Explanatory Notes on the Winnecke Creek Geological Sheet

Compiled by M. B. Huleatt

The Winnecke Creek Sheet area is bounded by longitudes 130°30' and 132°E and latitudes 18° and 19°S, and is located in the Tanami Desert, Northern Territory.

Two sets of vertical aerial photographs of the area are available. The first was flown by the RAAF in 1950 at a nominal scale of 1:50,000. From these an uncontrolled photomosaic at a scale of 1:250,000 was compiled by the Division of National Mapping in 1951. The second survey was flown in 1967 by Adastral Airways at a nominal scale of 1:85,000. Uncontrolled photomosaics at a scale of about 1:100,000 were produced from these photographs by the Division of National Mapping which also produced a 1:250,000 topographic sheet in 1964 from the 1950 aerial photographs. A 1:250,000 photogeology map of the area compiled in 1965 from 1:50,000 scale aerial photographs (Riviereau & Perry, 1965) was amended to prepare the accompanying geological map.

The Hooker Creek Aboriginal Reserve in the northwest corner contains the only settlement in the Sheet area. The only formed road, linking Hooker Creek and Wave Hill station to the north, may be impassable during wet weather. Cross-country travel is hindered by scrub and sand dunes, and is virtually impossible after wet weather.

A dry-weather landing field, suitable for light aircraft, is operational at the Hooker Creek Settlement.

Most rain falls from November to March, though showers and storms may occur throughout the year. The average annual rainfall is 360 mm and the annual evaporation about 2700 mm.

Mean temperatures remain high throughout the year with a mean maximum of 30°C and a minimum of 24°C for January; in July mean temperatures range from a maximum of 27°C to a minimum of 11°C.

GEOLoGICAL AND GEOPHYSICAL INVESTIGATIONS

The first geologist to pass through the area was Davidson (1905) who traversed the southern portion in 1900. He described and figured a section at Buchanan Hills consisting of '50 feet' of ironstone conglomerate (laterite soil profile on Buchanan Hills Beds) capping up to '200 feet' of sandstone (Buchanan Hills Beds and Hooker Creek Formation) which is in turn underlain by crystalline limestone (Hooker Creek Formation). Brief references were also made to ferruginous sandstone and other ironstone conglomerate occurrences.

Chewings (1928, 1931) made several observations concerning the sandstone and shale sequence that he referred to as the Winnecke Creek Tableland Formation, subsequently renamed the Merrina Beds (Milligan et al., 1966). Chewings (1931) also stated that '... in no case, notwithstanding that the Tableland Formation covers such extensive areas of country, did it appear to have any great vertical dimensions'.
Wade (1924) published a map which included the Sheet area. He showed, incorrectly, granite outcropping at longitude 131°E and latitude 18°30'S.

Hossfeld (1954) used the term Wiso Tableland for a large area, including the Sheet area, which he believed to be underlain by Cambrian sediments, and postulated that the latter were continuous with sediments of the Daly River Basin.

Aero Service Ltd covered the area during an aeromagnetic survey of the Wiso Basin for Exoil in 1964 (Zarzavatjian & Hartman, 1964). Two north-trending magnetic basement depressions were suggested.

A photogeological map of the Sheet area was prepared by the Bureau of Mineral Resources (BMR) before the 1965 field survey (Riveneau & Perry, 1965).

A program of geological mapping and stratigraphic drilling was undertaken by BMR in 1965 (Milligan et al., 1966). Four shallow holes were drilled in the area but none penetrated basement rocks. Early Middle Cambrian fossils were recovered from both the Hooker Creek Formation and the underlying Montejinni Limestone, and an unpublished preliminary geological map was prepared.

During 1965 Wongela Geophysical Pty Ltd carried out a gravity survey of the Sheet area as part of a regional survey, under contract to BMR (Flavelle, 1965). Most of the Sheet area is covered by the 'Buchanan Regional Gravity Platform', an area of intermediate Bouger anomalies ranging from +5 to —45 mGal.

Adastra Hunting Geophysics Pty Ltd (1967) carried out an airborne magnetometer survey for American Overseas Petroleum in 1966-67. Part of the Sheet area was covered by the survey and it was concluded that basement was at shallow depth.

During 1975 BMR geologically surveyed the Sheet area in reconnaissance detail by helicopter. These notes and the accompanying map were compiled on completion of this survey in the light of new information obtained.

**PHYSIOGRAPHY**

The Winnecke Creek Sheet area, which lies on the northern edge of the Tanami Desert, is part of the Main Plateau of Hays (1967).

The area is mostly sand plain interrupted by a few areas of hills (e.g. Buchanan Hills) and a dissected basalt plateau in the northwest. The sand plain is part of an erosion surface in a very advanced state of planation referred to by Hays (1967) as the Tennant Creek Surface.

The plain gradually rises from a depression in the northeast with an elevation of about 220 m, to about 375 m in the southwest. The depression is a northward extension of the low area occupied by the Lander River floodout in the adjoining Tanami East Sheet area. The topographic formlines on the 1:250 000 map have been compiled by the author from BMR gravity station elevations.

Within the area six physiographic zones are recognised (Fig. 1).

*Basalt plateau*

In the extreme northwest the Antrim Plateau Volcanics underlie a plateau which is a continuation of the Victoria River Plains and Benches of Paterson (1970) and Bultitude (1973). The streams are strongly incised and there are a few small mesas.
Fig. 1. Physiographic zones of the Winnecke Creek Sheet area.

Low rises and pediments

An extensive meridional system of low rises occurs near the centre of the Sheet area. Scarps formed by erosion of the rises (breakaways) expose a lateritic soil profile developed on the bedrock in places. Pediments flanking the breakaways are underlain by colluvial deposits. Smaller breakaways, gravel ridges, and mesas occur elsewhere in the Sheet area and are surrounded by extensive gravel deposits in the southwest. This zone is part of the area referred to as the Winnecke Tableland by Chewings (1928).

Sand plains

Sand plains occur throughout the Sheet area and are broken by a few small gravel rises. Redistribution of the sand has taken place by stream action and slope wash. There has been stabilization of most of the sand by vegetation, preventing movement by wind action.
<table>
<thead>
<tr>
<th>Era</th>
<th>Period</th>
<th>Rock unit and symbol</th>
<th>Lithology</th>
<th>Est. max. thickness (m)</th>
<th>Distribution</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAINozoic QUATERNARY</td>
<td></td>
<td>Qa</td>
<td>Sand, gravel, silt, clay</td>
<td>Unknown</td>
<td>In S and NW in stream channels and floodouts</td>
<td>Unconsolidated alluvial deposits</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Q1</td>
<td>Clay, silt, sand, gravel, evaporites</td>
<td>3</td>
<td>Throughout E, most common in SE. Formed in salt and claypans</td>
<td>Lacustrine deposits formed by run-off, slope wash and evaporation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Qg</td>
<td>Gravel, lateritic gravel</td>
<td>5</td>
<td>In S on small rises, and flanking ridges</td>
<td>Unconsolidated residual gravel derived from laterite soil profile on underlyng bedrock, in part deflated</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Qc</td>
<td>Quartz sand, rock fragments, silt, clay</td>
<td>5</td>
<td>Throughout Sheet area, mainly in SE, around breakaways, outcrops and re-worked sand</td>
<td>Unconsolidated colluvium, outwash deposits and reworked aeolian sand</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Qs</td>
<td>Red, fine quartz sand, gypsiferous around salt lakes</td>
<td>12</td>
<td>Throughout Sheet area</td>
<td>Unconsolidated aeolian sand in longitudinal dunes or sand plains</td>
</tr>
<tr>
<td></td>
<td></td>
<td>KTc</td>
<td>Laterite conglomerate</td>
<td>10</td>
<td>Central S</td>
<td>Consolidated conglomerate; fragments of lateritized bedrock cemented with ferruginous cement by a possible later laterization; terrestrial</td>
</tr>
<tr>
<td>Cretaceous OR TERTIARY</td>
<td>Stipple</td>
<td></td>
<td>Upper part of laterite soil profile</td>
<td>6</td>
<td>Throughout Sheet area</td>
<td>Soil profile developed on bedrock. Upper part of profile exposed on bedrock on Buchanan Hills Beds at Buchanan Hills; lower part exposed throughout Sheet area</td>
</tr>
<tr>
<td></td>
<td>Buchanan Beds KTb</td>
<td></td>
<td>Fine to coarse, poorly sorted quartz sandstone, minor siltstone</td>
<td>50</td>
<td>At Buchanan Hills and Lothari Hill</td>
<td>Consolidated, silicified, fluvial sandstone</td>
</tr>
<tr>
<td>Era</td>
<td>Period</td>
<td>Rock unit and symbol</td>
<td>Lithology</td>
<td>Est. max. thickness (m)</td>
<td>Distribution</td>
<td>Remarks</td>
</tr>
<tr>
<td>---------------------</td>
<td>--------------</td>
<td>----------------------</td>
<td>------------------------------------------------</td>
<td>-------------------------</td>
<td>-------------------------</td>
<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td>PALAEOZOIC</td>
<td></td>
<td>Lothari Hill Sandstone Gml</td>
<td>Red, fine, silty quartz sandstone, minor siltstone</td>
<td>15</td>
<td>Extreme S and SE</td>
<td>Shallow marine to supratidal, conformable on Hooker Creek Formation</td>
</tr>
<tr>
<td></td>
<td>MIDDLE</td>
<td>Hooker Creek Formation Gmh</td>
<td>Dolomitic siltstone, siltstone, silty sandstone, sandstone, dolomite, claystone</td>
<td>130</td>
<td>Throughout</td>
<td>Shallow marine, conformable on Montejinini Limestone and unconformable on Antrim Plateau Volcanics and Winnecke Granophyre. Fossilerous</td>
</tr>
<tr>
<td></td>
<td>CAMBIAN</td>
<td>Montejinini Limestone Gmm</td>
<td>Dolomitic dolomitic limestone, siltstone, chert</td>
<td>160</td>
<td>Probably underlies most of Sheet area</td>
<td>Shallow marine, unconformably overlies basement rocks. Fossilerous</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Antrim Plateau Volcanics Gla</td>
<td>Basalt</td>
<td>88</td>
<td>Extreme NW corner</td>
<td>Part of extensive basalt flows. Unconformably overlies Proterozoic sediments</td>
</tr>
<tr>
<td></td>
<td>EARLY</td>
<td>Carpentarian or Adelaide Gw</td>
<td>Quartz sandstone, siltstone, chert, quartzite</td>
<td>Unknown</td>
<td>Extreme N, W, and NW</td>
<td>Low ostracods. Thought to form basement for most Palaeozoic sediments</td>
</tr>
<tr>
<td>PROTEROZOIC</td>
<td></td>
<td>Winnecke Granophyre Gw</td>
<td>Granite</td>
<td>Unknown</td>
<td>Extreme W; subsurface distribution unknown</td>
<td>Unconformably below Hooker Creek Formation</td>
</tr>
<tr>
<td></td>
<td>EARLY</td>
<td>Mount Winnecke Formation Gw</td>
<td>Quartzite</td>
<td>Unknown</td>
<td>Extreme SW corner</td>
<td>Forms part of prominent strike ridge. Dips at 60°. Hard and resistant</td>
</tr>
<tr>
<td></td>
<td>PROTEROZOIC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Dunefields

Large areas of the eastern half of the Sheet area are characterized by parallel or sub-parallel, west-northwesterly-trending longitudinal sand dunes averaging 7 m high and about 150 m apart. Extensive spinifex growth has stabilised the dunes to a large extent although there has been some redistribution of sand by slope wash.

Floodouts

Winnecke Creek and, to a lesser extent, Hooker and Cattle Creeks drain the area. These streams are ephemeral and their courses contain a few small waterholes. They terminate in floodouts covered with sandy silt and some gravel.

Saltpans and claypans

Saltpans and claypans are present throughout the Sheet area, particularly in low-lying areas in the southeast. They are large, flat, rounded areas which hold water for several months after rain, but are often hard and sun-cracked. The saltpans have thin surface crusts of gypsum.

STRATIGRAPHY

Cainozoic sediments overlie a relatively thin sequence of Early Palaeozoic sedimentary rocks which in turn rest on basement sedimentary and crystalline rocks. The Palaeozoic sequence is a southward extension of rocks of the northern Wiso and Daly River Basins (Randal & Brown, 1967; Brown, 1968; Randal, 1973; Kennewell & Hulett, in prep.), and was referred to previously as the Merrina Beds. The revised stratigraphy of the Sheet area is summarized in Table 1.

EARLY PROTEROZOIC

The Mount Winnecke Formation (P1w) was originally defined by Traves (1955) as the Mount Winnecke Sandstone and the name was subsequently amended by Blake et al. (1975). At least 30 m of the unit crops out in the Sheet area in a strike ridge in the extreme southwestern corner. Better exposures occur in the Birrindudu Sheet area to the west and the Tanami Sheet area to the southwest.

Quartzite of the Mount Winnecke Formation crops out on the eastern limb of a north-trending syncline and dips more than 60°, in contrast to flat-lying Precambrian sediments elsewhere in the Sheet area. It ranges from white to grey to purple and is fine to medium-grained and very hard. It is generally massive, although some exposures have a poorly defined lamination, low-angle cross-bedding or indistinct graded bedding.

Most quartz grains are highly strained, showing strongly undulose extinction, and most grain contacts are sutured; some quartz overgrowths are present. The quartzite contains rare detrital hornblende, muscovite, and zircon, and its siliceous cement has been partly recrystallized.

Blake et al. (1975) and Page et al. (1976) report an age of about 1800 m.y. for acid lavas from the Mount Winnecke Formation in the Birrindudu Sheet area.
The Winnecke Granophyre (Egw) was named and described by Traves (1955) and discussed by Blake et al. (1975) and Page et al. (1976). It is exposed in the central western edge of the Sheet area as several small outcrops of coarse-grained granite. It contains quartz, orthoclase, and plagioclase grains interlocked with clusters of both muscovite and biotite. Most outcrops are highly weathered and some are strongly lateritized. Exposures of the granite on the northern branch of Winnecke Creek have a very well developed north-trending vertical foliation, but this is not seen in other exposures. Page et al. (1976) report an isotopic age of 1802 ± 15 m.y. for the Winnecke Granophyre, which they say is probably comagmatic with the volcanics of the Mount Winnecke Formation.

CARPENTARIAN OR ADELAIDEAN

Small isolated outcrops, mainly of quartz sandstone with lesser siltstone, chert, and quartzite are mapped as unit B in the northeast, north, northwest, and west of the Sheet area. Outcrops of photo-interpreted Proterozoic rocks are prefixed by a question mark. The rocks are distinguished from the Mount Winnecke Formation by their horizontal disposition and the weaker development of metamorphic textures. Low rocky outcrops a few centimetres above plain level are typical.

The sandstone is generally white or grey where fresh but weathers to brown. Small to medium-scale, low-angle cross-bedding, graded bedding, and a few small siltstone or claystone clasts are present.

Quartz grains are dominantly subangular, and some have strongly undulose extinction; many grains show solution on grain boundaries resulting from weathering, and others have quartz overgrowths. The rock contains a few chert and quartzite fragments, and a sparse cement of finely crystalline silica. Thickness and depositional environment of the rocks are not known and their age is regarded as Carpentarian or Adelaidean. Their horizontal disposition suggests that they overlie the Winnecke Granophyre and Mount Winnecke Formation and may correlate with rocks of the Birrindudu Basin to the west and north.

PALAEOZOIC

Basalts of the Antrim Plateau Volcanics (Gla) (Traves, 1955) crop out in the extreme northwest corner of the Sheet area and are a southerly extension of very widespread flows to the north (Traves, 1955, and Bultitude, 1971). Their extent beneath the Sheet area is not known.

To the north and northwest Sweet et al. (1974) report an angular unconformity between the Antrim Plateau Volcanics and the underlying Precambrian sediments.

A precise age has not been established for the volcanics; however, Bultitude (1971) inferred an Early Cambrian age from stratigraphic evidence to the north of the Sheet area.

The basalts are dark green to black, very hard, and mostly fine-grained, though some are coarse-grained. Bultitude (1971) notes a gradation in composition from olivine tholeite to quartz-rich tholeite in the area north and northwest of the Sheet area. Minor interbeds of limestone and calcareous shale were recorded in a total thickness of 88 m of Antrim Plateau Volcanics penetrated
by Hooker Creek No. 8 Bore, near Hooker Creek Settlement. Sedimentary rocks of aeolian origin have been recorded within the Volcanics elsewhere, but have not been observed in the Sheet area.

The Montejinni Limestone (6 mm) is the oldest known sedimentary unit of the Wiso Basin, and is a shallow-water marine sequence. It was mapped and named by Traves (1955) in the Wave Hill Sheet area. In Winnecke Creek Sheet area its outcrop is restricted to the north, northeast, and east, where several metres of the formation is exposed, but it probably extends under most of the Sheet area. In BMR Green Swamp Well No. 6 stratigraphic hole, 110 km to the southeast of the Sheet area, it is at least 152 m thick.

North of the Sheet area the Montejinni Limestone unconformably overlies the Antrim Plateau Volcanics (Bultitude, 1973), but this relationship is not seen in the area. Here it appears to unconformably overlie Proterozoic quartz sandstone, though the contact has not been observed.

Randal (1973) divided the Montejinni Limestone of the northern Wiso Basin into three units, all of which are exposed in the Sheet area. The basal dolomite is exposed at locality 6 in the vertical walls of a large sinkhole. The middle unit overlies it, forming the upper part of the sinkhole; it is very weathered, apparently unfossiliferous, chocolate-coloured siltstone with minor yellow chert concretions.

The uppermost unit is a massive fossiliferous dolomite or dolomitic limestone with chert nodules. Most exposures show some degree of recrystallization to a coarse-grained rock. Most of the carbonates contain small amounts of fine quartz sand or silt. Milligan et al. (1966) noted the presence of Biconulites, Acrothelae and other phosphatic brachiopods, and echinoderm fragments, and the alga Girvanella, from which an early Middle Cambrian (Ordian) age was inferred. The uppermost unit is correlated with the Tindall Limestone of the Daly River Basin on the basis of lithology, fossil assemblages, and subsurface data from drill-holes in that area (Randal, 1973), and with the Gum Ridge Formation of the Tennant Creek area (Opik, 1956).

The Hooker Creek Formation (6 mm) is defined by Kennewell & Huleatt (in prep.) and crops out in large parts of the Sheet area. Exposure is such that it is not possible to see the complete sequence at any one locality. Dolomitic siltstone and interbedded dolomite from the lower part of the sequence are best exposed on the breakaways between Buchanan Hills and Cattle Creek. The interbedded siltstone and sandstone at the top of the sequence crop out at Lothari Hill.

The dolomitic siltstone beds are commonly red-brown although some are buff or grey, micaceous, and although some outcrops are thin bedded, most are massive. A few thin claystone beds may be present. Dolomite is commonly leached from the siltstone in outcrop. The dolomite interbedded with the siltstone is commonly stylolitic, and fine to coarsely crystalline; some of the grains of quartz are concentrated along stylolites.

Silty, fine-grained quartz sandstone with thin siltstone interbeds is increasingly common toward the top of the sequence. The sandstone contains a few plagioclase grains, and some chert and quartzite fragments.
Fossils are common in the dolomite, although the number of species is small. Combining palaeontological data obtained from Milligan et al. (1966), and 1975 field observations, and BMR Winnecke Creek No. 2 stratigraphic hole, the following fauna has been identified: Biconulites and hyolithids; Acrotreta, Acrothole, and linguloid brachiopods; echinoderm ossicles; and Redlichia and ptychopariid trilobites. Small oncillites are numerous. The fauna indicates an early Middle Cambrian (Ordian) age (J. Gilbert-Tomlinson, pers. comm.).

Hooker Creek Formation conformably overlies the Montejinni Limestone. Contact with the overlying Lothari Hill Sandstone is gradational and conformable. Thickness of outcrop, combined with that in BMR Winnecke Creek No. 2 stratigraphic hole, shows that the Hooker Creek Formation is at least 130 m thick in the Buchanan Hills area.

Shallow-water marine conditions are indicated by the fauna and lithological characteristics of the sediments, for the deposition of the Hooker Creek Formation. Uplift of the source area, or deposition under higher-energy conditions toward the end of deposition is indicated by an increase in sandstone content in the formation.

Undivided Montejinni Limestone and Hooker Creek Formation (6mm-h) has been mapped in the southeast of the Sheet area, where dolomite crops out as low, rubbly pavements. The outcrops occur within a photo-pattern continuous with that of the Montejinni Limestone (but BMR Winnecke Creek No. 1 stratigraphic hole was drilled near an area with the same photo-pattern, and penetrated Hooker Creek Formation to a total depth of 72 m, hence the stratigraphic position of the dolomite outcrops is uncertain.

The Lothari Hill Sandstone (6ml) (Kennewell & Huleatt, in prep.) is a sandstone sequence with a gradational and conformable contact with the Hooker Creek Formation, cropping out in the southern parts of the Sheet area.

Red, fine-grained silty quartz sandstone is dominant, with a few siltstone interbeds. Burrows and mudcracks are common, with the burrows partly or wholly filled with a leached, porous sandstone. Although there is some low-angle cross-bedding, most of the unit is massive.

Quartz grains range in size from fine to very fine and are poorly to well sorted and enclosed in a matrix of silica and clay. A few chert and quartzite fragments are present, and ferruginization due to weathering is common.

The unit has a maximum thickness of about 15 m in the Sheet area, but thickens to the south and southeast, where 94 m were penetrated by BMR Green Swamp Well No. 4, 75 km to the southeast of the Sheet area. Although no fossils have been found, the Sandstone overlies the Middle Cambrian (Ordian) Hooker Creek Formation with a gradational contact, and is overlain with a gentle unconformity in the neighbouring Green Swamp Well Sheet area by the Middle Cambrian (Templetonian) Point Wakefield Beds (Kennewell, in press), implying a Middle Cambrian age. The red colouration, near-vertical burrows, and mudcracks suggest a supratidal to tidal flat depositional environment, although low-angle cross-bedding and a gradational contact with the Hooker Creek Formation suggest occasional shallow marine conditions, particularly during deposition of the basal part of the unit.
The Buchanan Hills Beds (K Tb) (Kennewell & Huleatt, in prep.) are well exposed along the scarp delineating the eastern flank of Buchanan Hills, and occur as lateritized fragments in gravel in many parts of the Sheet area. The unit rests unconformably on the Middle Cambrian Hooker Creek Formation and the Lothari Hill Sandstone, and in most exposures is highly ferruginized owing to laterization.

At the type section at central Buchanan Hills, about 50 m of sandstone of the Buchanan Hills Beds is exposed; a laterite soil profile is developed on the outcrop.

Moderately to poorly sorted, subangular, fine to coarse-grained sandstone is typical. Most is grey to white, but weathering has partly replaced the silica cement with iron oxides, producing a red-brown colour. Fragments of quartzite and chert, and discontinuous siltstone beds occur in places.

The age of the sandstone is uncertain, although it must be younger than Middle Cambrian as it overlies sediments of that age, and older than Miocene as a laterite soil profile of that age is developed on it. Its texture suggests a fluvial origin, and its occurrence on the edge of a large gentle slope over which rivers are now flowing suggests an origin similar to that of the Hooker and Winnecke Creek alluvia. Hence its age is probably slightly older than that of the laterite soil profile, i.e. Late Cretaceous or Early Tertiary.

A laterite soil profile is well developed throughout the Sheet area, and is well exposed at Buchanan Hills. Here, in the upper iron-rich zone, represented by a stipple on the map Sheet, the bedrock is impregnated with red-brown iron oxides.

Most of the iron minerals fill vughs and pore spaces, although some replace the siliceous cement. In the lower, mottled zone, opaline silica is also concentrated. The underlying pallid zone, and lowermost zone of weathered bedrock are exposed in most outcrops in the Sheet area. The laterite soil profile is developed on Early Cretaceous rocks to the north, and is overlain by the early Miocene Camfield Beds in the adjoining Wave Hill Sheet area, indicating an age between late Early Cretaceous and early Miocene.

Laterite conglomerate (KTe) up to 10 m thick occurs in a small area to the north of Buchanan Hills along the banks of Winnecke Creek. The iron-rich rock fragments and pisolites up to 2 cm across, of which it is composed, were derived from the laterite soil profile and later cemented with iron oxides, possibly during a later period of lateritization.

Aeolian sand (Qs) occurs over much of the Winnecke Creek Sheet area. Large areas of the eastern half of the Sheet area have well-developed longitudinal dunes which have a west-northwesterly trend, and may be up to 9 m in height with the interdunal area covered with sand of the same composition. The western half of the Sheet area is also covered dominantly by aeolian sand, but has small irregular dunes. There has been some redistribution of the sand by stream activity.

The sand is quartzose, fine-grained, and moderately well rounded, the individual grains having a complete or partial coating of red iron oxide, resulting in an overall red colour for the unit. A few grains of black iron oxide and muscovite are commonly present, and gypsum grains occur near some salt lakes. Most of the sand has been stabilized by the extensive growth of spinifex and to a lesser extent other vegetation.
Outwash deposits (Qc) contain quartz sand, silt, clay, and rock fragments distributed both by creep and slope wash from outcrops and low rises, and by stream activity and slope wash from areas of aeolian sand. They occur through the Sheet area, surrounding rock outcrops and covering gentle rises.

The material is unconsolidated. That derived directly from bedrock is poorly sorted, whereas that formed mainly from sand has better sorting, possibly because of the original composition, but retains little other evidence of the original aeolian nature. The deposits are probably less than 5 m thick.

Areas of gravel (Qg) within the Sheet area form low, rubbly rises. The composition of the gravel is controlled by the underlying bedrock and there is commonly a large laterite component. The gravel is unconsolidated, subangular to rounded, moderately to poorly sorted, and contains fragments of bedrock up to several centimetres across in a sand and clay matrix.

Lacustrine deposits (Ql) of clay, silt, gravel, and evaporites occur in small ephemeral playa lakes throughout the Sheet area. The clastic sediments are probably only a few metres thick, and were deposited by stream action, slope wash, and wind action.

Alluvium (Qa) is formed in the channels of all streams in the area; the deposits in Winnecke Creek are the most extensive. The sediments consist of silt, sand, gravel, and clay. Most of the finer material tends to be deposited on the floodout areas of the streams. Alluvium is only several metres thick in stream beds, but the thickness in floodout areas is not known.

STRUCTURE

The Sheet area covers the central western part of the Wiso Basin, which consists of a flat-lying sequence of Palaeozoic sediments thinning westward onto a basement of crystalline and sedimentary Proterozoic rocks.

Basement rocks include strongly folded quartzite in the southwestern part, granite in the western part, and gently folded quartzite in the northwestern part of the Sheet area. Antrim Plateau Volcanics form basement in the northwestern part of the area, and beneath them almost flat-lying Adelaidean sediments may extend under the Sheet area from the northwest.

Rocks of the Wiso Basin are almost all flat-lying. In the deeper erosional gullies at Buchanan Hills small-scale folds caused by penecontemporaneous deformation range in amplitude from several centimetres to 2 m. The maximum dips on the limbs of these folds range from 20° to 60° and all fold axes trend north. These folds have been observed only in siltstone beds of the Hooker Creek Formation.

Structure contours prepared by Randal & Brown (1967) on the base of the early Middle Cambrian carbonate sediments indicate some slight post-depositional tilting in the area immediately north of the Sheet area. It is likely that this gently tilting has had a small effect on similar rocks in the area.

Siltstones of the Hooker Creek Formation at location 11 have abundant slickensides, which have random orientation and are a local feature possibly caused by subsidence into solution depressions in the underlying Montejinni Limestone.

The Buchanan Hills Beds and Cainozoic units show no signs of tectonic disturbance.
GEOLOGICAL HISTORY

Sediments of the Mount Winnecke Formation were deposited during a period of shallow-water marine sedimentation and were accompanied by the extrusion of acidic lavas in the adjoining Birrinduud Sheet area. Granite of the Winnecke Granophyre intruded these rocks soon after their deposition. There followed a period of strong tectonism with folding and subsequent erosion. The unnamed Proterozoic sediments were then deposited.

At the end of Proterozoic time, uplift and erosion took place. The Early Cambrian was a period of volcanic activity in which subaerial basalts were extruded over the northwest part of the Sheet area and vast areas to the north. The presence of marine sediments within the Antrim Plateau Volcanics (Bultitude, 1973) suggests a series of minor marine transgressions between flows.

In early Middle Cambrian time, epeirgenic movements resulted in the formation of the Wiso Basin and its invasion by a shallow sea in which the Montejinni Limestone accumulated. The presence of stromatolites in this unit (Randal, 1973) suggests some intertidal deposition. A small influx of terrigenous material produced the middle siltstone unit of the Montejinni Limestone. An increase in influx of terrigenous material (Hooker Creek Formation) terminated sedimentation of the Montejinni Limestone, although carbonate deposition continued in some areas.

A gradual increase in grain size of the clastic material then took place, producing the fine sandstones of the Lothari Hill Sandstone. These sands probably filled the gently sloping, producing tidal flat and supratidal deposits and causing the sea to retreat from the Sheet area.

No further record of events is available for the Sheet area until the deposition, possibly in Early Tertiary time, of fluvialite sand of the Buchanan Hills Beds. Extensive laterization then affected most rocks of the area. Subsequent erosion in Cainozoic time removed much of the extensive laterite sheet, producing a plain with low hills of laterite and weathered bedrock.

During Quaternary time, development of the major streams and the subsequent alluviation along their channels probably commenced; most of the area was covered with aeolian sand and in places extensive dune fields formed.

ECONOMIC GEOLOGY

Water may be held after heavy rains for several months in clay pans, along the channels of Hooker and Winnecke Creeks, and occasionally between sand dunes.

Little information has been gathered about the groundwater potential of the area. Some data are presented by Randal (1973) on the seven bores at the Hooker Creek Settlement. All apparently draw water from the Antrim Plateau Volcanics and one, Hooker Creek No. 8, draws additional supplies from the underlying sediments. Aquifers in the Volcanics also supply good-quality water to Wave Hill station 55 km to the north of the Sheet area. It is possible that further supplies may be available from this unit although there has been a high proportion of unsuccessful bores. The possibility of good water being obtained is, according to Randal (1973, p.51) '... largely dependent on the
intersection of open bedding planes, joints and fractures not only sufficiently large and interconnected to contain and transmit water but also beneath the water table. It is also possible that small aquifers may be present in the interbedded sediments if they can be located in this Sheet area.

Water has been obtained from the Montejinni Limestone and its equivalent unit the Tindall Limestone to the north (Randal, 1973). No bores have penetrated a sufficient thickness of the Montejinni Limestone in the area to test its capacity, though from results obtained to the north it seems likely that good water may be obtained. Randal (1973) suggests that most water comes from its basal beds.

It is unlikely that large volumes of water would be obtained from the younger Palaeozoic units in this area. Only a small seepage of water was obtained from the siltstones of the Hooker Creek Formation in BMR Winnecke Creek No. 2 stratigraphic hole, probably because of their low permeability. Small aquifers may occur in the channel deposits of Hooker and Winnecke Creeks.

Aggregate suitable for road surfacing, and rough stone for local construction may be obtained by crushing the basalt of the Antrim Plateau Volcanics. Gravel from Hooker and Winnecke Creeks may also be suitable for aggregate.

Ore minerals and gemstones have not been recorded from the Sheet area but traces of malachite, chalcolite, and native copper have been noted elsewhere in the Antrim Plateau Volcanics by Bultitude (1973) who also records that prehnite, agate, chalcedony, quartz, amethyst, smoky quartz, and calcite are common in the basalts, but they are usually of poor quality.

Petroleum potential of the area is poor owing to the lack of a thick sequence of Palaeozoic rocks.
BIBLIOGRAPHY


ZARZAVATJIAN, P. A., & HARTMAN, P. R., 1964—Interpretation report of airborne magnetometer survey over Tanami area, Northern Territory. Aero Service Ltd for Exoil Ltd (unpubl.).