITY SURVEY

The area was covered by a regional gravity survey carried out by Wongela Geophysical Pty. Ltd, for the Geophysical Branch, B.M.R. Three major gravity features were recognised in the area occupied by Palaeozoic sedimentary rocks (Flavelle, 1965) (Figure 27).

1. Lander Regional Gravity Low. This trends west-north-west across the southern part of the area and coincides with the area of outcrop of Middle Palaeozoic and the youngest Lower Palaeozoic rocks. Flavelle (loc. cit.) points out that a thick sequence of sedimentary rocks might be expected in this area. He also points out that an appreciable thickness of sedimentary rocks could be expected to extend north and east if dense dolomite occurred in the section. (Dolomite has been recovered from scout holes drilled north and east of the Lander Regional Gravity Low). It is probable that Adelaidean sedimentary rocks occur in the area of the Lander Regional Gravity Low. This area has structural and depositional similarities with the Dulcie and Toko Synclines (Georgina Basin) where Adelaidean sedimentary rocks crop out on the south west flanks. Also, Adelaidean sedimentary rocks have a widespread development south and east of the Lander Regional Gravity Low, and probable Adelaidean - Lower Cambrian glauconitic sandstone has been identified by E.N. Milligan, 50 miles to the south, on MOUNT PEAKE.

2. Buchanan Regional Gravity Platform. The higher gravity area is located around the outcrop of the Antrim Plateau Volcanics on WINNECKE CREEK. The extension of the Platform across north-east WINNECKE CREEK may reflect a south-east extension of the Antrim Plateau Volcanics under the Merrina Beds. However, the aeromagnetic data does not appear to support this.

GEOLOGICAL HISTORY

Erosion in pre-Adelaidean times developed a terrain of irregular relief with low areas of crystalline rocks and high areas of resistant quartzites. The region subsided during Adelaidean to early-Palaeozoic time. Shallow water argillaceous and glauconitic sandstone and dolomite were the first sediments to be deposited in nearby areas, they may have been the first sediments in parts of the Wiso Basin. Volcanic activity in the north-west resulted in the extrusion of plateau type basalt lava flows and ejection of tuff.

Lower Middle Cambrian fossiliferous limestone was in places (e.g. west TENNANT CREEK) deposited directly on the basement, during a transgression under stable tectonic conditions. At the same time, carbonate muds were being deposited in confined basins enriched in magnesium. Increase in salinity resulted in a diminution of the fauna. A gradual increase in tectonism followed which resulted in an increase in terriginous material, firstly clay, then fine sand and silt, and finally, medium to coarse grained sand. Shallow water conditions prevailed, as evidenced by cross bedding structures, the formation of glauconite and algal and nodule dolomites.

Conditions in Upper Cambrian time are unknown in the Wiso Basin. The sediments of the neighbouring Georgina Basin show a vertical transition from dense carbonate muds to illitic, pelletoid and oolitic carbonates with sandstone interbeds (Arrinthrunga Formation) and finally to kaolinitic sandstone (Tomahawk Beds). The nearest Georgina Basin sedimentary rocks to the Wiso Basin are on BARROW CREEK where less information is available. However, fossiliferous Upper Cambrian kaolinitic sandstone does outcrop, and is underlain by pelletoid and oolitic dolomite (mapped as Tomahawk Beds by Smith and Milligan, 1964). Also, fossiliferous Upper Cambrian dolomitic siltstone and pelletoid (?oolitic) dolomite was recorded from a B.M.R. core-hole, Grg 18, drilled on the Stuart Highway (Milligan, 1963). On the northern margin of the Georgina Basin on BARROW CREEK unfossiliferous rocks with similar lithologies to the Merrina Beds lie directly on Lower Proterozoic basement. These beds have been mapped by Smith and Milligan (1964) as Tomahawk Beds, but may be time equivalents as well as lithologic equivalents of the Merrina Beds. It is possible, then, that conditions in the Upper Cambrian, in at least the south-east part of the Wiso Basin, were similar to those in the Georgina Basin.

Early Ordovician sedimentation in the Wiso Basin was of open shelf type; strong currents partly sorting sand and silts and almost completely winnowing and concentrating shelly and phosphatic pelletal carbonate sediments.

Uplift of part, if not all, of the area, and erosion of Ordovician (and perhaps, in the west, Cambrian) rocks resulted from the increasing tectonic activity during the Cambrian and Ordovician Periods. No Silurian rocks are known. Subsidence in the south during the Upper Devonian resulted in the deposition of argillaceous sands in ?freshwater conditions. Tectonic activity culminated in the uppermost Devonian and appears to have been concentrated in the southern part of the basin. Faulting in this area probably delineated the present day outline of the southern margin of the basin.

Following this orogeny, stable tectonic conditions prevailed. Subsidence occurred in Lower Cretaceous times, and sediments were deposited north and north-east of the area (marine fossils are preserved on HELEN SPRINGS (Randal, Brown and Doutch, 1966)). A long period of emergence followed, when extensive planation and later deep weathering produced bevelled surfaces and pisolitic laterite plains. Probably in Miocene times, there was a marine incursion north-east of the Wiso Basin. The associated rise in base level of the drainage system resulted in widespread ponding and the formation of calcareous lacustrine deposits.

Increasing (?Pleistocene) aridity resulted in the mobilisation of large areas of alluvium, with resulting development of aeolian deposits. These deposits have since been subjected to erosion under more humid atmospheric conditions and, especially in the west, aeolian dunes have been eroded into low sandhills and broad sand plains. No loess deposits have been recognised in the area.

ECONOMIC GEOLOGY

Underground Water Prospects:

Five rock units in the area are known to contain aquifers supplying moderate to good quantities of good water in the area.

(1) Antrim Plateau Volcanics: These rocks are restricted to north-west Winnecke Creek. Aquifers in these rocks supply large quantities of good water on Wave Hill Station on WAVE HILL. Two bores on Hooker Creek Native Welfare Settlement, almost certainly drilled in the volcanics, give supplies of 1200 and 1900 gph.

(2) Middle Cambrian friable sandstone (Merrina Beds): G.S.W. 5 (and perhaps G.S.W. 4) encountered aquifers in this unit in north-west GREEN SWAMP WELL where the piezometric surface is approximately 740 feet above sea level. This unit has not been encountered in other scout holes below the piezometric surface and may contain useful aquifers in western GREEN SWAMP WELL.

(3) Vughy Middle Cambrian dolomite (Merrina Beds and Montejinni Limestone) is known only from the northern part of the area. Water obtained from aquifers in the eastern part of the area are of suitable quality for domestic or stock use, although the flouride content was as high as 3.5 parts per million in G.S.W. 3.

(i) WINNECKE CREEK and SOUTH LAKE WOODS. Vughy dolomite has been encountered in bore holes and in outcrop over a wide area at elevations of between 750 and 800 feet. No information on the piezometric surface is available, but if it is comparable to that in the GREEN SWAMP WELL area, good water should be expected at shallow depths over most of the area. An exception is in the region of core hole W.C.3 which reached 162 feet (approximately 650 feet above sea level) without striking dolomite.

(ii) TANAMI EAST: T.E.1 reached 412 feet (approximately 600 feet above sea level) before striking dolomite; deeper drilling in this area may be necessary to reach vughy sections in the dolomite.

(iii) GREEN SWAMP WELL: In the eastern sector of northern GREEN SWAMP WELL, aquifers in the dolomite occur below the level of the piezometric surface (approximately 750 - 800 feet above sea level). In the central sector of northern GREEN SWAMP WELL the dolomite is somewhat deeper (between 450 and 200 feet above sea level).

(iv) Tertiary sediments. Bob's Well draws water (750 gph) from shallow depths in Tertiary limestone in south-west LANDER RIVER. Good aquifers are common in this type of limestone in central Australia. The limestone is widespread in central GREEN SWAMP WELL and central and south-central TANAMI EAST. It also crops out locally on other Sheet areas. Local developments of clay can be expected to be associated with some Tertiary limestones; limestone outcrop surrounds the site of G.S.W. 1, but the well penetrated approximately 90 feet of probable Tertiary clays.

(v) Quaternary deposits: Variable supplies of good quality water are drawn from Quaternary alluvium on the Hanson and Lander Rivers. No information is available on subsurface water from any of the alluvial basins of the other larger river systems.

Petroleum Prospects:

Most of the area is considered to be non-prospective for commercial hydrocarbon accumulations, due to the lack of Palaeozoic sections with suitable lithologic characteristics; the exception is the Lander Trough in the southern part of the area (Fig. 28). The assumption that this is indeed a trough of Lower Palaeozoic sedimentary rocks, and the preliminary assessment of its prospects, must be based on the following considerations -

Thickness: (a) aeromagnetic data suggests depths to basement of the order of 5,000 - 10,000 feet;

(b) analysis of the gravity gradient at the southern boundary of the Lander Regional Gravity Low suggests thicknesses of sedimentary rocks of the order of over 10,000 feet (pers. comm. A. Flavelle);

(c) lithologic and (less certainly) structural similarity can be recognised with some units in the Dulcie Syncline in the west of the Georgina Basin where over 6,000 feet of Cambrian sedimentary rocks occur (Smith, 1965).

Extent: Assuming Cambrian, Ordovician (and perhaps younger) rocks underlie Devonian outcrop in the eastern part of the Trough, the Trough is approximately 4,000 square miles in area. If the rocks on TANAMI EAST, mapped as undifferentiated Lower Palaeozoic, are uppermost Cambrian or Ordovician then the area of the Trough would exceed 5,000 square miles.

Age: Evidence of the proportions of the various ages of the sedimentary rocks in the Lander Trough is incomplete. Comparisons could be made with the section in the Georgina Basin (on HUCKITTA) where the proportions of Adelaidean/Lower Cambrian to Cambro-Ordovician to Devonian are 2:3:1. However, information on the Palaeozoic section on BARROW CREEK is too poor to allow any really meaningful extrapolation from the HUCKITTA area. Adelaidean/Lower Cambrian can be expected to occur in the Lander Trough, as rocks of this age crop out south and south-east of the Trough (at least 1 - 2,000 feet of Adelaidean/Lower Cambrian section crops out on BARROW CREEK). No useful information is available to allow postulation of the presence in the Trough of rocks of any other age than those actually cropping out.

Nature of the sediments: Again, making a comparison with the rocks of the Georgina Basin, Adelaidean and early Cambrian sandstones must be considered to have poor or no prospects for commercial accumulations of hydrocarbons; outcrop and well samples are almost invariably highly argillaceous and/or indurated. The Grant Bluff Formation does, however, contain some beds of clean porous sandstone.

The lower Middle Cambrian to lower Upper Cambrian rocks of the Georgina Basin are predominantly calcareous or dolomitic. More than 20 stratigraphic wells have penetrated an aggregate exceeding 20,000 feet of rocks of this age in the Georgina Basin. Five wells have encountered traces of hydrocarbons - organo-metallic 'bitumen', waxy oil and rare gas - from vughy limestone and dolomite. Petroliferous odour is not uncommon in lower Middle Cambrian limestone and calcareous shale in outcrop and in three wells. In the Wiso Basin, scout-hole G.S.W. 1 encountered Middle Cambrian dolomite with a show of hydrocarbons. The indications are, then, that the Middle Cambrian carbonate sequence of the Wiso Basin may have contained source beds but are less likely to have suitable reservoir conditions.

The Middle Cambrian sandstone (Merrina Beds) of the northern part of the Wiso Basin is, for the most part, highly argillaceous. The reservoir characteristics of the sandstone could, however, change, if the sandstone extends south into the Lander Trough.

Good reservoir rocks can be expected in the Hanson River Beds. Sandstones are lithologically similar to the Upper Cambrian - Lower Ordovician Tomahawk Beds sandstone which forms good aquifers in the Georgina Basin. Petrological observations on samples of pellet carbonates shows that strong current action causing winnowing were active during the time of deposition of the Hanson River Beds. These are likely to have produced clean sandstones. Dololutites and siltstone in the Hanson River Beds could be suitable cap rocks.

The argillaceous nature of the Dulcie Sandstone indicates that it is unlikely to provide extensive reservoirs for hydrocarbon accumulation.

Tectonic and depositional history. Indications are that the earlier Cambrian sediments were deposited in paralic and shallow marine environments under stable shelf conditions (at least in the northern part of the basin). Later sediments were deposited in shallow marine environments under unstable shelf conditions. Thus, a sequence of tectonic - environmental conditions occurred which was favourable for hydrocarbon migration and accumulation.

Phosphate

Two samples of quartzose pellet dolomite from north central LANDER RIVER wer analysed at 10.6% and 3.2% P_2O_5. The samples were collected approximately 5 miles apart but the extent of the bed(s) is unknown due to extensive sand cover in the area.

The phosphate occurs as rolled pellets which may be clasts or pellets concentrated by winnowing of finer material. The remoteness of the area and the poor outcrop make the region a poor prospect for commercial development.

RECOMMENDATIONS FOR FUTURE WORK

Ground Traverse:

(1) On south-west TANAMI EAST to determine the age (or ages) of the rocks mapped there as undifferentiated Lower Palaeozoic;

(2) On north-east LANDER RIVER to establish:-

(i) presence or absence of Upper Cambrian fossils in the Hanson River Beds;

(ii) the Ordovician stratigraphic and fossil succession.

Stratigraphic drilling:

A north-south line of shallow holes drilled along the Hanson River on LANDER RIVER and southern GREEN SWAMP WELL to determine the age and lithology of the rocks lying stratigraphically between the Merrina Beds and the Hanson River Beds; or, a deep well in the Lander Trough to determine the nature, reservoir characteristics and extent of sedimentary rocks under the Hanson River Beds.

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APPENDIX I

WISO SCOUT DRILLING

LITHOLOGICAL DESCRIPTIONS.

GREEN SWAMP WELL NO. 1

0 - 10 feet	Sand, clay: 20%, red, brown, rounded quartz, med.grained: clay minerals. Calcareous clay and sand; 80% white, light grey clay and crystals, soft.
10 - 20 feet	Calcareous clay and sand: 95%, white, light grey, clay and calcite crystals, soft. Chert: 5%, white, cryptocrystalline slightly calcareous; some veining, hard. (19-20 feet hard).
20 - 30 feet	Clay: 60%, brown, white, soft, brown external stain, some quartz grains. Calcareous clay and sand: 30%, white, microcrystalline, clay minerals, soft. Limestone: 10%, white, microcrystalline, medium hard.
30 - 40 feet	Clay: 50%, brown, rare quartz grains, soft, partly indurated?, ferruginous? Calcareous clay: 49%, white, clay minerals, slightly calcareous, soft. Limestone: 1%, white, microcrystalline, hard, (brown clay - white clay at 35 feet).
40 - 50 feet	Calcareous clay: 100%, brown, yellow, some white, partly ferruginous?, soft, some quartz silt.
50 - 60 feet	Clay: 100%, brown, white, soft, some silt, ferruginous?
60 - 70 feet	Clay: 100%, brown, white, soft, some silt, ferruginous?
70 - 80 feet	Clay: 85%, brown, white, soft, some silt, ferruginous? Chert: 15%, cryptocrystalline, white, light grey, brown, hard.
80 - 90 feet	Clay: 50%, brown, white, soft, some silt, ferruginous? Calcite sand: 40%, brown, calcite crystals, medium crystalline, possibly soft limestone, (change at 86 feet) Chert:8%, white, light brown, microcrystalline. Limestone: 2%, light brown, microcrystalline - medium crystalline, soft.
90 - 100 feet	Calcareous dolomite: 90%; 50% brown, microcrystalline, saccharoidal, and silty (quartz), hard. 50% white, light grey, microcrystalline, rare quartz silt, some veining, hard. Clay: 10%, white, soft.

100 - 110 feet	Calcareous dolomite: 70%; 50%, brown, microcrystalline, saccharoidal, partly dolomitic and silty, hard. 50% white, light grey, microcrystalline, rare quartz silt, some veining, hard. Clay: 30% as above (cavings?)
110 - 120 feet	Dolomitic limestone: 75%, brown, microcrystalline, some silt, ferruginous hard. Calcareous dolomite: 20%, light grey, microcrystalline, clayey, quartz? silt, some chert fragments, medium hard. Chert: 5%, brown, cryptocrystalline, hard. (WATER 119 feet Supply 300-400gph)
120 - 130 feet	Calcareous dolomite: 100%; 50%, light grey, microcrystalline, clayey, medium hard. 50%, brown, microcrystalline, silt? ferruginous, hard.
130 - 140 feet	Dolomite: 95%; 40%, brown, micro-medium crystalline, partly silty, slightly calcareous, some chert? fragments (fossils?), hard. 40%, grey, microcrystalline, slightly calcareous. 20%, light grey, saccharoidal, micro-medium crystalline, silty, some chert fragments (fossils?), hard. Chert: 5%, brown, grey, cryptocrystalline, hard.
140 - 147 feet	Dolomite; 90%; 70% brown, micro-medium crystalline, ferruginous? slightly silty. 30%, white, brown, mottled, microcrystalline, partly siliceous, hard. Chert; 10%, brown, grey, cryptocrystalline.
147 - 147'9"	CORE NO.1
147'9" - 150 feet	Dolomite; 90%, brown, grey, microcrystalline, ferruginous, slightly silty, hard, tight. Chert; 10%, brown, grey, cryptocrystalline.
150 - 160 feet	Dolomite; 98%, grey, brown, brown and red mottled (1%), microcrystalline, ferruginous, some silt, hard, tight. Chert; 20%, grey, cryptocrystalline, hard.
160 - 170 feet	Dolomite; 100%, grey, brown, mottled microcrystalline, with medium crystalline patches, saccharoidal, ferruginous, small siliceous parts (fossil? fragments), hard, tight, Mn dendrites. (More water 160' - air lifting 1,000 gph.)
170 - 180 feet	Dolomite; 100%, light brown-grey, micro-medium crystalline, partly ferruginous, hard, tight.

180 - 190 feet	Dolomite; 100%, light brown-grey, micro-medium crystalline patches, saccharoidal in parts, vughy, fractures, hard, porous. (More water at 187 feet; 2,000 gph.)
190 - 200 feet	Dolomite; 98%, grey-brown, micro-medium crystalline, ferruginous, veins, hard, partly fractured, fossil(?) fragments. Chert; 20%, dark brown-orange, cryptocrystalline, with fossil? fragments or clasts?
200 - 210 feet	Dolomite; 100%, light brown, grey, micro-medium crystalline patches, slightly silty (grey), some saccharoidal, ferruginous, rare silicified fragments, hard, partly fractured.
210 - 220 feet	Dolomite; 98%; 90%, dark grey, microcrystalline, carbonaceous?, argillaceous, silty?, hard, tight. Some veins, white, medium crystalline dolomite with tarry residue. Pyritic 10%, light brown-light grey, microcrystalline, as above. Clay-siltstone; 2%, black, argillaceous, carbonaceous, soft, fissile. (as laminae?)
220 - 230 feet	Dolomite; 95%. As above. Clay-siltstone; 5%. As above.
230 - 240 feet	Dolomite; 100%; 8%, light grey, very light brown, micro-medium crystalline, saccharoidal, light. 20% dark grey, microcrystalline, argillaceous, carbonaceous?, silty? hard, tight, some mottling, veins of white dolomite with tarry residue. Rare clay-siltstone.
240 - 250 feet	Dolomite; 100%; 50%, dark grey, microcrystalline, argillaceous, carbonaceous? 30% light brown, microcrystalline. 20% green-grey, microcrystalline, argillaceous, soft, tight. Pyritic.
250 - 260 feet	Dolomite; 100%; 80%, green-grey, microcrystalline, argillaceous, tight-soft, pyritic. 20% red-brown microcrystalline, argillaceous, ferruginous?, soft. Some dark grey as above (caving?)
260 - 270 feet	Dolomite; 98%; 80%, dark red-brown, microcrystalline, argillaceous, ferruginous?, silty (mica?), soft, tight, pyritic. 20%, light brown-grey, mottled, microcrystalline, soft. Some vughs, porous. Some thin, alternating clay and silt laminae. Quartz sandstone; 2%, purple, fine-medium grained, poor to average sorting, sub-angular to sub-rounded quartz (90%); ferruginous matrix.

270 - 280 feet	Quartz sandstone; 90%; 90%, purple, rare white mottling, medium grained, rare coarse grained quartz, some blue chert? grains; average sorting, sub-angular to sub-rounded, ferruginous. 8%, white, medium grained, sub-rounded, average to well sorted, some black insolubles. 20%, red-brown, medium grained, poor-average sorting; ferruginous and siliceous matrix; medium hard. Dolomite; 10%, red-brown, microcrystalline, argillaceous, ferruginous soft. (Caving?).
280 - 290 feet	Quartz sandstone; 95%, as above. Dolomite; 5%, as above. (Caving?).
290 - 300 feet	Quartz sandstone; 98%, as above. Dolomite; 2%, as above (Caving?)
300 - 305 feet	Quartz sandstone; 100%, as above.
	CORE NO. 1 (Rec. 7 inches)
147 - 147'9"	Dolomite; grey, brown, mottled, microcrystalline, ferruginised, partly silicified, blue-white cryptocrystalline chert - irregular nodules. Some fine grained pellets. Some blue-black spots, (manganese?), hard, tight.

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T.D. 305 feet

GREEN SWAMP WELL NO. 2.

0 - 10 feet	Claystone; 80%, brown, argillaceous, micaceous, soft. Sand, clay, ironstone gravel; 20%, brown, red, quartz, clay minerals, brown, ferruginous gravel.
10 - 20 feet	Claystone-siltstone; 100%, white, brown, quartz silt, argillaceous, micaceous? ferruginous, soft.
20 - 30 feet	Siltstone; 100%, red-brown, silty, argillaceous, friable, soft, some fine grained quartz sand; ferruginous.
30 - 40 feet	Siltstone; 70%, as above. Clay; 30%, brown, rare grey, soft.
40 - 50 feet	Siltstone; 70%, as above. Clay; 30%, as above.
50 - 60 feet	Siltstone; 70%, as above. Clay; 30%, as above.
60 - 70 feet	Siltstone; 100%, light brown, fawn, light grey, quartzose, micaceous, argillaceous, soft. Some clay.
70 - 80 feet	Siltstone; 100%, as above.
80 - 90 feet	Dolomitic siltstone; 50%, dark red-brown, argillaceous, micaceous, quartzose, micro-crystalline, soft. Siltstone; 48%, very light grey, brown, quartzose, argillaceous, soft. (Some dolomitic fine gr. sandstone).

90 - 100 feet	Dolomitic siltstone; 98%; 90%, as above. 10% very light grey-brown, silty microcrystalline, soft. Dolomitic sandstone; 2%, grey, fine grained, soft.
100 - 110 feet	Dolomitic siltstone; 98%; 90% (as above). 10% (as above). Dolomitic sandstone; 2%, as above.
110 - 120 feet	Dolomitic siltstone; 100%, red-brown, argillaceous, micaceous, quartzose, microcrystalline, ferruginous, soft. Some light grey siltstone. Rare fine-grained quartzose dolomite.
120 - 130 feet	Dolomitic siltstone; 100%; 90%, as above. 10% light grey, silty, microcrystalline, argillaceous, tight. Some fine grained quartzose dolomite.
130 - 140 feet	Dolomitic siltstone; 100%, as above.
140 - 150 feet	Dolomitic siltstone; 100%, as above.
150 - 160 feet	Dolomitic siltstone; 100%, as above
160 - 170 feet	Dolomitic siltstone; 70%; 50%, very light brown, microcrystalline, quartzose, micaceous, argillaceous. 50% dark red-brown, microcrystalline, quartzose, argillaceous, soft, ferruginous. Dolomite; 20%, very light brown, microcrystalline, hard, tight. Chert; 10% light brown, grey, cryptocrystalline, hard.
170 - 180 feet	Dolomitic siltstone; 95%, dark red-brown, silty (quartz), argillaceous, micaceous, microcrystalline, ferruginous, soft. Dolomite; 5%, light brown, microcrystalline, saccharoidal, slightly calcareous, hard, tight. Rarely quartzose.
180 - 190 feet	Dolomitic siltstone; 100%, as above.
190 - 200 feet	Dolomitic Siltstone; 90%, as above. Dolomite; 10%, very light brown-grey, microcrystalline, hard, tight, Rare quartzose dolomite, 1%, hard, tight. (Water at 197 feet : 800 gph.)
200 - 210 feet	Dolomite; 70%, light brown, microcrystalline, hard, vughy porosity. Dolomitic siltstone; 30%, dark red brown, rare grey mottling, argillaceous, micaceous, quartzose, ferruginous, soft, tight.
210 - 222 feet	Dolomite; 98%, light grey, light brown, medium grey, microcrystalline, partly argillaceous (med. grey), hard, vughy porosity. Chert; 2%, light grey, cryptocrystalline, hard.

CORE NO. 1 (Rec. 5' 0")

222' - 227'6"

7 inches	Dolomite; brown, green, grey, microcrystalline, quartz silt (20%), argillaceous, hard, tight.
3 inches	Dolomite; green, brown, silty, argillaceous, black carbonaceous? flecks.
3½ inches	Clay; grey, green, silty.
4 inches	Dolomite; green, grey, microcrystalline, quartz silt, argillaceous, black carbonaceous? flecks, hard; grades to:
1' 2"	Dolomitic siltstone; dark red-brown, argillaceous, microcrystalline, ferruginous, partly mottled, slightly quartzose, soft.
9 inches	Dolomite; grey, green, some brown, microcrystalline, argillaceous, banded (clay? minerals), some quartz silt, some argillaceous layers, hard.
7½ inches	Clay; brown.
6 inches	Dolomite; grey, green, mottled brown, microcrystalline, some fine quartz silt, slightly argillaceous, hard.
3 inches	Clay; medium grey, silty.
3 inches	Dolomite; medium grey, green, mottled brown, quartz silt, black carbonaceous? flecks and laminae discontinuous, hard, tight.

T.D. 227 feet 6 inches

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GREEN SWAMP WELL NO. 3

0 - 10 feet	Sand and clay; 80%, red-brown, quartz and clay minerals. Ironstone gravel; 20%, purple, brown, ferruginous, hard.
10 - 20 feet	Clayey sandstone; 90%, orange, yellow, brown, argillaceous, fine grained, angular-sub-angular quartz, ferruginous, soft. Clay-siltstone; 10%, yellow, white, clay minerals and quartz silt, soft.
20 - 30 feet	Siltstone; 50% red-brown, micaceous, argillaceous, quartz? silt, ferruginous, soft. Quartz sandstone; 50%, white, brown mottling, fine grained quartz, sub-angular, well sorted, soft.

30 - 40 feet	Quartz sandstone; 90%, white, brown, yellow mottling, fine-medium grained, poor sorting, sub-rounded, white, hard, clay? matrix, tight. Siltstone; 10%, brown, red, argillaceous, soft.
40 - 50 feet	Siltstone; 95%, red, brown, white-tan, tan (alternating thin beds), micaceous, quartz silt, argillaceous, laminated (banded-white/tan), fine-grained quartz, angular, average sorting, some very fine grained quartz sand, hard, tight. Quartz sandstone; 5%, white, fine-grained, sub-angular, average sorting, hard.
50 - 60 feet	Siltstone; 95%, as above. Quartz sandstone; 5%, white, yellow-brown mottled, fine-medium grained, sub angular - sub rounded, average sorting, medium hard. Hard white clay? matrix.
60 - 70 feet	Siltstone; 80%, as above. Claystone; 10%, purple, grey, yellow, argillaceous, soft. Quartz sandstone; 10%, white, yellow, fine-medium grained, poorly sorted, sub-rounded, hard. Some insoluble black minerals, (tourmaline?).
70 - 80 feet	Siltstone; 70%, yellow-tan, brown-red, grey, quartz silt, micaceous, argillaceous, fissile, medium hard; black spots, (Mn?). Clay; 20%, yellow, tan, purple, grey, argillaceous, soft. Quartz sandstone; 10%, grey, fine-grained, sub-angular to sub-rounded, average sorting, clay? matrix, medium hard.
80 - 90 feet	Siltstone; 80%, grey, brown-red, micaceous, argillaceous, quartz silt, soft. Clay; 15%, brown, purple, argillaceous, soft. Quartz sandstone; 5%, grey, fine grained, average sorting, micaceous.
90 - 100 feet	Siltstone; 60%, as above. Quartz sand; 30%; 90% purple, medium grained, sub-angular, average sorting, loose, soft. 10% white, fine grained, average sorting, sub-rounded, medium hard. Clay; 10%, brown, tan, argillaceous, soft. (Possibly soft sandstone).
100 - 110 feet	Quartz sand; 100%, brown, white, fine-medium grained, sub-angular to sub-rounded, poorly sorted, loose. (Possibly soft sandstone).
110 - 120 feet	Quartz sand; 100%, as above.
120 - 130 feet	Quartz sand; 90%, dark yellow, brown, as above. Quartz sandstone; 10%, dark yellow, fine grained, some medium grained, sub-rounded, average sorting, some clay matrix.

130 - 140 feet	Quartz Sand; 50%, dark yellow, as above. Clay-silt; 40%, dark brown, quartz silt, angular, some fine sand, clay minerals, loose. Quartz sandstone; 10%, white, fine grained, soft.
140 - 150 feet	Clay-silt; 90%, as above. Some brown-yellow laminae, with scattered quartz. Quartz sandstone; 10%, white, yellow, fine grained, angular - sub-angular; well sorted, clay matrix, medium hard.
150 - 160 feet	Quartz sand; 80%, yellow-brown, fine-grained, sub-angular, well sorted, some clay, loose, (possibly soft sandstone). Quartz sandstone; 20%, as above.
160 - 170 feet	Quartz sandstone; 50%, white, grey, as above. Quartz sand; 50%, as above.
170 - 180 feet	Clay; 50%, dark brown, argillaceous, soft. Clay silt; 50%, dark brown, argillaceous, quartz silt, angular, loose. Rare white, grey quartz sandstone.
180 - 190 feet	Clay, silt, quartz sand; 100%, yellow, brown, argillaceous, quartz silt and fine sand, angular, average sorting, loose, some slightly harder bands.
190 - 200 feet	Clay, silt, quartz sand; 80%, as above. Quartz sandstone; 20%, white, yellow, fine grained, sub-angular, average sorting, medium hard.
200 - 210 feet	Siltstone-sandstone; 70%, grey, quartz silt-fine sand, angular, well sorted, argillaceous, slightly calcareous, hard. Clay; 30%, yellow, red-brown, argillaceous, ferruginous?, some silt, soft.
210 - 220 feet	Quartz sand; 60%, yellow-brown, fine grained, sub-rounded, well sorted, loose, (possibly soft sandstone). Clay-siltstone; 20%, medium grey-light brown, argillaceous, micaceous?, quartz silt, medium soft. Quartz sandstone; 20%, white, light yellow, fine grained, sub-angular, well sorted, medium hard, porous.
220 - 230 feet	Quartz sand, silt, clay; 50%, medium yellow-brown, fine grained quartz, angular - sub-angular, mixed clay and silt, loose. Clay-siltstone; 45%, as above. Quartz sandstone; 5%, white, fine grained, sub-rounded, average sorting, clay? matrix, medium hard, porous.
230 - 240 feet	Quartz sandstone; 60%, yellow, as above. Clay-siltstone; 40%, dark red-brown, purple, argillaceous, quartz silt, micaceous, ferruginous? soft.

240 - 250 feet	Quartz sand, clay; 95%, yellow, brown, white, fine quartz sand, sub-angular, well sorted, loose clay admixture. Quartz sandstone; 5%, brown-red, white, yellow, fine-grained, well sorted, ferruginous?, sub-angular, medium hard, porous.
250 - 260 feet	Quartz sand; 90%, yellow-brown, white fine grained quartz, sub-angular, well sorted, loose (possibly soft sandstone). Quartz sandstone; 10%, brown, yellow, some banding, quartz, fine grained, angular, well sorted, medium hard, clayey, ferruginous matrix.
260 - 270 feet	Sand; 90%, as above. Quartz sandstone; 10%, brown and grey, as above. Rare chert fragments.
270 - 280 feet	Quartz sand; 60%, as above. Quartz sandstone; 30%, white, brown, fine grained, well sorted, partly calcareous, medium hard, porous. Clay-siltstone; 10%, red-brown, argillaceous, micaceous? quartz silt, slightly calcareous, medium soft. Rare chert.
280 - 290 feet	Quartz sand; 50%, brown, white, as above. Quartz sandstone; 30%, brown, as above. Clay-siltstone; 20%, brown, some yellow laminae, as above.
290 - 300 feet	CORE NO. 1. (Rec. 9 feet 9½ inches)
1 foot 1 inch	Dolomitic siltstone; medium brown, rare white mottling, micaceous, argillaceous, micro-crystalline, quartz silt, ferruginous. Some fine quartz sand in white lenses.
1 foot 2 inches	Claystone-siltstone; laminae, dark brown horizontal and inclined, (slurry? beds). Small vughs, white discontinuous layers and lenses of quartzose dolomite. Dark brown clay layers, discontinuous. Some load casting and possible scour surfaces.
2 inches	Claystone and dolomitic quartz sandstone; grey-green clay layers, with lenses of light grey-brown dolomitic sandstone.
11 inches	Dolomitic quartz sandstone; very light grey-green, fine grained, microcrystalline, fine quartz silt and sand, micaceous, hard, porous; brown and green clay laminae. Alternating white brown layers, lenses, mottled, ferruginous, dark brown, micaceous, silty clay laminae.
2 foot 10 inches	Dolomitic quartz sandstone; medium-light brown, microcrystalline, fine grained, micaceous, quartz silt, hard, tight.
5 inches	Calcareous sandstone; white, light grey, fine grained, well sorted, sub-rounded quartz; white calcareous matrix, tight, hard.

3½ inches	Claystone and quartz sandstone; light brown, fine grained, quartz layers, alternating with dark brown claystone layers.
2 foot 11 inches	Dolomitic quartz sandstone; dark brown, white mottled lenses and layers (approx 1" thick), fine grained quartz, microcrystalline, argillaceous, micaceous, silty, with clayey, micaceous laminae, ferruginous. Small vughs, rarely large (1" diam), generally porous, hard.

T.D. 300 feet.

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GREEN SWAMP WELL NO. 4

0 - 10 feet	Quartz sandstone; 95%; 50%, orange, dark brown, fine grained, average sorting, sub-angular, ferruginous?, hard, siliceous matrix. 50%, white, fine-medium grained, poor to average sorting, sub-angular to sub-rounded, black insolubles, white siliceous matrix, hard, tight. Sand, clay; 5%, brown, grey, fine grained quartz, some clay minerals. Rare limestone fragments.
10 - 20 feet	Quartz sandstone; 50%, white, some brown-yellow mottling, (ferruginous?), fine-medium grained, poor-average sorting, sub-angular to sub-rounded, white siliceous matrix, hard, tight, black insolubles. Siltstone-claystone; 50%, white, very fine grained, clay minerals, angular quartz silt, fissile, tight, medium hard; rare scattered sub-angular quartz sand.
20 -- 30 feet	Quartz sandstone; 60%, white, light grey, fine grained, average to well sorted, sub-rounded, black insolubles, clay? matrix, soft porous. Claystone; 20%, white, clay minerals, scattered quartz silt, soft, tight. Clay; 20%, white, soft. (Seep of water at 21 feet, more at 23 feet)
30 - 40 feet	Claystone; 70%, as above. Clay; 20%, as above. Quartz sandstone; 10%, as above.
40 - 50 feet	Quartz sand; 70%, white, light grey, fine grained, well sorted, sub-rounded, some black insolubles, loose. Clay; 20%, as above. Quartz sandstone; 10%, as above. (More water)
50 - 60 feet	Quartz sand; 70%, as above. Clay; 30%, as above.
60 - 70 feet	Quartz sand; 90%, as above. Quartz sandstone; 10%, as above.
70 - 80 feet	Quartz sand; 80%, as above. Quartz sandstone; 10%, as above. Clay; 10%, white, soft, rare fine quartz sand and silt with red clay-silt, ferruginous laminae.

80 - 90 feet	Quartz sand; 85%, as above. Quartz sandstone; 10%, as above. Chert; 5%, brown, grey mottling, cryptocrystalline, hard.
90 - 100 feet	Quartz sand; 80%, white, as above. Quartz sandstone; 20%, as above, with red, ferruginous laminae
100 - 110 feet	Quartz sand; 80%, as above. Quartz sandstone; 20%, as above.
110 - 120 feet	Quartz sand; 70%, as above. Quartz sandstone; 30%, as above with 10% yellow-brown, ferruginous? patches.
120 - 130 feet	Quartz sand; 50%, as above. Quartz sandstone; 50%, white, light grey, fine-medium grained, some mica (muscovite?), very porous, with cavities, soft, (forms thin beds).
130 - 140 feet	Quartz sand; 80%, as above. Quartz sandstone; 20%, as above.
140 - 150 feet	Quartz sand; 55%, as above, with some yellow and light red staining. Quartz sandstone; 30%; 80% white, light grey, as above; 20%, brown, micaceous, fine-medium grained, well sorted, ferruginous? Some yellow fragments. Clay-siltstone; 15%, dark brown, argillaceous, micaceous, ferruginous, quartz silt; some red and grey, clay patches and laminae, slightly dolomitic. Chert; 10%, dark grey, cryptocrystalline, hard.
150 - 160 feet	Quartz sand; 50%, white, light grey, as above. Quartz sandstone; 45% 60%, white, light grey, as above. 40%, brown, micaceous, as above. Clay-siltstone; 5%, as above.
160 - 170 feet	Quartz sandstone; 95%, white, medium brown, medium yellow, fine-medium grained, sub-angular, average sorting, partly dolomitic (brown), ferruginous, medium porous, hard. Siltstone; 5%, dark-medium brown, argillaceous, quartz silt, ferruginous, tight, soft.
170 - 180 feet	Quartz sandstone; 100%, medium brown, minor white, yellow; medium grained, average sorting, sub-angular to sub-rounded, black insolubles, partly dolomitic, porous, medium hard.
180 - 190 feet	Quartz sandstone; 100%, brown, white, as above.
190 - 200 feet	Quartz sandstone; 100%, as above.
200 - 210 feet	Quartz sandstone; 95%, as above. Clay; 5%, white, soft.

210 - 220 feet	Quartz sandstone; 90%, brown, white, fine grained, sub-angular, average sorting, red and white laminae, black insolubles, white mica; dolomitic matrix (brown), soft, porous. Clay; 5%, white, soft, as laminae. Ironstone; 5%, (caving?).
220 - 230 feet	Quartz sandstone; 95%; 80%, brown, fine grained, average sorting, sub-angular, ferruginous, dolomitic, 15% white, light grey - as above. 5%, green-grey, fine grained, micaceous (biotite), poorly sorted, sub-angular, dolomitic, porous. Clay-siltstone; 5%, red-brown, argillaceous, quartz silt, tight, soft.
230 - 240 feet	Quartz sandstone; 65%, brown, white, grey-green, as above. Silty dolomite; 30%, medium - dark grey, microcrystalline, with glauconite, micaceous, quartz silt, hard, tight. Some light grey, white. Chert; 5%, grey, cryptocrystalline, hard. Rare brown clay-siltstone.
240 - 250 feet	Quartz sandstone; 95%; 65%, brown, fine grained, as above. 25%, white fine grained, as above. 5%, green-grey, micaceous, as above. Dolomite; 3%, white, microcrystalline, hard, tight. Chert; 2%, as above.
250 - 260 feet	Quartz sandstone; 80%; 85%, brown, fine grained, as above. 10%, white, fine grained, as above. 5%, green-grey, micaceous, as above. Siltstone; 20%, brown, quartz silt, micaceous (biotite), dolomitic, hard, tight.
260 - 270 feet	Quartz sandstone; 100%; 80%, brown, fine grained, as above. 15%, white, fine grained, as above. 5%, green-grey, micaceous, as above.
270 - 280 feet	Quartz sandstone; 100%; 70%, brown, fine grained, as above. 25%, white, fine grained, as above. 5%, green-grey, micaceous, as above. Rare grey chert.
280 - 290 feet	Quartz sandstone; 100%; 50%, brown, fine grained, as above. 50%, white, light grey, fine grained, as above. <1% green-grey, micaceous, as above.
290 - 300 feet	Quartz sandstone; 100%; 95%, brown, fine grained, as above. 5%, light grey, fine grained, as above. Rare brown, micaceous siltstone.
300 - 300' 2"	CORE NO. 1.
300'2" - 310 feet	Quartz sandstone; 80%, brown, minor green-grey, fine grained, sub-angular, well sorted, black insolubles, micaceous; dolomitic matrix, porous, medium hard. Siltstone; 20%, dark brown, argillaceous, micaceous, quartz silt, rare quartz sand, tight, soft.

310 - 320 feet	Clay-siltstone; 60%; 95%, dark brown, argillaceous, micaceous, some large biotite or black carbonaceous? material, some quartz silt, scattered quartz sand, dolomitic, soft, tight. 5%, green-grey, micaceous, clay layers, soft. Quartz sandstone; 40%, brown, grey-green, as above.
320 - 330 feet	Clay-siltstone; 70%; 60%, dark brown, as above. 20%, green-grey, argillaceous, micaceous, dolomitic, quartz silt. 20%, purple, quartz silt, grey-green mottling, ferruginous? Quartz sandstone; 30%, brown, as above. Some gypsum.
330 - 340 feet	Quartz sandstone; 55%; 95%, light grey, fine grained, sub-rounded, well sorted, black insolubles, calcareous matrix. 5%, brown, as above. Dolomite; 40%, medium-dark grey-brown, microcrystalline, partly argillaceous, tight, hard. Siltstone; 5%, dark brown, purple, argillaceous, micaceous, soft. Rare gypsum.
340 - 350 feet	Dolomite; 80%, light grey-brown, medium-dark grey-brown, microcrystalline, partly argillaceous, carbonaceous, some glauconite or chlorite. Some dark grey, carbonaceous laminae with chlorite? and quartz silt, hard, tight. Quartz sandstone; 20%, brown, light grey, fine grained, as above. Rare siltstone, brown, purple, as above.
350 - 360 feet	Quartz sandstone; 90%; 60%, light grey, fine grained, well sorted, sub-rounded, black insolubles, dolomitic matrix, 40%, brown, as above. Some micaceous layers, hard, porous. Siltstone; 10%, dark brown, argillaceous, micaceous, quartz silt, carbonaceous? flakes, soft.
360 - 370 feet	CORE NO. 2
370 - 380 feet	Quartz siltstone; 90%; 99%, red brown; 1% grey; dolomitic, medium hard to soft, micaceous. Claystone; 10%, red brown, dolomitic, shaly, micaceous, soft.
380 - 390 feet	Quartz siltstone; 90%, red brown, as above. Claystone; 10%, red brown, as above.
390 - 400 feet	Quartz siltstone; 90%, red brown, as above. Claystone; 10%, red brown, as above.
400 - 410 feet	Quartz siltstone; 90%; 90%, red brown; 10%, grey, as above. Claystone; 10%, as above.
410 - 420 feet	Quartz siltstone; 80%; 90%, red brown; 10% grey, as above. Claystone; 20%; 75%, red brown; 25%, purple, as above.

420 - 430 feet	Quartz siltstone; 80%, red brown, as above. Claystone; 20%, red brown, as above.
430 - 440 feet	Quartz siltstone; 90%; 99%, red brown; 1%, grey, as above. Claystone; 10%, red brown, as above; with gypsum crystals.
440 - 450 feet	Quartz siltstone; 80%; 90%, red brown; 10% grey, as above. Claystone; 20%; 90%, red brown; 5%, blue grey; 5%, purple, as above.
450 - 460 feet	Quartz siltstone; 90%; 95%, red brown; 5%, grey, as above. Claystone; 10%; 99%, red brown; 1%, blue-grey, as above. Trace whitish aphanitic dolomite.
460 - 470 feet	Quartz siltstone; 90%; 99%, red brown; 1% grey, as above. Claystone; 10%; 99%, red brown; 1%, grey, as above.
470 - 480 feet	Quartz siltstone; 99%; 95%, red brown; 5%, grey, as above. Claystone; 1%; 100%, red brown, as above. Trace whitish aphanitic dolomite.
480 - 490 feet	Quartz siltstone; 99%; 95%, red brown; 5%, grey, as above. Claystone; 1%; 100%, red brown, as above. Aphanitic dolomite, whitish, <1%.
490 - 500 feet	Quartz siltstone; 99%; some grading to sandy siltstone; 95%, red brown; 5%, grey, as above but much of it very soft. Claystone and clay; 1%, red brown, as above.
500 - 510 feet	Quartz siltstone; 90%; 95%, red brown; 5%, grey, as above. Claystone; 10%; 100%, red brown, as above.
510 - 520 feet	Quartz siltstone; 60%; 50%, red brown; 50%, grey, as above, with pyrite and gypsum. Dolomite; 40%; 79%, buff, aphanitic; 20%, dark grey; 1%, pink; 95%, as above, some silty - very fine sandy, some muscovite.
520 - 530 feet	Quartz siltstone; 80%; 50%, red brown; 5% grey, as above. Dolomite; 20%, buff to grey, micaceous, aphanitic.
530 - 540 feet	Quartz siltstone; 50%; 99%, red brown; 1%, grey, as above. Claystone; 50%, red-brown.
540 - 550 feet	Quartz siltstone; 95%; 95%, red brown; 5%, grey, as above. Claystone; 5%, red-brown.

550 - 560 feet	Quartz siltstone; 95%; 95%, red brown, 5%, grey, as above. Claystone; 5%; 90%, red brown; 10%, purple, as above.
560 - 570 feet	Quartz siltstone; 80%; 95%, red brown, soft, as above; 5%, grey, grading to silty dolomite. Dolomite; 15%; 50%, pink; 50%, grey, aphanitic, as above. Gypsum and dolomite crystals. Claystone; 5%; 90%, red brown; 10%, pink, as above.
570 - 580 feet	Claystone; 90%; 100%, red brown, soft, grading to clay. Quartz siltstone; 10%; 50%, red brown; 50%, grey, as above. Dolomite; <1%, grey, aphanitic.
580 - 585 feet	Claystone-clay; 90%, red brown, soft, as above. Quartz siltstone; 8%, grey, as above. Dolomite; 2%, pink, grey, aphanitic, hard.
	CORE NO. 1. (Rec. 2 inches)
300' - 300'2"	
2"	Quartz sandstone; dark brown, fine grained, sub-rounded, well sorted; ferruginous? dolomitic matrix, porous, medium hard.
	CORE NO. 2. (Rec. 10 feet)
360 - 370 feet	
1"	Siltstone-sandstone; pink, fine grained.
4"	Siltstone and claystone; grey.
7' 7"	Siltstone; red brown, some laminae of siltstone; grey, and claystone; red brown, cross laminae, worm burrows and trails, vughs, some with gypsum.
2' 0"	Claystone; red brown with Claystone; green grey near top (1"). Quartz siltstone; 85%, grading to fine grained sandstone; 95%, red brown, some pink, 5%, grey; dolomitic, micaceous, <1% heavy minerals, black; laminated, cross laminated, worm trails and burrows, uncommon vughs up to 2" diameter, some gypsum-filled. Claystone; 15%; 75%, red brown, some purple; 25%, grey and green grey; dolomitic, micaceous to very micaceous, some interlaminated siltstone, undulate bedded.

CORE NO. 3 (Rec. 4 feet 4 inches)

585 - 589'4"	Dolomite; Uniform; aphanitic, hard, grey, with thin claystone-siltstone, dolomitic, laminae, 1cm - 6 cms apart. Worm trails; gypsum, vughs, stylolites.
4' 0"	Dolomite; 99%, grey - light grey, aphanitic, possibly rare pelletal, slightly calcareous, hard; rare mica (muscovite). Vughs, (589'0") up to 1" diameter, and many solution pits, most small pits and vughs-gypsum filled (colourless and pink), some larger vughs-dolomite lined. Some calcite in veins and pits. Joints (near vertical), small joints - gypsum filled. Stylolites, mostly low amplitude, rarely over 2mms.
4"	Claystone-siltstone; 1%, dark grey, dolomitic, micaceous, laminated (max. thickness 0.5 cm) some undulate bedding, rare worm trails, some haematite? flecks, medium hard.

T.D. 589 feet 4 inches

R.A.H. NICHOLS
E.N. MILLIGAN

GREEN SWAMP WELL NO. 5.

0 - 10 feet	Sand; red, with ironstone pebbles up to 3 cm.
10 - 20 feet	Quartz sandstone; 100%, medium to fine grained, argillaceous, well sorted, sub-rounded, white, yellow and pink, silicified in part, with silica brecciation, (Bedded-nearby outcrop). Hard to friable. Solution pits filled with pink zeolite?, or colloidal silica.
20 - 30 feet	Quartz sandstone; 100%, argillaceous, as above.
30 - 40 feet	Quartz sandstone; 100%, as above, with much white, clay matrix.
40 - 50 feet	Quartz sandstone; 100%, as above, with some red colouration.
50 - 60 feet	Quartz sandstone; 100%, as above, (but more porous and friable); 80%, red; 20%, white.
60 - 70 feet	Quartz sandstone; 100%, as above, 90%, red; 10% white. (Water seepage).
70 - 80 feet	Quartz sandstone; 100%, as above, 50%, red; 50%, white.
80 - 90 feet	Quartz sandstone; 100%, as above, 40%, red; 60%, white.

90 - 100 feet	Quartz sandstone; 100%, as above, 80%, dark red brown; 20%, white.
100 - 110 feet	Quartz sandstone; 100%, as above, 90%, reddish brown; 10%, white.
110 - 120 feet	Quartz sandstone; 100%, as above, 99%, reddish brown; 1%, white. (Water at 120 feet; 1500-2000 gph).
120 - 130 feet	Quartz sand; 70%, red (possibly soft sandstone). Quartz sandstone; 30%, red brown, soft, friable.
130 - 140 feet	Quartz sand; 100%, red, as above, (possibly soft sandstone).
140 - 150 feet	Quartz sand; 100%, as above.
150 - 160 feet	Quartz sand; 100%, as above.
160 - 170 feet	Quartz sand; 100%, as above.
170 - 180 feet	Quartz sand; 100%, as above.
180 - 190 feet	Quartz sand; 100%, as above.
190 - 200 feet	Quartz sand; 100%, as above.
200 - 210 feet	Quartz sand; 100%, as above.
210 - 220 feet	Quartz sand; 100%, as above.
220 - 230 feet	Quartz sand; 100%, as above.
230 - 240 feet	Quartz sand; 100%, as above.
240 - 250 feet	Quartz sand; 99%, red, as above. Quartz siltstone; 1%, purple, moderately ferruginised, micaceous, moderately hard. (Ironstone, sandstone caving from surface).
250 - 260 feet	Quartz sand; 99%, red, as above. Quartz siltstone; 1%, purple, ferruginised, micaceous to very micaceous.
260 - 270 feet	Quartz sand; 99%, red, as above. Quartz sandstone; $<1\%$, medium grained, argillaceous, mottled, red-brown and grey, micaceous, soft. Quartz sandstone; $<1\%$; 50%, fine grained, moderately soft, mottled grey and green grey, with haematite staining, very micaceous. 50%, hard, dolomitic, pink, very micaceous, well sorted, but with poorly sorted laminae of quartzo - feldspathic sandstone. Quartz siltstone; $<1\%$, dolomitic, hard, purple, slightly micaceous. Dolomite; $<1\%$, argillaceous, mottled pink, green, pale violet, green grey, with solution pits.

270 - 280 feet	Quartz sand; 50%, red as above. Quartz sandstone; 30%; 50%, medium-fine grained, moderately soft, mottled, red brown, grey and green grey, micaceous. 50%, pink, hard, dolomitic, micaceous. Quartz siltstone; 10%, purple, dolomitic, shaly, micaceous. Dolomite; 10%, argillaceous, mottled pink, green, pale violet, green grey, some silicified.
280 - 287 feet	Quartz sand; 95%, red as above. Quartz sandstone; 3%, fine-medium grained, red-brown, grey and green-grey, dolomitic, as above. Dolomite; 2%, argillaceous, mottled pink, green grey, grey, micaceous. Chert; <1%, cryptocrystalline, pink, white.
	CORE NO. 1. (Rec. Top 7inches)
287 - 295 feet	
7 inches	Siltstone; 100%, argillaceous, dolomitic, red brown, with rare green-grey mottling, moderately hard, micaceous, lenses of more argillaceous siltstone (2cm x 0.5cm.), Medium bedded, worm? trails.

T.D. 295 feet

E.N. MILLIGAN.

TANAMI EAST NO. 1

0 - 10 feet	Gravel; pisolitic laterite pebbles.
10 - 20 feet	Sandstone; 100%, quartzose, argillaceous, ferruginised, red, friable.
20 - 30 feet	Sandstone; 100%, as above.
30 - 40 feet	Sandstone; 100%, as above.
40 - 50 feet	Sandstone; 100%, very argillaceous, as above, with white streaks; 90%, red; 10%, white.
50 - 60 feet	Claystone; 90%, finely laminated, partly micaceous (muscovite); 60%, brown; 40%, lilac and pale green mottled. Sandstone; 10%, soft, grading to sand, as above. (Seepage water)
60 - 70 feet	Sand; 50%, red, formed from - Sandstone; 50%, as interval 10' - 40'.
70 - 80 feet	Sandstone; 100%, as above.
80 - 90 feet	Sand; 90%, as above. Sandstone; 10%, as above. (Seepage water).

90 - 100 feet	Sand; 50%, as above. Claystone; 40%, shaly, micaceous (muscovite) Siltstone; 10%, argillaceous, micaceous (muscovite), pale brown.
100 - 110 feet	Siltstone; 45%, argillaceous, slightly dolomitic, some hard and ferruginised, red brown and grey mottled. Claystone; 45%, shaly, soft, slightly dolomitic. Sandstone; 10%, as above, very soft.
110 - 120 feet	Siltstone; 80%, shaly, micaceous, red-brown dolomitic. Sandstone; 10%, very fine grained; 10%, hard, red-brown, ferruginised; 90%, soft, green grey and pink. Siltstone; 9%, very calcareous, argillaceous, grey. Limestone; 1%, white, argillaceous, aphanitic, hard.
120 - 130 feet	Claystone; 50%, shaly, brown, micaceous, dolomitic. Siltstone; 50%, ferruginised, red brown, micaceous.
130 - 140 feet	Siltstone; 90%, as above, hard, red brown, ferruginised. Claystone; 10%, hard, dolomitic, pink.
140 - 150 feet	Siltstone; 60%, hard, red brown, dolomitic, ferruginised; 60%, red; 40%, pink. Silt; 40%, from siltstone.
150 - 160 feet	Siltstone; 70%, hard, red brown, dolomitic, as above. Dolomite; 30%, aphanitic, pink, some muscovite.
160 - 170 feet	Siltstone; 60%, argillaceous, slightly ferruginised, micaceous; 95%, red brown; 5%, pink, grey. Claystone; 30%, shaly, slightly micaceous, brown and grey mottled. Silt; 10%, red, from siltstone.
170 - 180 feet	Siltstone; 90%; 90%, red brown; 10%, pink, dolomitic, micaceous (muscovite and biotite), shaly. Claystone; 10%, shaly, slightly micaceous, brown and grey mottled.
180 - 190 feet	Siltstone; 80%, dolomitic; 90%, red brown to pink; 10%, grey; micaceous (muscovite and biotite), shaly. Claystone; 20%; 5%, silty; 90%, red brown; 10%, grey, shaly, micaceous (muscovite and biotite) interbedded with siltstone.
190 - 200 feet	Siltstone; 80%; 99%, red brown, as above, 1%, grey, as above. Claystone; 20%, grading, interlaminated with silty claystone; 99%, red brown; 1%, grey.

200 - 210 feet	Siltstone; 70%; as above; 90%, red brown; 10%, mottled pink and grey. Claystone; 30%; as above; 70%, blue grey and grey; 30%, red brown.
210 - 220 feet	Siltstone; 50%; as above, red brown. Claystone; 50%; as above, pink.
220 - 230 feet	Siltstone; 50%, as above, red brown to brown, strongly ferruginised. Claystone; 50%, partly micaceous, pink to purple, some siltstone-claystone interlaminated.
230 - 240 feet	Siltstone; 50%, as above. Claystone; 50%, as above.
240 - 243'6"	Siltstone; 50%, as above. Claystone; 50%, as above.
243'6" - 260'	CORE NO. 1.
260 - 270 feet	Dolomite; very silty, 1 cm. band. Siltstone; 80%, as above; 70%, red brown and dark purple; 30%, grey. Sandstone; 10%, quartzose, argillaceous, grey, as above. Claystone; 10%, as above, dark purple.
270 - 280 feet	Sandstone; 80%, fine grained, as in core, glauconitic. Siltstone; 15%, as above, purple. Claystone; 5%, as above, dark purple.
280 - 290 feet	Sandstone; 80%, as above, 60%, fine grained; 40%, very fine grained, pink and grey. Siltstone and silty claystone; 15%, pink and purple. Claystone; 5%, shaly, little mica, purple.
290 - 300 feet	Sandstone; 99%, as above. Claystone; 1%, silty, micaceous, dark purple.
300 - 310 feet	Sandstone; 80%, dolomitic, fine grained - very fine grained, argillaceous, grey and grey green; 1%, very glauconitic, some pellets, fossil? casts. Siltstone; 15%, argillaceous, green-grey. Claystone; 5%, green-grey.
310 - 320 feet	Siltstone; 100%, very dolomitic, hard, purple, slightly micaceous.
320 - 330 feet	Siltstone; 80%, very dolomitic, hard, slightly micaceous, grey. Sandstone; 20%, dolomitic, very fine grained, as above.
330 - 340 feet	Siltstone; 80%, very dolomitic, purple, slightly micaceous. Sandstone; 20%, fine grained, as above, grey and purple mottled.

340 - 350 feet	Sandstone: 100%, fine grained, light grey-pink to pale brown.
350 - 360 feet	Siltstone; 80%, as above, red brown. Claystone; 20%, red brown and purple.
360 - 370 feet	Siltstone; 100%, as above, 99%, dark brown; 1%, grey.
370 - 380 feet	Siltstone; 50%, as above, brown. Claystone; 50%, as above, pink, purple, grey. Dolomite; <1%, microcrystalline, argillaceous, rare muscovite.
380 - 392 feet	Siltstone: 50%, as above, 95%, brown; 5%, grey.
392 - 402 feet	No returns (drillers log - dolomite).
402 - 412 feet	CORE NO. 2.

CORE NO. 1. (Rec. 16 feet 3 inches)

243'6" - 260'

1' 0"	Quartz sandstone; fine to very fine grained, dolomitic, argillaceous, grey to green grey and pink, micaceous, (muscovite and biotite and green biotite?), glauconitic to very glauconitic. Some thin ferruginous bands, markedly cross bedded, graded bedding, scour and fill, slump structures, mud balls, worm trails, rare quartz crystal filled vughs, 20 mm. across. Some gypsum in vughs. Glauconite concentrated in thin laminae or localised in rich bands up to 3 cms. and disseminated throughout.
5' 9"	Sandstone and siltstone interlaminated in equal amounts; rare claystone. Sandstone; as above, 80%, pink; 20%, green grey. Siltstone; as for sandstone, colour variable, pink and red brown. Claystone; pink to purple colouration.
1' 0"	Sandstone; as above, with glauconite occurring as above.
6' 0"	Sandstone, siltstone and claystone; equal amounts, 50%, grey; 50%, red to pink; interlaminated as in top 1' of core. Glauconite occurs in very rich bands. Also thin, red, iron rich, purple clay? bands.
5"	Quartz siltstone; sandy, purple and blue grey, thin bedded. Vughs with quartz crystals, some phosphatic? brachiopods.

2' 1"	Sandstone; fine grained; siltstone, minor claystone, laminated to thin bedded, rare cross bedding and undulate bedding. Sandstone and siltstone; as above, grey. Siltstone with rare iron oxide clay bands, as above. Claystone; light blue-grey, moderately micaceous.
	CORE NO. 2. (Rec. 10 feet)
402 - 412 feet	Dolomite; sacchroidal, medium crystalline, white to light grey.

T.D. 412 feet

E.N. MILLIGAN.

WINNECKE CREEK NO. 1

0 - 10 feet	Sand; reddish, some more or less compacted.
10 - 20 feet	Claystone; 50%, shaly, micaceous; 80%, brown, moderately micaceous; 20%, buff, with red brown mottling, unctuous, rare mica. Silt particles rare to common; grading to and interlaminated with silty claystone and siltstone. Siltstone; 40%, dark red brown, strongly ferruginised, micaceous, shaly. Quartz sandstone; 10%; fine grained, argillaceous, silicified, lithic fragments and mica common.
20 - 30 feet	Siltstone; 70%, dark red brown, strongly ferruginised, micaceous, shaley, as above. Claystone; 29%, shaly, micaceous, brown. Quartz sandstone; 1%, as above, with haematite or manganese staining.
30 - 40 feet	Siltstone; 50%; 99% dark red brown; 1%, grey, highly ferruginised, as above. Claystone; 50%; 99%, purple, shaly, micaceous; 1%, buff, slightly micaceous.
40 - 50 feet	Claystone; 80%, red, shaly, micaceous. Siltstone; 20%, very argillaceous, some silicified, hard, micaceous, 80%, red brown; 20%, pink and white; 1%, dolomitic. Dolomite; $<1\%$, silty, argillaceous, pink.
50 - 60 feet	Silt and clay; 40%, red. Siltstone; 50%, argillaceous, ferruginised, micaceous; 80%, red brown; 20%, purple and white mottled. Sandstone; 1%, fine grained, argillaceous, lithic, micaceous, buff.
60 - 70 feet	Siltstone; 100%; argillaceous; 45%, red brown, ferruginised; 45%, dolomitic, purple, hard; 10%, argillaceous, lithic, soft, mottled, purple and white.

70 - 80 feet	Siltstone; 50%; 80%, red brown, ferruginised, as above; 20%, dolomitic, light grey to green grey, hard, chloritic. Sandstone; 30%; 100%, fine grained, grey, lithic, argillaceous. Dolomite; 10%, aphanitic, calcareous, grading to dolomitic limestone, light grey, micaceous, partly silicified. Chert; <1%, cryptocrystalline, light grey.
80 - 90 feet	Siltstone; 100%; 60%, red brown, hard, ferruginous; 38%, brown, soft, slightly ferruginised; 1%, argillaceous, lithic, micaceous, green to green-grey; 1%, argillaceous, lithic, grey, dolomitic.
90 - 100 feet	Siltstone; 100%, strongly ferruginised.
100 - 110 feet	Siltstone; 99%; 80%, as above; 20%, purple, argillaceous, shaly, micaceous. Dolomitic siltstone-silty dolomite; 1%, microcrystalline matrix hard, pink, purple, grey.
110 - 120 feet	Siltstone; 100%, red brown, strongly ferruginised.
120 - 130 feet	Siltstone; 100%, red brown, strongly ferruginised, as above.
130 - 140 feet	Siltstone; 50%, dolomitic, argillaceous, red brown, micaceous. Dolomite; 50%, sparry? recrystallised, light grey, micaceous, vughy, many solution pits.
140 - 150 feet	Siltstone; 100%, dolomitic, argillaceous, red brown, micaceous.
150 - 160 feet	Dolomite; 60%, aphanitic, mottled pink and light grey, hard, slightly micaceous, solution pits, manganese staining and dendrites. Siltstone; 40%, dolomitic, argillaceous, hard, red brown and purple, micaceous.
160 - 163 feet	Dolomite; 100%, aphanitic, light grey to grey, some muscovite flakes, manganese dendrites.
163 - 170 feet	No returns, lost circulation.
170 - 173' 6"	CORE NO. 1. (Rec. 3 feet 6 inches)
3' 6"	Dolomite; 100%, aphanitic, calcareous, grey, dense, hard, micaceous (muscovite). Discrete quartz grains of silt size, in patches, quartz silt lenses (vughs concentrated on lenses), soft, green grey, argillaceous, quartz-siltstone coating on bedding faces. Evidence of strong solution at bedding faces. Regular and irregular shapes of brown, finely crystalline, dolomite rimming milky coarsely crystalline dolomite (fossils?).

T.D. 173 feet 6 inches

E.N. MILLIGAN.

WINNECKE CREEK NO. 2.

0 - 10 feet	Sand 90% and gravel alluvium; Gravel composed of silty dolomite, dolomitic siltstone, chert, hard claystone, pisolitic, ironstone pebbles.
10 - 20 feet	Gravel; 90%, as above. Sand; 10%.
20 - 30 feet	Silt, sand and gravel; as above.
30 - 40 feet	Silt, sand and gravel; as above.
40 - 50 feet	Claystone; 89%, slightly dolomitic, shaly, micaceous, brown. Quartz sandstone-siltstone; 1%, very fine grained sandstone grading to siltstone, dolomitic, lithic, light green clay pellets, weathered ?glauconite, mafics (incl. haematite) and garnet? Silt, sand and gravel; 10%, as above.
50 - 60 feet	Siltstone; 70%, dolomitic, argillaceous, pink, purple, red brown, buff, green, green-grey, soft, micaceous (muscovite biotite, chlorite); 5%, shaly (very micaceous). Claystone; 30%, silty, shaly, chocolate brown, micaceous.
60 - 70 feet	Claystone; 70%, dolomitic, shaly, brown, pink, purple, rarely green-grey, micaceous (biotite). Quartz siltstone; 30%, dolomitic, garnet, micaceous haematite, chlorite?, biotite, muscovite.
70 - 80 feet	Claystone; 99%, shaly, micaceous; 80%, pink to green-grey, fossiliferous, (lingulid brachiopods, trilobite? fragments); 20%, dark purple. Dolomite; 1%, aphanitic, argillaceous, hard, purple, slightly micaceous.
80 - 90 feet	Claystone; 95%, dolomitic, shaly, green-grey, micaceous (muscovite and biotite), fossiliferous? Quartz siltstone; 5%, dolomitic, hard, green-grey to red.
90 - 100 feet	Quartz siltstone; 95%, dolomitic, argillaceous, as above, green grey. Claystone; 5%, dolomitic, olive green, grey and pink.
100 - 110 feet	Siltstone; 50%, dolomitic, quartzose, micaceous, (muscovite, biotite), chloritic, green-grey. Claystone; 50%, dolomitic, shaly, muscovite, biotite, green-grey.
110 - 120 feet	Claystone; 80%, dolomitic, shaly, muscovite, biotite, 19%, red brown; 1%, purple. Siltstone; 20%, dolomitic, micaceous, soft, brown and grey.

120 - 130 feet	Siltstone; 100%, very fine grained, grading to silty claystone, argillaceous, ferruginised, micaceous, mafics, ironstained quartz.
130 - 140 feet	Claystone; 80%, dolomitic, shaly, micaceous, slightly ferruginised; 80%, brown; 20%, pink. Siltstone; 20%, very fine grained, as above, brown, slightly ferruginised.
140 - 150 feet	Siltstone; 100%, very fine grained, quartzose, argillaceous, ferruginised, brown.
150 - 160 feet	Siltstone; 100%, as above.
160 - 170 feet	Siltstone; 100%, as above.
170 - 180 feet	Siltstone; 100%, as above.
180 - 190 feet	Siltstone; 70%, as above, some grey, mottled. Claystone; 30%, shaly, micaceous, brown, silt particles.
190 - 200 feet	Claystone-siltstone; 80%, dolomitic, micaceous (muscovite and biotite), black heavy minerals, haematite; 60%, red brown; 20%, pink; 20%, light grey. Dolomite; 15%; 80%, aphanitic, white; 20%, saccharoidal. Sandstone; 4%, fine grained, pink, with pale green clay pellets, glauconite? Chert; 1%, cryptocrystalline, light grey. (Water seepage).
200 - 210 feet	Claystone; 70%, dolomitic, shaly, soft to hard, micaceous, buff to pink. Siltstone; 30%, dolomitic, micaceous, pink and buff. Dolomite; <1%, aphanitic, red brown. (Water seepage).
210 - 227 feet	(No returns but chips were obtained from air hammer). Dolomite; buff, saccharoidal. Chert; buff to grey. Dolomite; buff, coarsely crystalline.
227 - 237'6"	CORE NO. 1. (Rec. 7 feet 6 inches)
7' 6"	Dolomite; 100%, medium crystalline to saccharoidal, grey to buff, very vughy, algal? structures.

T.D. 237 feet 6 inches

E.N. MILLIGAN.

WINNECKE CREEK NO. 3.

0 - 10 feet	Sand, soil, ironstone; red, pisolitic, some chips yellow, sandy clay.
10 - 20 feet	Clay; 95%, pink, sandy, some yellow, sandy, 5%, pisolitic ironstone.
20 - 30 feet	Sandstone; 100%, 50%, buff and white; underlain by red (50%), soft.
30 - 40 feet	Sandstone; 100%, red, fine grained, some shale layers; few chips of white and yellow siltstone, soft.
40 - 50 feet	Sandstone; 100%, as above, some micaceous.
50 - 60 feet	Sandstone; 100%, as above, harder.
60 - 70 feet	Siltstone; 65%, red, sandy, micaceous, soft. Sandstone; 35%, grey, white, fine grained, silty, some chert chips.
70 - 80 feet	Claystone; 70%, pink. Sandstone; 30%; 50%, hard, grey, silty; 50%, red brown, soft. Some grey, green chert chips.
80 - 90 feet	Sandstone; 85%, red, silty, fine grained; cream and white, fine grained, silty, hard. Siltstone; 15%, red, hard.
90 - 100 feet	Sandstone; 70%, red, white, as above. Siltstone; 30%, red, white, soft.
100 - 110 feet	Sandstone; 90%, white, buff, fine grained, silty. Siltstone; 10%, soft.
110 - 120 feet	Sandstone; 90%, 80%, khaki, fine-grained, clayey; 20%, red, fine-grained. Clay; 10%, khaki.
120 - 130 feet	Claystone; 100%, yellow, soft, sandy.
130 - 140 feet	Claystone; 100%, as above, but not sandy.
140 - 150 feet	Claystone; 100%, as above.
150 - 162 feet	Claystone; 100%, as above.

T.D. 162 feet

K.G. SMITH

WINNECKE CREEK NO. 4.

0 - 10 feet	Gravel; red pisolites, 10%, quartz pebbles.
10 - 20 feet	Clay; yellow, sandy (poorly sorted sand grains, from fine grained, to fine conglomerate size). Some chert chips.
20 - 30 feet	Clay; 100%; 50%, yellow, as above; 50%, red, sandy.
30 - 40 feet	Clay; 100%, as above.
40 - 50 feet	Sand; 100%, red, poorly sorted, fine-coarse grained, argillaceous, partly compacted.
50 - 60 feet	Sand; 100%, yellow, buff, poorly sorted, argillaceous, with chips of chert and rounded pebbles of basalt (one with copper? mineralisation).
60 - 70 feet	Sand; 100%, as above, with basalt pebbles (¼" dia).
70 - 80 feet	Sand; 100%; 70%, yellow and buff; 30%, argillaceous.
80 - 90 feet	Sand; 100%; 60%, red, yellow; 40%, buff, all argillaceous.
90 - 100 feet	Claystone; 100%; 90%, red, sandy; 10%, yellow, sandy, all firm.
100 - 110 feet	Siltstone; 100%, red, slightly sandy, rarely micaceous.
110 - 120 feet	Siltstone; 100%, as above, but not micaceous.
120 - 130 feet	Siltstone; 100%, as above, with trace of white siltstone.
130 - 140 feet	Siltstone; 100%, red, rarely sandy.
140 - 150 feet	Siltstone; 90%, red. Dolomite; 10%, white, hard, finely crystalline, thin bands, at 148 feet.
150 - 160 feet	Siltstone; 60%, purple, slightly calcareous. Dolomite; 40%, white, buff, dense, very hard. Lithologies alternate in thin bands.
160 - 170 feet	Dolomite; 100%, white, buff, hard, finely crystalline, some pelletal, all slightly calcareous.
170 - 175 feet	Dolomite; 90%, white, buff, finely crystalline, hard, slightly calcareous.

177 feet	CORE NO. 1.	(Rec. 1 foot 3 inches (broken)).
1' 3"	Dolomite; cream and pale brown, hard, calcareous, pelletal, some intraclasts, partly recrystallised, joint planes lined with limonite, vughy - mainly about 1/16 diameter, but some larger, and many vughs of pin-hole size.	

T.D. 177 feet

K.G. SMITH

APPENDIX 2

Logs of Bores (Water)

WINNECKE CREEK.

Hooker Creek Native Settlement:

	Hooker Creek No. 1	Hooker Creek No. 5	Hooker Creek No. 6
Location (from Hooker Creek)	0	0	0
Total Depth	164'	170'	180'
Standing Water Level	80'		92' (1964)
Water Struck at			
Pump Depth	112'		
Date Drilled	1948(112')1964(164')	1955	1955
Supply	1200 gph 220 gph	1000gph (1965)	600gph

Analysis[1]			
Date			
T.D.S. (ppm)		611	
Cl.		130	
SO_4		0	
F		0.3	
Ca		47	
HCO_3		165	
CO_3		-	
Na		270	
K		-	
Mg		36	
NO_3		-	
Fe(trace)		0.05	

[1] Analysis by Animal Industry Branch, Northern Territory Administration, Darwin.

WINNECKE CREEK (Contd)

Hooker Creek Native Settlement:

	Hooker Creek No. 8	7 Mile	19 Mile
Location (from Hooker Creek)	0	6.5M N	17M N
Total Depth	330'	81'6"	176'
Standing Water Level	85'		85'
Water Struck at			
Pump Depth			
Date Drilled	1964	1948	1955
Supply	2000gph	1200gph	1900gph

WINNECKE CREEK (Contd)

B.M.R. Scout Hole:

	W.C. 1	W.C. 2	W.C. 3	W.C. 4
Location (from Hooker Creek)	88M ESE	48M SE	24M ESE	52M ESE
Total Depth	173' 6"	273' 6"	162'	177'
Standing Water Level				
Water Struck at		200',210'		
Date Drilled	10/7/65	13/7/65	19/7/65	20/7/65
Supply		Seepage		

TANAMI EAST — B.M.R. Scout Hole: T.E. 1

GREEN SWAMP WELL — B.M.R. Scout Hole: G.S.W. 1, G.S.W. 2

	T.E. 1	G.S.W. 1	G.S.W. 2
Location (from Hooker or Tennant Creek)	68M SE (H.Ck)	54M W (T.Ck)	70M W (T.Ck)
Total Depth	412'	305'	227' 6"
Standing Water Level		93'	184'7"
Water Struck at	60',90'	119', 160',187'	197'
Pump Depth			
Date Drilled	17/7/65	14/6/65	17/6/65
Supply	Seepage	2000 gph	800 gph
Analysis:[1]			
Date		11/10/65	/8/65
T.D.S.(p.p.m)		2330	3203
Cl		675	895
SO_4		421	904
F		2.2	3.5
Ca		61	89
HCO_3		426	283
CO_3		Nil	Nil
Na		560	830
K		87	98
Mg		72	91
NO_3		26	9

[1] Analyses by Animal Industry Branch, Northern Territory Administration, Alice Springs.

GREEN SWAMP WELL (Contd)

B.M.R. Scout Hole:

	G.S.W. 3	G.S.W. 4	
Location (from Tennant Creek)	85M WNW	110M WNW	
Total Depth	300'	589'4"	
Standing Water Level	275'	11'	
Water Struck at	280'	21 - 145' (saline @ 145')	
Pump Depth			
Date Drilled	22/6/65	1/7/65	
Supply	Seepage	6000 gph	
Analysis:		(cased to 300')	(10' - 300' casing pulled)
Date		11/10/65	11/10/65
T.D.S. (p.p.m.)		1186	2740
Cl		360	455
SO_4		235	1267
F		0.6	0.5
Ca		32	378
HCO_3		160	105
CO_3		Nil	Nil
Na		290	380
K		45	61
Mg		39	71
NO_3		24	22

GREEN SWAMP WELL

B.M.R. Scout Hole:

LANDER RIVER

Willowra Station:

	G.S.W. 5	Parklands	Bob's Well
Location (from homestead or Tennant Creek)	130M WNW (TCk)	53M NNW	32M N
Total Depth	295'	143'	45'
Standing Water Level	60'	95'	35'
Water Struck at	70, 120'	104'	35',45'
Pump Depth		114'	39'
Date Drilled	7/7/65	1961	
Supply	1500 - 2000gph	1400 gph	750gph
Log (Geologist)		*	
Analysis:			
Date	11/10/65	29/9/61	
T.D.S. (p.p.m)	2831	2096	4644
Cl	1256	720	1738
SO_4	Nil	274	844
F	1.3	2.2	Nil
Ca	108	95	87
HCO_3	368	397	661
CO_3	Nil	Nil	5
Na	575	460	890
K	315	76	114
Mg	184	69	125
NO_3	15	3	40

* 0 - 5' fine grained brown silty sand; - 15' fine-medium grained brown silty sand; - 20' creamy brown fine - medium grained silty sand; - 25' brown medium grained sandy silt; - 30' fine - medium and coarse grained grey sand; - 65' fine - medium and coarse brown silty sand; - 80' fine - coarse and very coarse very silty sand; - 90' medium - coarse and very coarse brown slightly silty sand; - 100' fine to medium and coarse brown silty clayey sand; 110' grey and pale brown very fine sandy silt; - 120' very fine to fine and medium grained silty sand; - 143' red brown fine grained silty sand. (Resident Geologist, Alice Springs).

LANDER RIVER (Contd)

Willowra Station (contd):

	Austerity Well	Jump up Well	Dud	Dud
Location (from homestead)	21M N	20M N	20M N	25M N
Total Depth	29'			
Standing Water Level	17'			
Water Struck at	17'			
Pump Depth	19'			
Date Drilled				
Supply	800gph			
Driller's Log	limestone	granite		
Analysis:				
Date	7/5/59			
T.D.S. (p.p.m.)	3631			
Cl	1105			
SO_4	602			
F	1.6			
Ca	87			
HCO_3	661			
CO_3	5			
Na	890			
K	114			
Mg	125			
NO_3	40			

LANDER RIVER (Contd)

Numagalong:

	No. 2
Location (from Homestead)	5M NW
Total Depth	100'
Standing Water Level	60'
Water Struck at	65',70',80'
Pump Depth	65'
Date Drilled	(deepened)1963
Supply	500gph
Quality	'good'
Geologist's Log	*

* (D. Woolley, Alice Springs) ?-40' medium - coarse grained silty sand; - 50' fine - medium grained brown silty sand; - 60' as - 50'; - 70' reddish brown fine to very coarse sand; - 80' medium to coarse pale brown to grey very silty sand; - 100' khaki and pale brown siltstone (?Tertiary). (Could perhaps be Lower Palaeozoic (E.N.M.)).

MAPS TO GO WITH RECORD 1966/47

GEOLOGY OF THE WISO BASIN, NORTHERN TERRITORY.

MAPS INCLUDE:

(a) 1:250,000 maps.

Tanami East
Winnecke Creek
South Lake Woods
Green Swamp Well
Lander River
Mount Solitaire.

(b) 1:1,000,000 map

Wiso Basin and Environs.

PRELIMINARY EDITION, 1966

SUBJECT TO AMENDMENT

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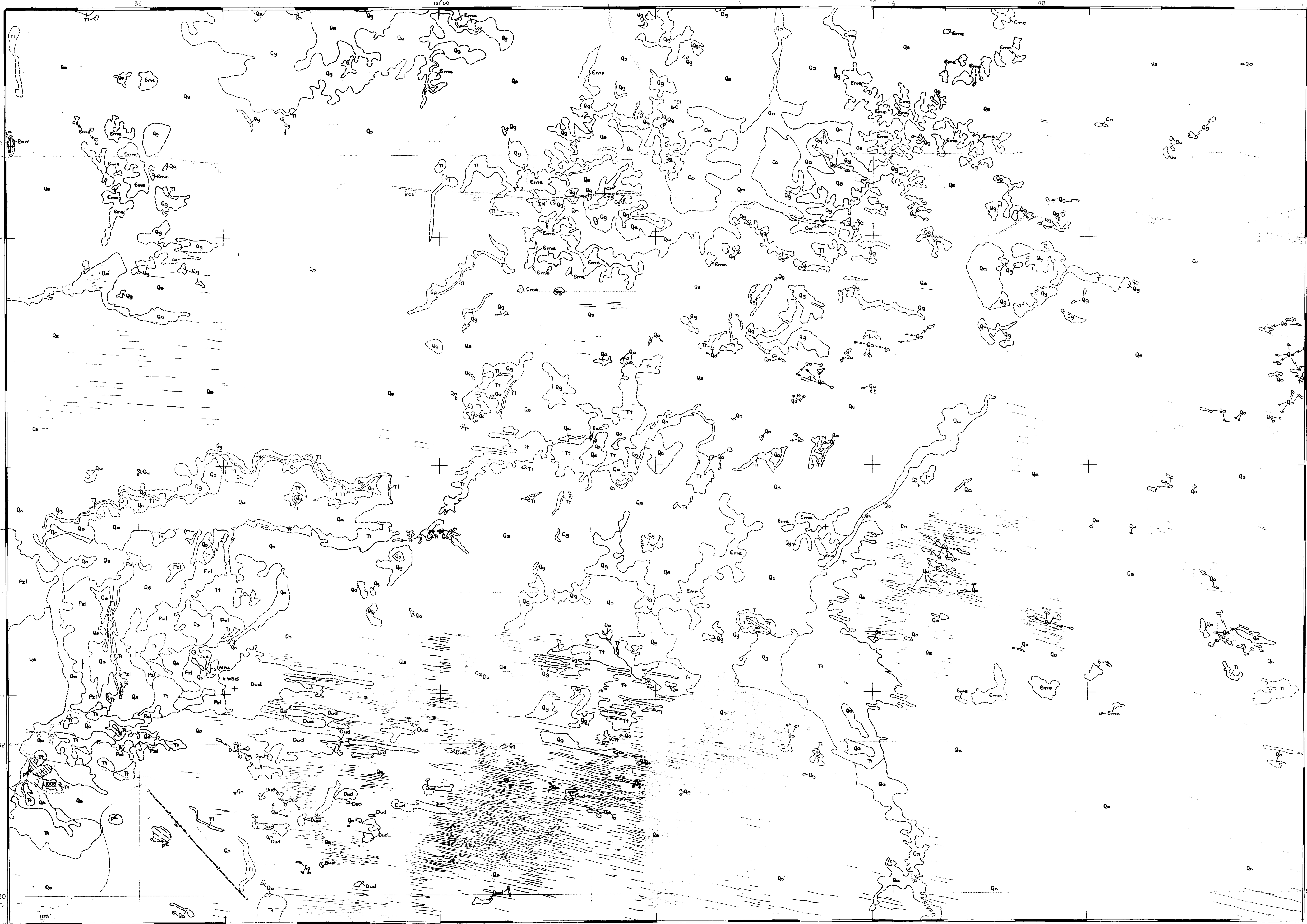
AUSTRALIA 1:250,000 GEOLOGICAL SERIES

TANAMI EAST

NORTHERN TERRITORY

SHEET SE 52-16



Reference

CAINOZOIC	QUATERNARY		Qa	Sand, silt, gravel
			Qs	Sand, some laterite and chert gravel
			Qg	Laterite gravel, pisolitic
	TERTIARY		Tl	Laterite, pisolitic, cemented, ferruginous
			Tt	Travertine, chalcedony
PALAEOZOIC	DEVONIAN	Dulcie Sandstone	Dud	Argillaceous sandstone
	LOWER PALAEOZOIC		Pzl	Quartzose, calcilutite, pelletal dolomite, aphanitic dolomite
	MIDDLE CAMBRIAN	Merrina Beds	Єme	Sandstone, siltstone, claystone
PRECAMBRIAN	UNDIFFERENTIATED		pЄ	Quartzite, lithic sandstone, quartz sericite schist, vein quartz
	CARPENTARIAN	Mt Winnecke Sandstone	Ecw	Silicified, lithic quartz sandstone

Geological boundary

Syncline

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, measured.

Strike and dip of strata, prevailing and unmeasured

Horizontal strata

Vertical strata

Trend lines

WB15 *Text reference to specimen locality*

Dyke q-quartz

TE1 SHO *Scout hole (B.M.R.)*

Waterhole

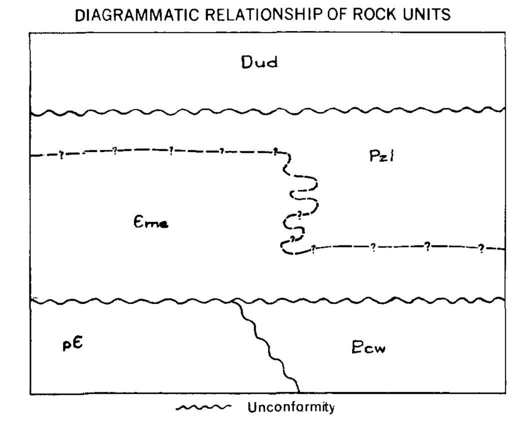
Sand dunes

Vehicular track (4 wheel drive only)

Astronomical station

Height in feet, instrument levelled, datum: mean sea level.

DIAGRAMMATIC RELATIONSHIP OF ROCK UNITS



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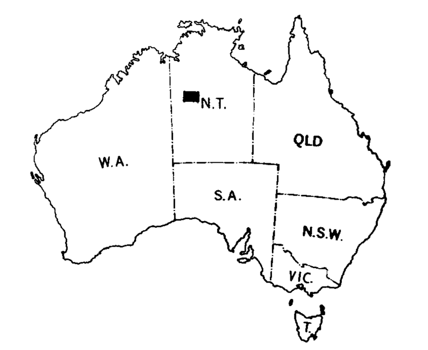
Tranverse Mercator Projection



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GORDON DOWNS SE 52-10	BIRRINDUDU SE 52-11	WINNECKE CREEK SE 52-12	SOUTH LAKE WOODS SE 53-9	HELEN SPRINGS SE 53-10
BILLILUNA SE 52-14	TANAMI SE 52-15	TANAMI EAST SE 52-16	GREEN SWAMP WELL SE 53-13	TENNANT CREEK SE 53-14
LUCAS SF 52-2	THE GRANITES SF 52-3	MOUNT SOLITAIRE SF 52-4	LANDER RIVER SF 53-1	BONNEY WELL SF 53-2
STANSMORE SF 52-6	HIGHLAND ROCKS SF 52-7	MOUNT THEO SF 52-8	MOUNT PEAKE SF 53-5	BARROW CREEK SF 53-6

ANNUAL CHANGE 4'E

Scale 1:250,000

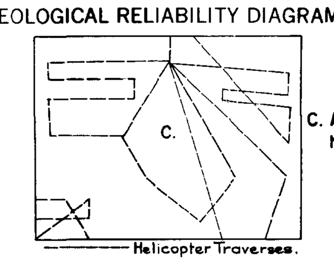
5 0 5 10 15 MILES

5 0 5 10 15 20 25 KILOMETRES

CROWN COPYRIGHT RESERVED

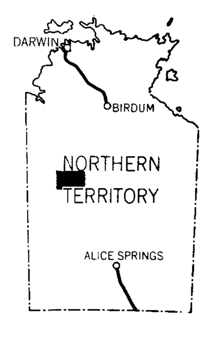
GREY NUMBERED LINES INDICATE THE 20,000 YARD TRANSVERSE MERCATOR GRID, ZONE 6 (AUSTRALIA SERIES)

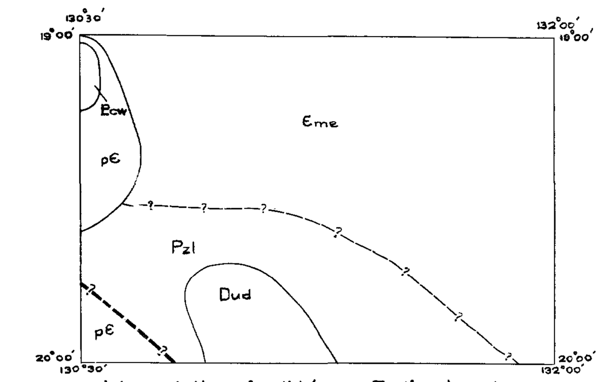
GEOLOGICAL RELIABILITY DIAGRAM



C. Air photo interpretation helicopter traverses

Geology, 1965, by: E.N. Milligan, R.A.H. Nichols
Compiled, 1965, by: E.N. Milligan
Cartography by: Geological Branch B.M.R.
Drawn, 1965, by: G.J. Squire





Interpretation of solid (pre-Tertiary) geology

TANAMI EAST

SHEET SE 52-16

Copies of this map may be obtained from the Bureau of Mineral Resources, Geology and Geophysics, Canberra, A.C.T., or Darwin, N.T.

WINNECKE CREEK

NORTHERN TERRITORY

AUSTRALIA 1:250,000 GEOLOGICAL SERIES

SHEET SE 52-12

PRELIMINARY EDITION, 1966

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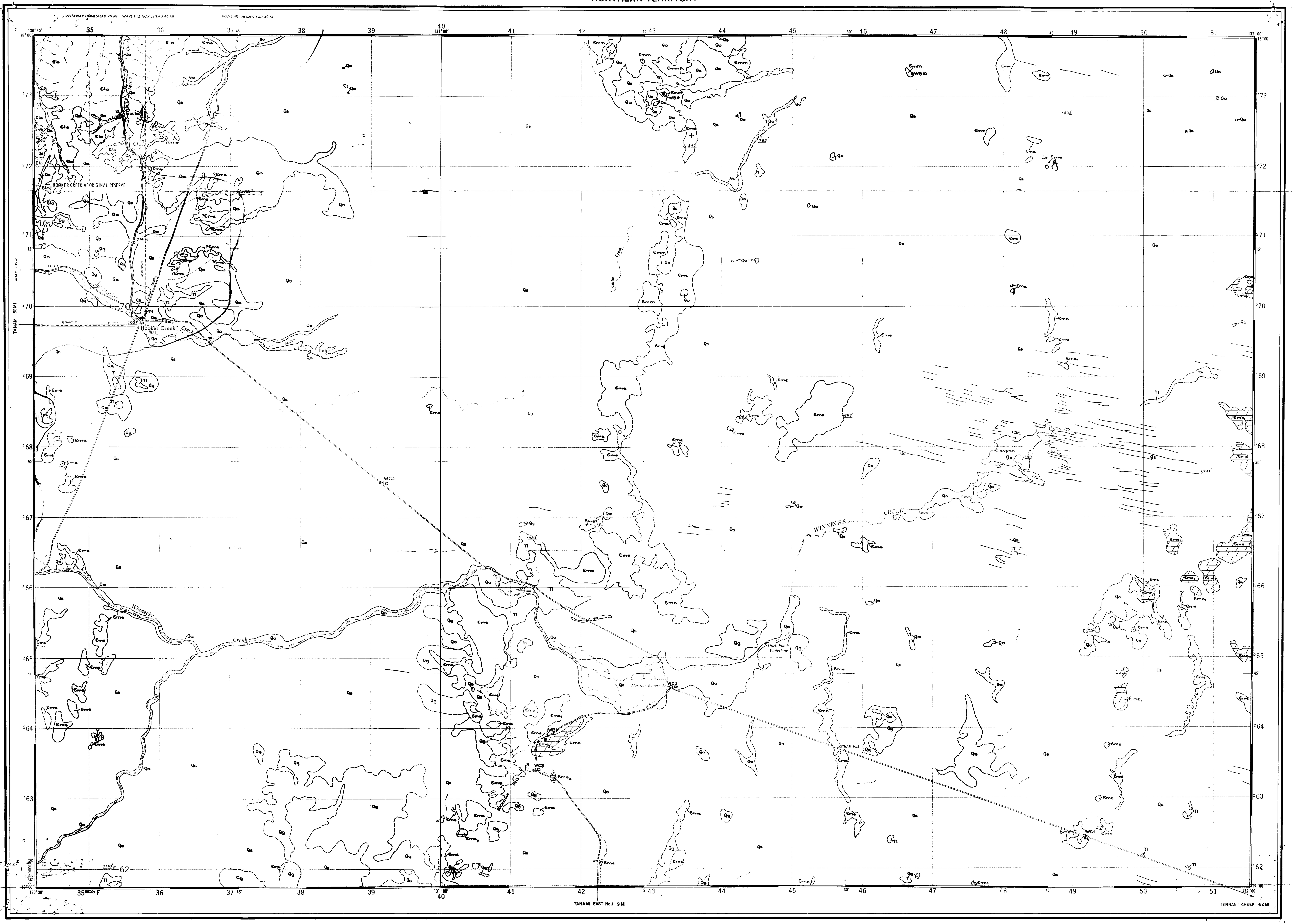
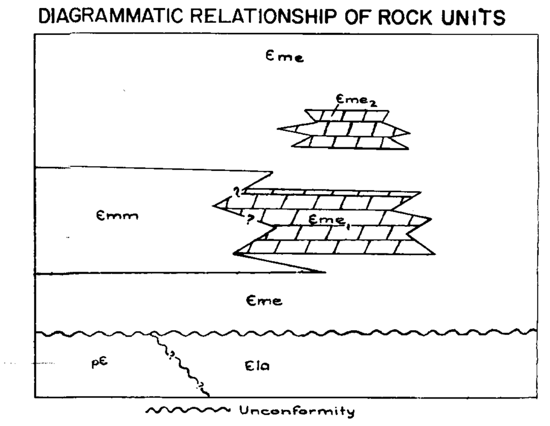


Reference

CAINOZOIC	QUATERNARY		Qa	Alluvium, sand, gravel, silt.
			Qs	Sand, some laterite and chert gravel.
			Qg	Laterite gravel, pisolitic.
	TERTIARY		Tl	Laterite, pisolitic, cemented, ferruginous, ?sandstone.
			Tt	Travertine, grey limestone.
PALAEOZOIC	MIDDLE CAMBRIAN	Merrina Beds	Ꞓme	Sandstone, siltstone, claystone. Crystalline dolomite, algal dolomite.
		Montejinni Limestone	Ꞓmm	Silty calcilutite, dolomite, siltstone, crystalline dolomite
	LOWER CAMBRIAN	Antrim Plateau Volcanics	Ꞓla	Basalt, agglomerate, tuff.
PRECAMBRIAN	UNDIFFERENTIATED		pꞒ	Sandstone, arkose

- Geological boundary (line is broken where boundary is approximate)
- Strike and dip of strata
- Horizontal strata
- Macrofossil locality
- Text reference to specimen locality
- Scout hole (B.M.R.)
- Water bore
- Tank
- Waterhole
- Windpump
- Sand dunes
- Road
- Vehicle track
- Fence
- Landing ground
- Yard
- Astronomical station
- Height in feet; instrument levelled; datum: mean sea level
- Position doubtful

DIAGRAMMATIC RELATIONSHIP OF ROCK UNITS



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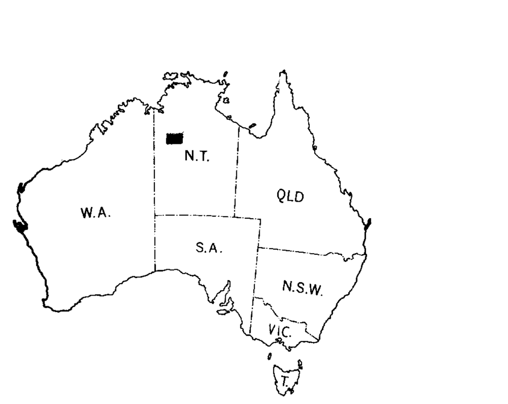

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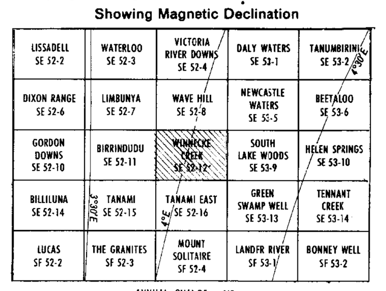
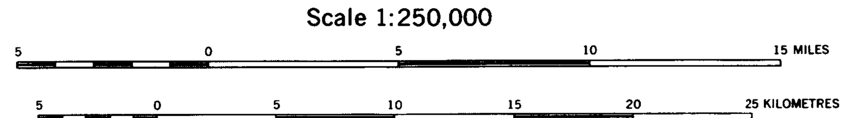


Scale 1:250,000



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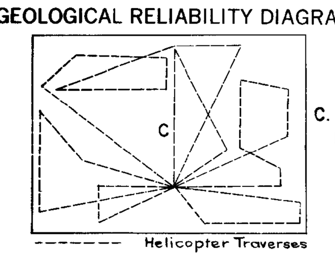
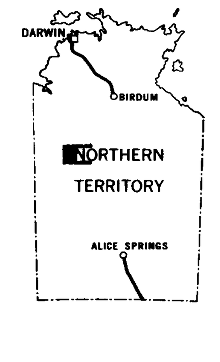
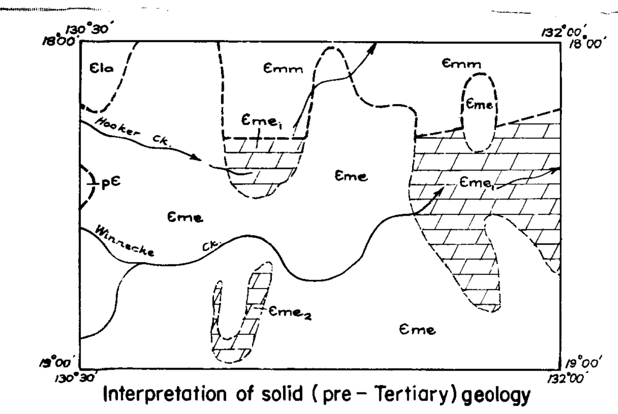
GREY NUMBERED LINES INDICATE THE 20,000 YARD TRANSVERSE MERCATOR GRID, ZONE 6 (AUSTRALIA SERIES)

GEOLOGICAL RELIABILITY DIAGRAM



Geology, 1965 by: E.N. Milligan, K.G. Smith and R.A.H. Nichols
Compiled, 1965 by: E.N. Milligan
Cartography by: Geological Branch B.M.R.
Drawn by: G.J Squire





Interpretation of solid (pre-Tertiary) geology

WINNECKE CREEK

SHEET SE 52-12

Copies of this map may be obtained from the Bureau of Mineral Resources, Geology and Geophysics, Canberra, A.C.T., or Darwin, N.T.

AUSTRALIA 1:250,000 GEOLOGICAL SERIES

SOUTH LAKE WOODS

NORTHERN TERRITORY

SHEET SE 53-9

PRELIMINARY EDITION, 1966

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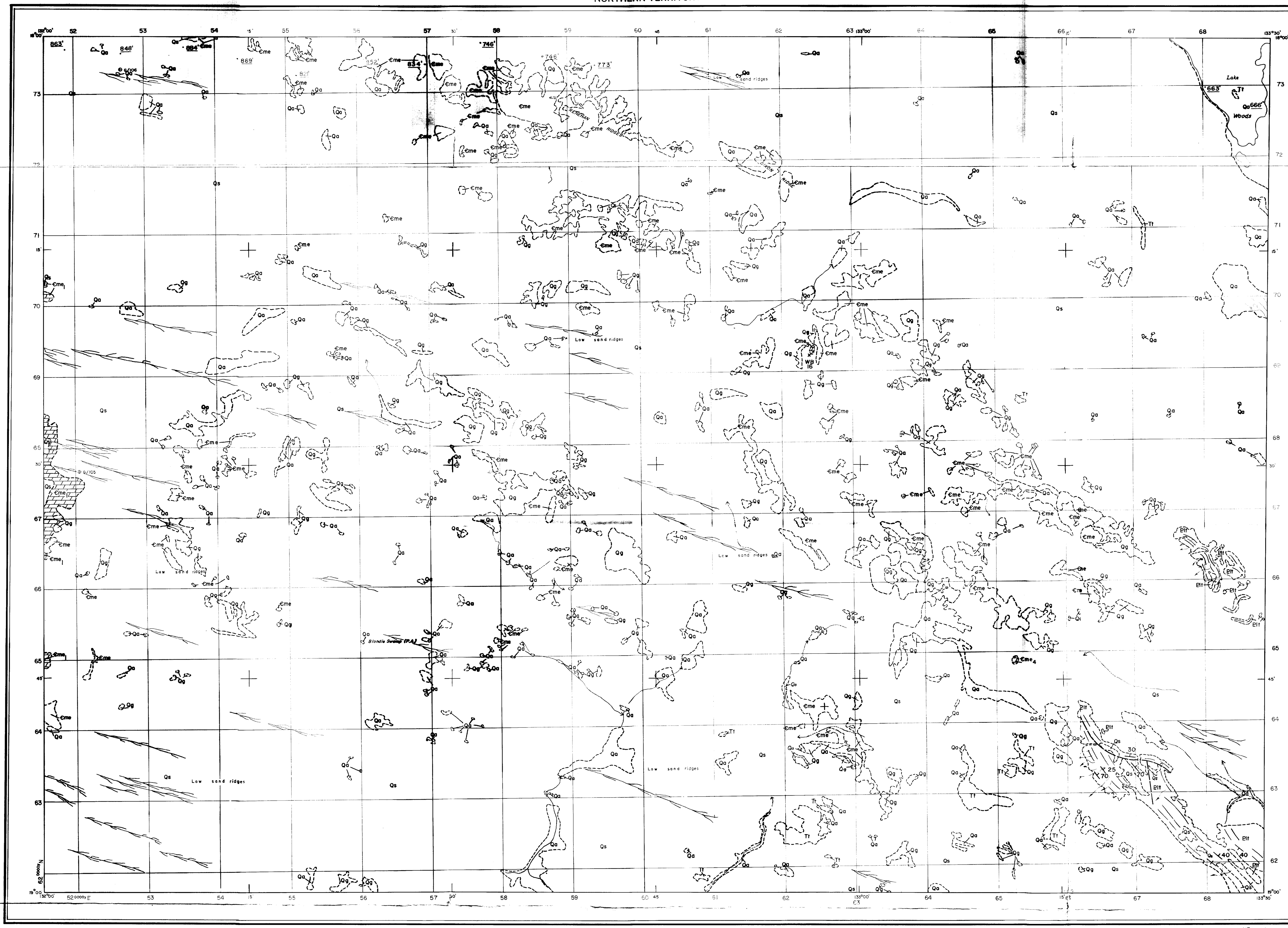


Reference

CAINOZOIC	QUATERNARY		Qa	*Alluvium, sand, gravel, silt*
			Qs	*Sand, some laterite, chert gravel*
			Qg	*Gravel, pisolitic laterite*
	TERTIARY		Tt	*Travertine, grey limestone*
PALAEOZOIC	MIDDLE CAMBRIAN	Merrina Beds	€me	*Quartz sandstone, siltstone, claystone* / *Dolomite, crystalline, ?fossiliferous*
		Montejinni Limestone	€mm	*Silty calcilutite, dolomite, siltstone (rock relationship and solid geology diagrams only)*
PRECAMBRIAN	LOWER PROTEROZOIC	Tomkinson Creek Beds	Blt	*Quartz sandstone, siliceous, medium to coarse-grained, pebble sandstone*

Geological boundary, position approximate

Fault, position approximate

25 *Strike and dip of strata*

Vertical strata

Horizontal strata

Trend lines, air-photo interpretation

× WB16 *Text reference to specimen locality*

Sand dunes, position generalised

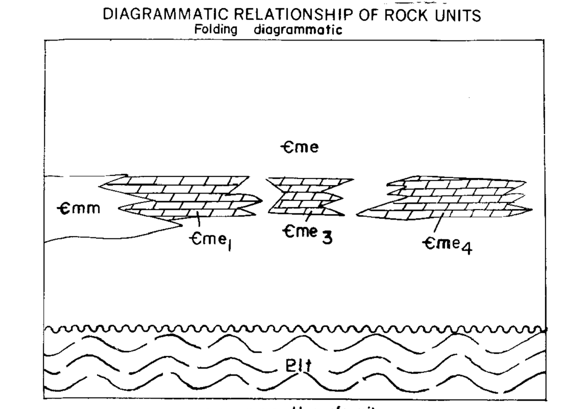
Astronomical station

643' *Height in feet, instrument levelled; datum: mean sea level*

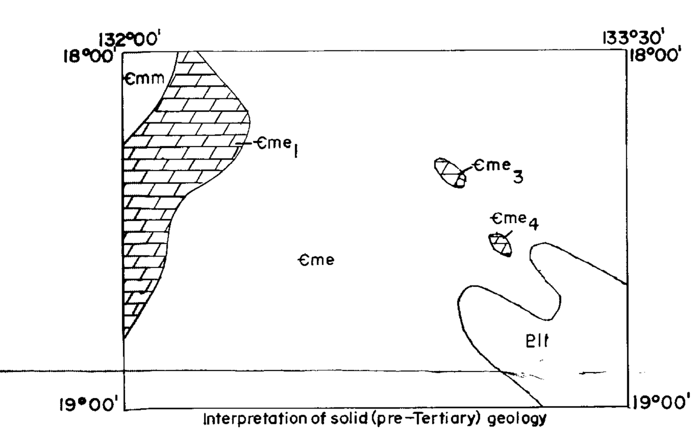
(PA) *Position approximate*

DIAGRAMMATIC RELATIONSHIP OF ROCK UNITS

Folding diagrammatic



Note: €me *dolomite has been divided into three areas shown as* €me1, €me3, €me4, *because continuity of the unit has not been established*



Interpretation of solid (pre-Tertiary) geology

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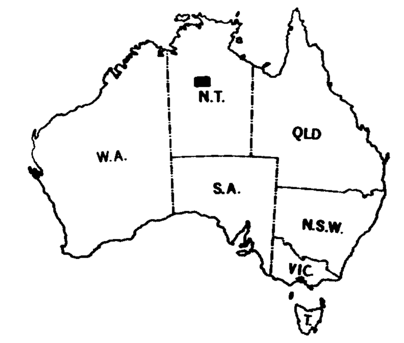

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LIMBUNYA SE 52-7	WAVE HILL SE 52-8	NEWCASTLE WATERS SE 53-5	BEETALOO SE 53-6	WALLHALLOW SE 53-7
BIRRINDUDU SE 52-11	WINNECKE CREEK SE 52-12	SOUTH LAKE WOODS SE 53-9	HELEN SPRINGS SE 53-10	BRUNETTE DOWNS SE 53-11
TANAMI SE 52-15	TANAMI EAST SE 52-16	GREEN SWAMP WELL SE 53-13	TENNANT CREEK SE 53-14	ALROY SE 53-15
THE GRANITES SF 52-3	MOUNT SOLITAIRE SF 52-4	LANDER RIVER SF 53-1	BONNEY WELL SF 53-2	FREW RIVER SF 53-3

ANNUAL CHANGE 0°30'E

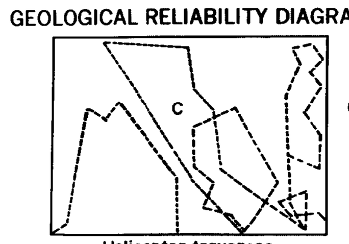
Scale 1:250,000

5 0 5 10 15 MILES

5 0 5 10 15 20 25 KILOMETRES

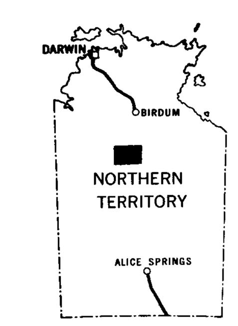
Geology & Compilation, 1965, by: K.G.Smith, R.A.H.Nichols, H.F.Doutch.
Cartography by: Geological Branch B.M.R
Drawn, 1966, by: W.W.Webb G.J.Squire

GEOLOGICAL RELIABILITY DIAGRAM



C – Air-photo interpretation and helicopter traverses

---- Helicopter traverses



AUSTRALIA 1:250,000 GEOLOGICAL SERIES

GREEN SWAMP WELL

NORTHERN TERRITORY

SHEET SE 53-13

PRELIMINARY EDITION, 1966

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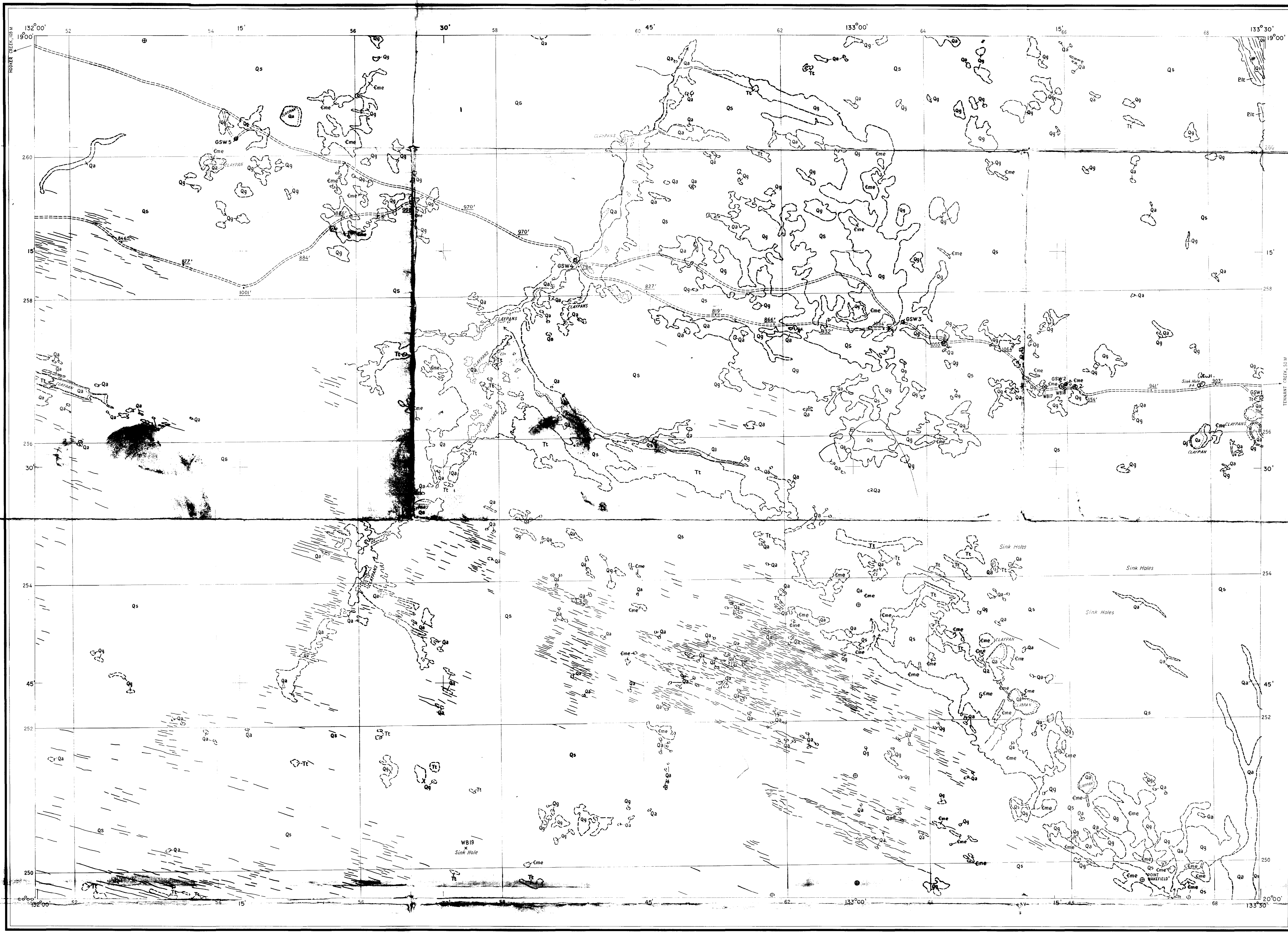

Reference

CAINOZOIC	QUATERNARY		Qa	Sand, silt, gravel
			Qs	Sand, sand with laterite gravel
			Qg	Laterite gravel (in places over Tertiary cemented pisolitic laterite)
	TERTIARY		Tt	Limestone, travertinous, grey and white
PALAEOZOIC	MIDDLE CAMBRIAN	Merrina Beds	€me	Sandstone, siltstone, claystone, silty dolomite
PRECAMBRIAN	LOWER PROTEROZOIC	Tomkinson Creek Beds	Elt	Sandstone, siliceous, argillaceous

Geological boundary, position approximate

Dip > 45° } *air-photo interpretation*
Trend lines }

× WB19 *Text reference to specimen locality*

GSW 1 *B.M.R. Scouthole*

Sand dunes

Vehicular track (4 wheel drive)

Astronomical station

Height in feet, instrument levelled; datum: mean sea level

Position approximate

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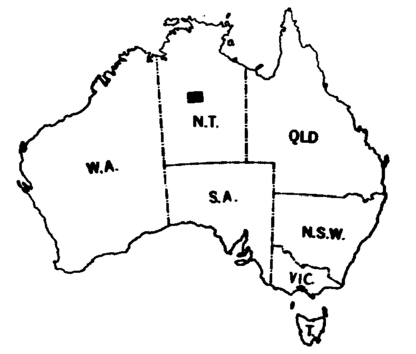


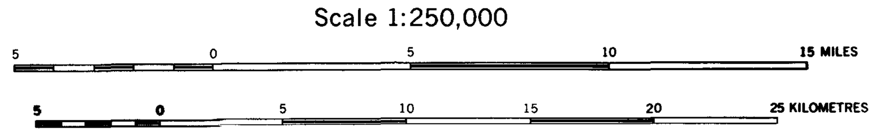
INDEX TO ADJOINING SHEETS

Showing Magnetic Declination

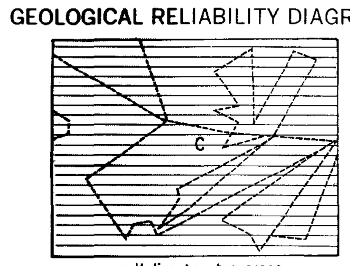
LIMBUNYA SE 52-7	WAVE HILL SE 52-8	NEWCASTLE WATERS SE 53-5	BEETALOO SE 53-6	[illegible]
BIRRINDUDU SE 52-11	WINNECKE CREEK SE 52-12	SOUTH LAKE WOODS SE 53-9	HELEN SPRINGS SE 53-10	[illegible]
TANAMI SE 52-15	TANAMI EAST SE 52-16	GREEN SWAMP WELL SE 53-13	TENNANT CREEK SE 53-14	[illegible]
THE GRANITES SF 52-3	MOUNT SOLITAIRE SF 52-4	LANDER RIVER SF 53-1	BONNEY WELL SF 53-2	[illegible]
HIGHLAND ROCKS SF 52-7	MOUNT THEO SF 52-8	MOUNT PEAKE SF 53-5	BARROW CREEK SF 53-6	[illegible]

ANNUAL CHANGE 0'30"E

Scale 1:250,000



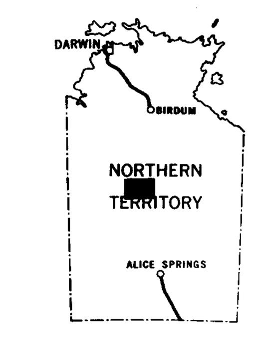
GEOLOGICAL RELIABILITY DIAGRAM



C Air-photo interpretation and helicopter traverses

Helicopter traverses

Geology, 1965, by : K.G. Smith, R.A.H. Nichols, H.F. Doutch, E.N. Milligan
Compiled, 1966, by : H.F. Doutch
Cartography by : Geological Branch, B.M.R.
Drawn by : G. Matveev and D.E. Brentnall



GREEN SWAMP WELL

SHEET SE 53-13

AUSTRALIA 1:250,000 GEOLOGICAL SERIES

LANDER RIVER

NORTHERN TERRITORY

SHEET SF 53-1

BUREAU OF MINERAL RESOURCES GEOLOGY AND GEOPHYSICS

PRELIMINARY EDITION, 1966

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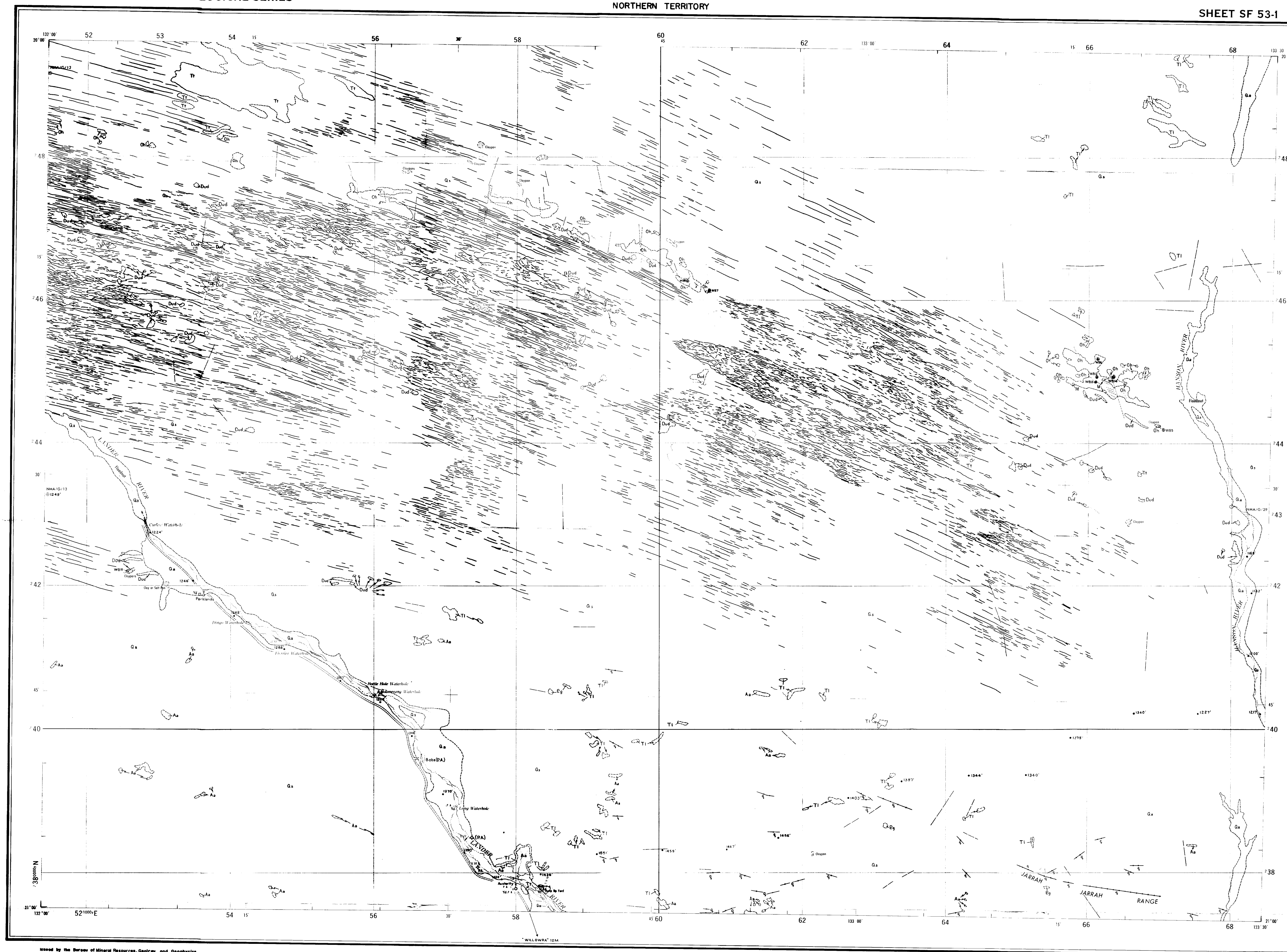


CAINOZOIC	QUATERNARY		Qa	*Sand, silt, gravel*
			Qs	*Sand*
	TERTIARY		Tl	*Laterite*
			Tt	*Limestone, chalcedonic limestone, quartz sandstone, travertine*
MESOZOIC	UNDIFFERENTIATED		M	*Silty, pebbly sandstone, siltstone*
PALAEOZOIC	DEVONIAN	Dulcie Sandstone	Dud	*Quartz sandstone, argillaceous sandstone*
	LOWER–MIDDLE ORDOVICIAN	Hanson River Beds	Oh	*Quartz sandstone, ferruginous sandstone, calcareous sandstone, crystalline dolomite, siltstone*
PRECAMBRIAN	UNDIFFERENTIATED		Eg	*Granite*
	ARCHAEAN?	Arunta Complex	Aa	*Gneiss, schist, amphibolite*

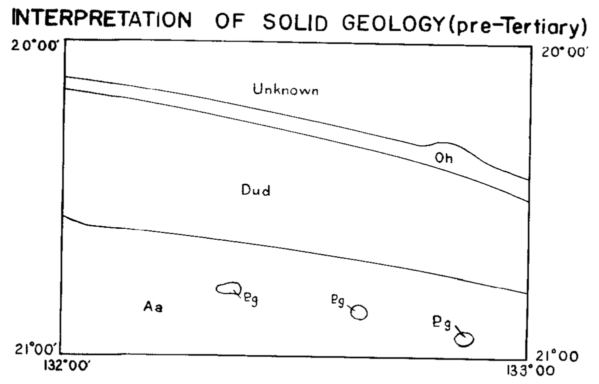
Geological bounaary (position approximate)
Strike and dip of bed
Trend lines } *Air-photo interpretation*
Joint pattern }

WB5 *Macrofossil locality* } *with text reference number*
WB11 *Specimen locality* }
Dyke q - quartz
Sand dunes

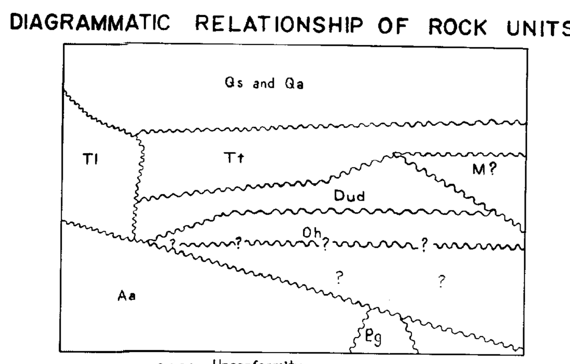
Bore
Abandoned bore
Well
Windpump
WH *Waterhole*
Claypan

Vehicle track
Yd *Yard*
1246 *Height in feet, instrumt levelled; datum: mean sea level*
Astronomical station
P.A. *Position approximate*

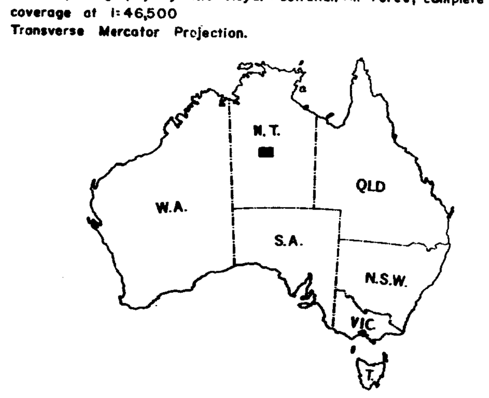
INTERPRETATION OF SOLID GEOLOGY (pre-Tertiary)



DIAGRAMMATIC RELATIONSHIP OF ROCK UNITS



Issued by the Bureau of Mineral Resources, Geology and Geophysics, Department of National Development. Issued under the authority of the Hon. David Fairbairn, Minister for National Development. Base map compiled by the Division of National Mapping, Department of National Development. Aerial photography by the Royal Australian Air Force; complete vertical coverage at 1:46,500
Transverse Mercator Projection.



INDEX TO ADJOINING SHEETS

Showing Magnetic Declination

BIRRINDUDU SE 52-11	WINNECKE CREEK SE 52-12	SOUTH LAKE WOODS SE 53-9	HELEN SPRINGS SE 53-10	BRUNETTE DOWNS SE 53-11
TANAMI SE 52-15	TANAMI EAST SE 52-16	GREEN SWAMP WELL SE 53-13	TENNANT CREEK SE 53-14	ALROY SE 53-15
THE GRANITES SF 52-3	MOUNT SOLITAIRE SF 52-4	LANDER RIVER SF 53-1	BONNEY WELL SF 53-2	FREW RIVER SF 53-3
HIGHLAND ROCKS SF 52-7	MOUNT THEO SF 52-8	MOUNT PEAKE SF 53-5	BARROW CREEK SF 53-6	ELKEDRA SF 53-7
LAKE MACKAY SF 52-11	MOUNT DOREEN SF 52-12	NAPPERBY SF 53-9	ALCOOTA SF 53-10	HUCKITTA SF 53-11

3°30'E 4°E 5°E

ANNUAL CHANGE 1'E

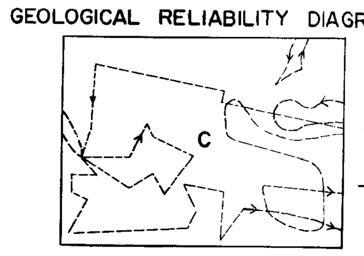
Scale 1:250,000

5 0 5 10 15 MILES

5 0 5 10 15 20 25 KILOMETRES

GREY NUMBERED LINES INDICATE THE 20,000 YARD TRANSVERSE MERCATOR GRID, ZONE 4 (AUSTRALIA SERIES)

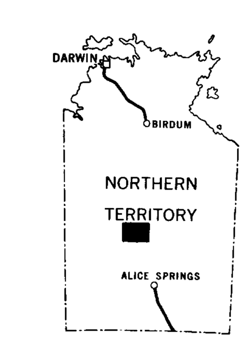
GEOLOGICAL RELIABILITY DIAGRAM



C Helicopter reconnaissance and air photo - interpretation

-- Helicopter traverses

Geology, 1965, by: K.G. Smith, R.A.H. Nichols, E.N. Milligan, H.F. Doutch
Compiled, 1966, by: K.G. Smith
Cartography, by: Geological Branch B.M.R.
Drawn, 1966, by: R.D. Cooper



LANDER RIVER

SHEET SF 53-1

AUSTRALIA 1:250,000 GEOLOGICAL SERIES

MOUNT SOLITAIRE

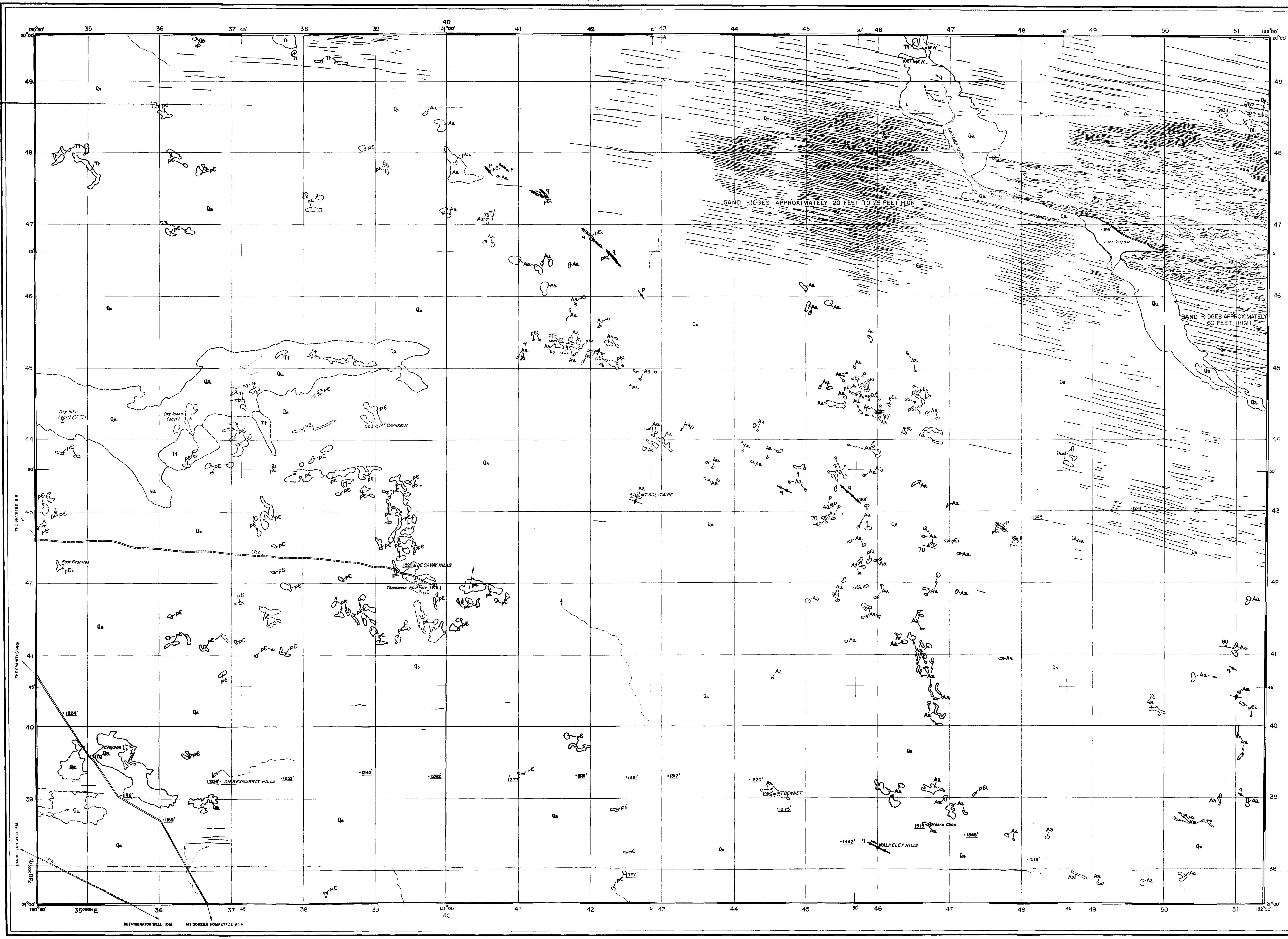
NORTHERN TERRITORY

SHEET SF 52-4

PRELIMINARY EDITION, 1966

SUBJECT TO AMENDMENT

NO PART OF THIS MAP IS TO BE REPRODUCED FOR PUBLICATION WITHOUT THE WRITTEN PERMISSION OF THE DIRECTOR OF THE BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS, DEPARTMENT OF NATIONAL DEVELOPMENT, CANBERRA, A.C.T.



Reference

CAINOZOIC	QUATERNARY		Qa	*Sand, silt and gravel.*
			Qs	*Some laterite and chert.*
	TERTIARY		Tt	*Travertine*
PALAEOZOIC	UNDIFFERENTIATED		Pzl	*Quartzose calcilutite, pelletal dolomite, aphanitic dolomite*
	DEVONIAN	Dulcie Sandstone	Dud	*Argillaceous sandstone*
	LOWER TO MIDDLE ORDOVICIAN	Hanson River Beds	Oh	*Quartzose dololutite, crystalline dolomite.*
PRECAMBRIAN	UNDIFFERENTIATED		p€	*Greywacke, sericite-mica-schist*
			p€i	*Granite, pegmatite, aplite, quartz.*
	ARCHAEAN ?	Arunta Complex	Aa	*Mica-schist, biotite-quartz-feldspar-gneiss*

Geological boundary, position approximate.
Fault, inferred

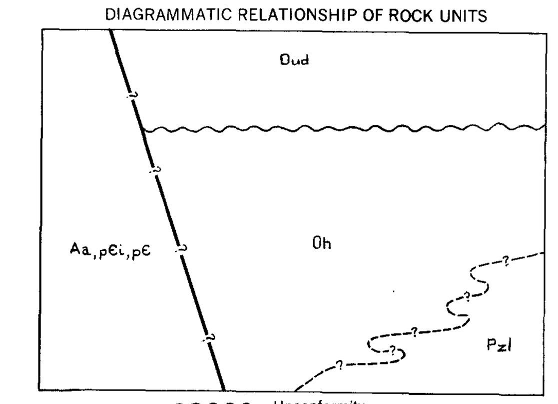
Strike and dip of foliation
Vertical foliation
Foliation with trend of lineation

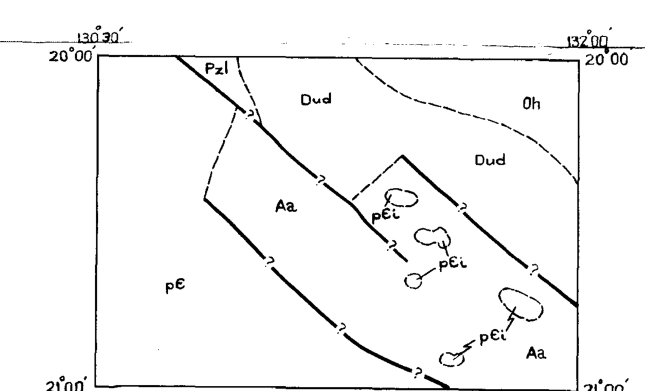
Microfossil locality
Text reference to specimen locality
Dyke; q - quartz, p - pegmatite.

Water hole
Sand dunes

Road
Vehicular track
Astronomical station
Trigonometrical station
Height in feet, instrument levelled, datum: mean sea level
Position approximate

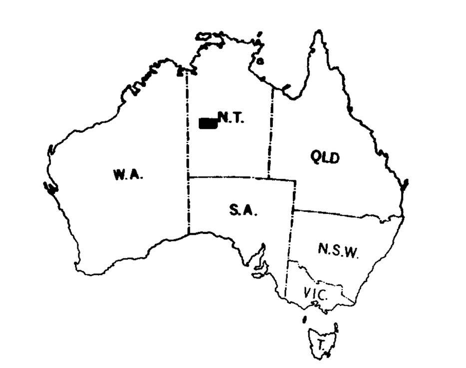
DIAGRAMMATIC RELATIONSHIP OF ROCK UNITS





Interpretation of solid (pre-Tertiary) geology

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 1:46,500 scale.
Transverse Mercator Projection.



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Showing Magnetic Declination

GORDON DOWNS SE 52-10	BIRRINDUDU SE 52-11	WINNECKE CREEK SE 52-12	SOUTH LAKE WOODS SE 53-9	HELEN SPRINGS SE 53-10
BILLILUNA SE 52-14	TANAMI SE 52-15	TANAMI EAST SE 52-16	GREEN SWAMP WELL SE 53-13	TENNANT CREEK SE 53-14
LUCAS SF 52-2	THE GRANITES SF 52-3	MOUNT SOLITAIRE SF 52-4	LANDER RIVER SF 53-1	BONNEY WELL SF 53-2
STANSMORE SF 52-6	HIGHLAND ROCKS SF 52-7	MOUNT THEO SF 52-8	MOUNT PEAKE SF 53-5	BARROW CREEK SF 53-6
WEBB SF 52-10	LAKE MACKAY SF 52-11	MOUNT DOREEN SF 52-12	NAPPERBY SF 53-9	ALCOOTA SF 53-10

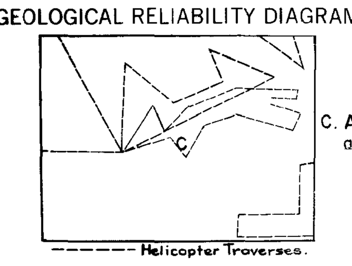
ANNUAL CHANGE 0°45' E

Scale 1:250,000

5 0 5 10 15 MILES

5 0 5 10 15 20 25 KILOMETRES

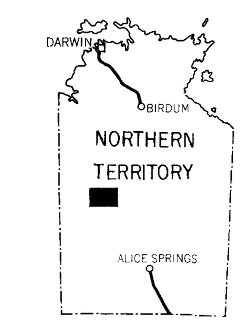
GEOLOGICAL RELIABILITY DIAGRAM



C. Air photo interpretation and helicopter traverses

Helicopter Traverses.

Geology 1965 by; E.N. Milligan, H.F. Doutch and K.G. Smith
Compiled 1965 by; E.N. Milligan.
Cartography by; Geological Branch. B.M.R.
Drawn 1966 by: G.J. Squire.



MOUNT SOLITAIRE

SHEET SF 52-4

PRELIMINARY EDITION, 1967

SUBJECT TO AMENDMENT

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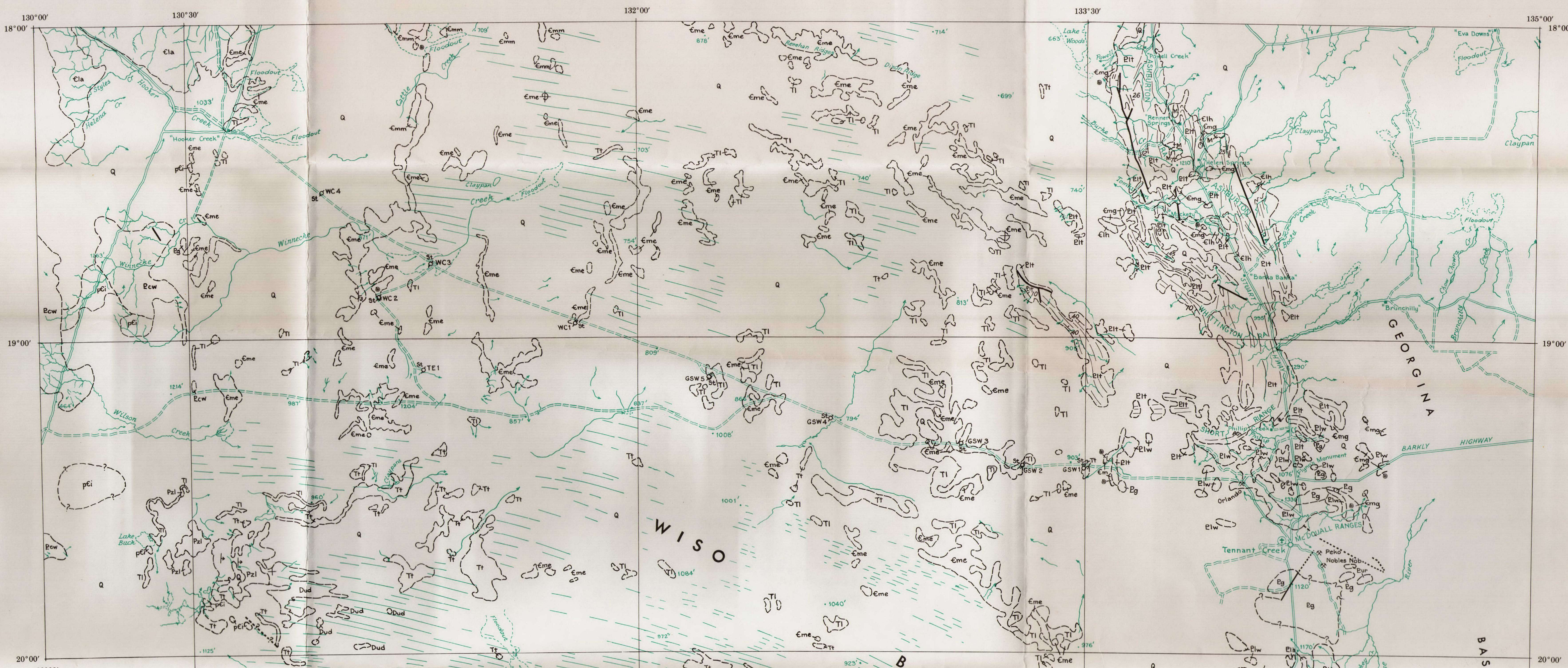
GEOLOGICAL MAP
WISO BASIN

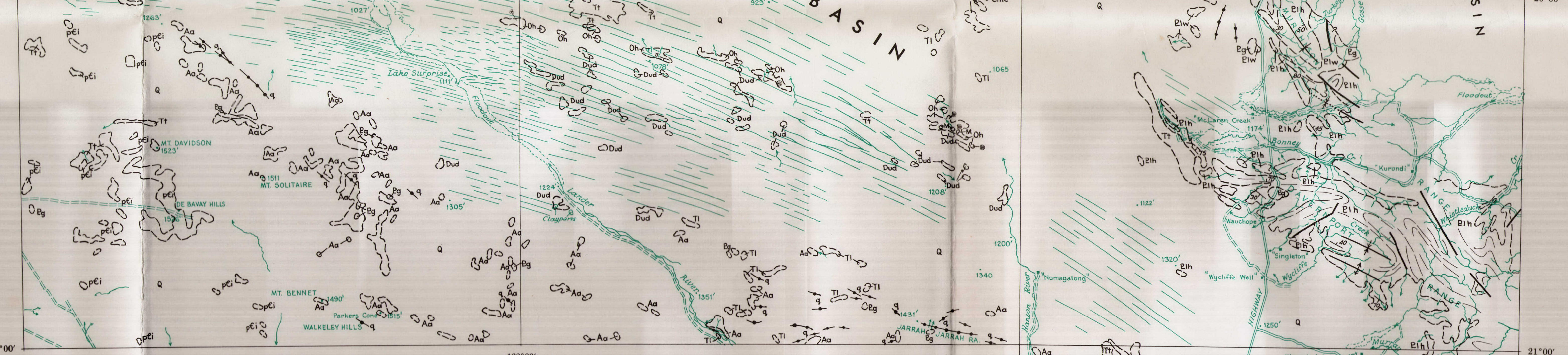
Scale 1 : 1,000,000

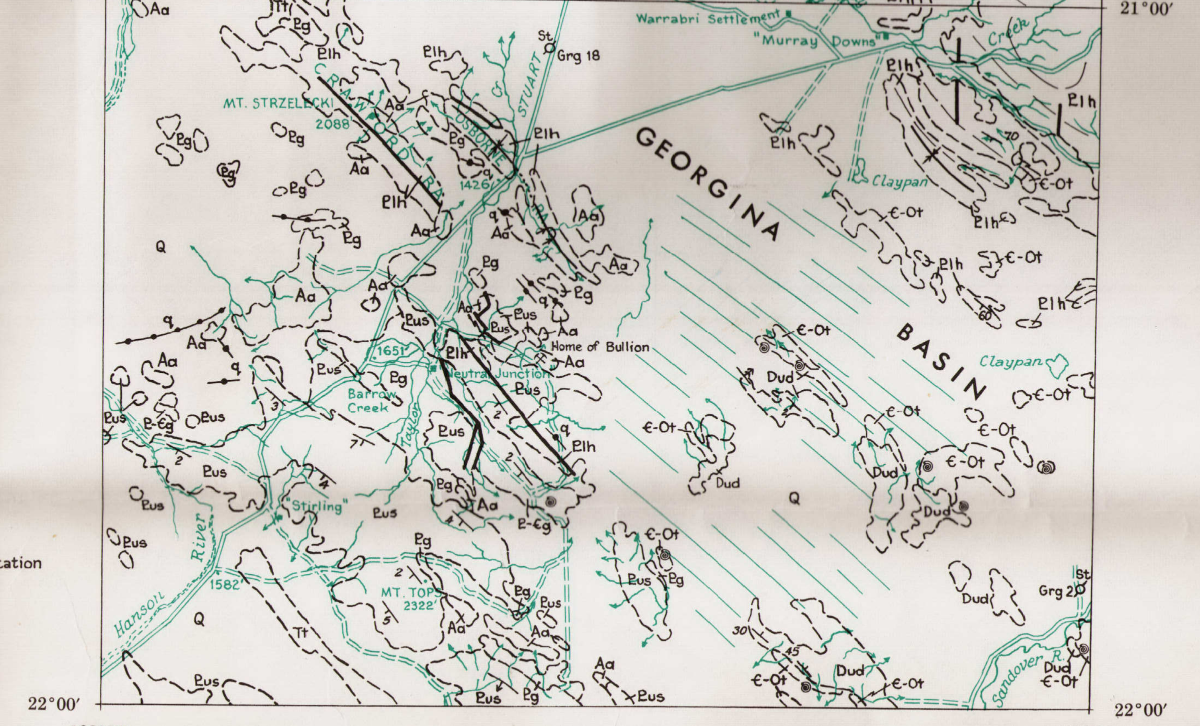
10 0 10 20 30 40 50 Miles

10 0 10 20 30 40 50 60 70 Kilometres

Geology to 1966 by : Officers of the Bureau of Mineral Resources
Compiled by : E.N.Milligan
Drawn by : F.J.Roberts







Reference

CAINOZOIC	QUATERNARY	Undifferentiated	Q	Sand, soil, gravel
CAINOZOIC	TERTIARY	Undifferentiated	Tt	Travertinous and chalcedonic limestone, sandy limestone, sandstone
			Tl	Pisolitic laterite
MESOZOIC	UNDIFFERENTIATED		M	Sandstone
PALAEOZOIC	UPPER DEVONIAN	Dulcie Sandstone	Dud	Sandstone
	MIDDLE ORDOVICIAN	Hanson River Beds	Oh	Sandstone, siltstone, dolomite
	UPPER CAMBRIAN – LOWER ORDOVICIAN	Tomahawk Beds	€-Ot	Sandstone, siltstone, dolomite
	MIDDLE CAMBRIAN	Merrina Beds	€me	Sandstone, dolomitic siltstone and claystone, dolomite
		Montejinni Limestone	€mm	Dolomite, limestone, siltstone
		Gum Ridge Formation	€mg	Silicified limestone, shale, sandstone
		Undifferentiated	€m	Fossiliferous chert
	LOWER CAMBRIAN	Helen Springs Volcanics	€lh	Basalt, sandstone
		Antrim Plateau Volcanics	€la	Basalt flows, tuff, agglomerate
	LOWER PALAEOZOIC	Undifferentiated	Pzl	Dolomite, limestone, siltstone
PRECAMBRIAN	ADELAIDEAN LOWER CAMBRIAN	Grant Bluff Formation	Ꝑ-€g	Sandstone, siltstone
	ADELAIDEAN	Central Mount Stuart Beds	Ꝑus	Sandstone, arkose, siltstone
		Rising Sun Conglomerate	Ꝑur	Boulder conglomerate, sandstone
	CARPENTARIAN	Mount Winnecke Sandstone	Ꝑcw	Siliceous sandstone
	UNDIFFERENTIATED		Ꝑg	Granite, pegmatite,
			p€i	Greywacke, arkose, schist, intrusives
	LOWER PROTEROZOIC	Hatches Creek Group	Ꝑlh	Sandstone, greywacke, siltstone, acid and basic lavas
		Tomkinson Creek Beds	Ꝑlt	Sandstone, greywacke, siltstone, acid and basic lavas
		Warramunga Group	Ꝑlw	Siltstone, greywacke, shale
	ARCHAEAN	Undifferentiated	Aa	Gneiss, schist, metaquartzite, amphibolite

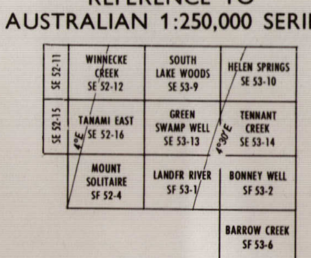
Geological boundary
Anticline
Syncline
Overturned syncline
Fault

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.

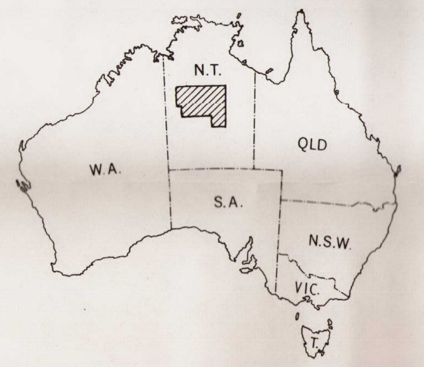
45 Strike and dip of strata
Horizontal strata
Dip < 15°
Dip 15°—45° air-photo interpretation
Trend lines

Macrofossil locality
Microfossil locality
Dyke or vein: q - quartz
Grg 2 St Stratigraphic hole with B.M.R. reference number
Mine
Road
Vehicle track
Airport
o Wauchope Town or village
"Stirling" Homestead
Sand dunes
· 1122' Height in feet

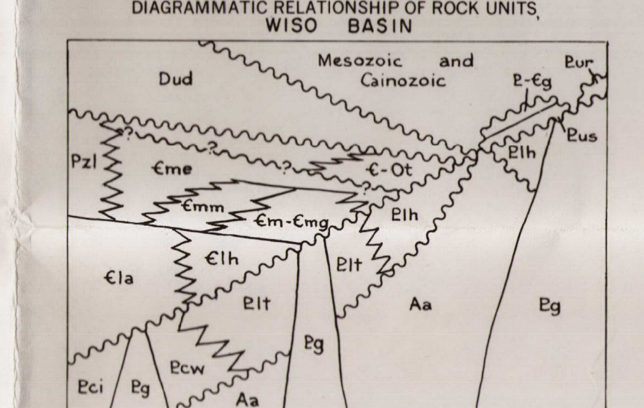
REFERENCE TO AUSTRALIAN 1:250,000 SERIES



ANNUAL CHANGE 4'E



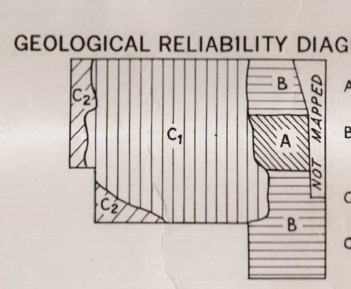
DIAGRAMMATIC RELATIONSHIP OF ROCK UNITS, WISO BASIN



Unconformity

Compiled and issued by the Bureau of Mineral Resources, Geology and Geophysics, Department of National Development. Issued under the authority of the Hon. David Fairbairn, Minister for National Development. Base maps compiled by the Division of National Mapping, Department of National Development.
Lambert Conformal Conical Projection. Standard Parallels 17° & 33°

GEOLOGICAL RELIABILITY DIAGRAM



A Detailed mapping

B Detailed reconnaissance — numerous traverses and air-photo interpretation

C_1 Helicopter traverses and air-photo interpretation

C_2 Air-photo interpretation