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THE GEOLOGY OF THE DARWIN-ADELAIDE RIVER AREA, NORTHERN TERRITORY

by

E. J. Malone

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SUMMARY

The Darwin- Adelaide River area comprises 4500 square miles of the north-western part of the Northern Territory. The area was mapped at a scale of 1 mile to 1 inch during the 1956 field season as part of the Bureau of Mineral Resources' regional mapping programme in the Katherine-Darwin Region.

Rocks of Lower Proterozoic age crop out over much of the area. These rocks include sediments which were deposited in the Pine Creek Geosyncline, the north-western flank of which is located in the area. The geosyncline is considered to have evolved in two stages both of which are recognised in this area.

The Lower Proterozoic sediments were intruded by basic sills, folded and intruded by granite.

Upper Proterozoic and Palaeozoic sediments were deposited in broad shallow basin structures produced by gentle downwarping. They unconformably overlie the Lower Proterozoic rocks. The whole area was transgressed during Lower Cretaceous time but only a thin veneer of sediments, about 200' thick, was deposited.

INTRODUCTION

This report deals with the geology of an area of approximately 4500 square miles in the north-western part of the Northern Territory. The area is covered by eleven sheets of the Australian 1-mile series. These are the Batchelor, Mt. Tolmer and Peron Island sheets in the Pine Creek 4-mile area and the Fog Bay, Tumbling Waters, Marrakai, Humpty Doo, Southport, Darwin, Koolpinyah and Cape Hotham sheets in the Darwin 4-mile area.

Geological field compilations of nine of the 1-mile areas are presented with this report (Plates 2-10). These compilations are based on uncontrolled photo mosaics at a scale of approximately 1 inch to 1 mile. The geology of the Peron Island and Fog Bay 1-mile areas is shown on the 1 inch - 10 miles Progress Geological Map of the Katherine-Darwin Region (Plate 1).

This report is based on field work carried out during the period May to October, 1956, and on the reports and maps produced by a number of geologists who have worked in the area since the discovery of uranium at Rum Jungle in 1949.

The geology of the Hundred of Goyder is based on the mapping of P. Dodd of the United States Atomic Energy Commission and on that of geologists of Territory Enterprises Pty. Much of the outcrop information in the western half of the Batchelor sheet is taken from mapping by F.J. Frankovitch, of the United States Atomic Energy Commission, and J. Firman and other geologists of the Bureau of Mineral Resources.

Mapping by geologists of Rio Tinto Pty. Ltd. was used as a guide in portions of the Mt. Tolmer and Marrakai sheets. However, most of the area was remapped during the 1956 field season.

The work of the 1956 field season was part of the Bureau of Mineral Resources regional mapping programme in the Katherine-Darwin Region, and was carried out under the supervision of B.P. Walpole.

The Marrakai Field Party, composed of E.J. Malone (leader), O.N. Warin, H.L. Davies, W.A. Robertson and S.M. Hasan, mapped the major part of the area. B.P. Walpole assisted the Marrakai Party for six weeks. P.R. Dunn, D.B. Dow and P.W. Pritchard of the Woolwonga Field Party mapped the eastern portions of the Marrakai, Humpty Doo and Koolpinyah 1-mile areas. K.W.A. Summers of the Darwin Uranium Co. mapped portion of the Koolpinyah, Darwin and Southport 1-mile areas.

ACCESS

Access to most parts of the area is good during the dry winter months. The Stuart Highway and the road linking Rum Jungle and Batchelor to the Stuart Highway are the only all weather roads in the area, apart from those in Darwin itself. A vehicle track, in places improved to the standard of an unsealed, all weather road, follows the North Australia Railway line across the area. There are numerous, more or less permanent, dry weather tracks, such as the Mt. Finniss, Mt. Bundey, Marrakai Homestead and Bynoe Harbour Roads and a network of timber cutters' and other tracks. They provide good access during the dry season to the east and west of the Stuart Highway. Vehicular travel (during the wet season) is restricted to the few all-weather roads.

CLIMATE

The climate is tropical. A wet season of monsoonal rain extends from November to April. The winter dry season extends from May to October.

POPULATION

The bulk of the population is concentrated at Darwin, the administrative centre of the Northern Territory, at Batchelor and at Adelaide River. A small number of Europeans live in the remainder of the area. They are engaged in the pastoral industry, tin mining and crocodile shooting. The aboriginal population is small and is mainly concentrated around the towns and homesteads.

PHYSIOGRAPHY

Three physiographic regions are represented in the Darwin-Adelaide River area. A roughly rectangular uplands region occupies the central and southern part of the area. This region contains most of the area of outcrop of the Proterozoic rocks. The uplands extend from the Tolmer Plateau in the south-west, east to the Stuart Highway and north almost to Darwin. The topography consists, in part, of steep-sided hills rising to a maximum relief of about 600 feet. These hills are separated by wide alluvial flats where the uplands region grades into lowlands.

A lowlands region of very mature topography flanks the uplands to the east, north and west. The lowlands include the broad alluvial plain of the Adelaide River and flat lying swamp and plain country extending along the coast line. In general, the relief is very low. Mangrove and paperbark swamps are common, particularly near the west coast. The drainage is either into the swamps or by braided and meandering streams into the sea.

A low, level plateau, rising to a height of 80 feet above sea level, occupies part of the Fog Bay 1-mile area and the western part of the Tumbling Waters and Southport 1-mile areas. This plateau is covered by a pisolitic ferruginous gravel developed mostly on Cretaceous rocks and is broken up into a number of mesas near the west coast.

GEOLOGY

Rocks of Lower Proterozoic age crop out over much of the Darwin-Adelaide River area. These rocks consist of sediments which were deposited in the Pine Creek Geosyncline. They were intruded by basic sills and then folded, and intruded by granite.

The Lower Proterozoic rocks are unconformably over-lain by Upper Proterozoic and Palaeozoic sediments which were deposited in broad shallow basin structures produced by gentle downwarping. The whole area was transgressed during Lower Cretaceous time but only a

thin veneer of sediments, about 200 feet thick, was deposited.

STRATIGRAPHY

Lower Proterozoic

The Darwin-Adelaide River area lies on the north-western flank of the Lower Proterozoic Pine Creek Geosyncline. Walpole (1958) considers that the geosyncline developed in two stages - both of which are represented in the complicated geology of this relatively small area. During the initial stage the western margin of deposition was a short distance west of Rum Jungle, and alternating near-shore clastics and algal reef dolomites, derived from source areas to the west and north, were deposited. These sediments constitute the Batchelor Group. They are overlain by fine clastic, carbonaceous and dolomitic deposits of the Golden Dyke Formation. These were mainly derived from source areas to the east and north and are trough type sediments first deposited basinward of the Batchelor Group. They later transgressed the Batchelor Group with the gradual westward migration of the geosynclinal margin.

The Mt. Partridge and Masson Formations were also deposited during the initial stage. The Mt. Partridge Formation was deposited in a shelf environment around the northern flank of the geosyncline. The Masson Formation was deposited basinward of the Mt. Partridge Formation. It consists mainly of material originally deposited in the shelf area and redistributed into the basin.

The sediments deposited in the Darwin-Adelaide River area during the later stage belong to the Stapleton, Burrell Creek and Noltenius Formations. Of these, the Stapleton Formation is transitional. It interfingers with the Golden Dyke Formation below and passes into Burrell Creek Formation above.

The Noltenius Formation and the Burrell Creek Formation constitute a lateral facies assemblage. The Noltenius Formations contains the coarser fraction of the trough type sediments. It also contains sheet deposits of conglomerate and greywacke, originally deposited near the western shelf edge of the geosyncline, and redistributed by turbidity currents.

The Burrell Creek Formation contains typical trough sediments, siltstone, greywacke siltstone and greywacke. The Burrell Creek Formation regionally overlaps the Golden Dyke Formation in this area.

Two isolated outcrops of the Chilling Sandstone were mapped in the western part of the area. Further south, the Chilling Sandstone conformably overlies the Noltenius Formation. It represents widespread platform deposition in the closing stage of the geosyncline's evolution.

Batchelor Group

The Batchelor Group contains the oldest sediments deposited on the north-western margin of the Pine Creek Geosyncline. The group crops out in two adjacent domal structures in the vicinity of Batchelor, and in the core of a major dome northeast of Manton Dam (Plates 1-6).

The group is composed of an alternation of arenaceous and dolomitic rocks, which have been divided into the Beestons Creek Formation, Celia Creek Dolomite, Crater Formation and the Coomalie Dolomite. All these units are markedly lenticular. The group has its maximum development around the southeast margin of the Rum Jungle Granite. In this area, the sediments dip to the south-east and are overlain by younger sediments, deposited in the trough zone of the geosyncline.

The distribution of rock types in the Batchelor Group was possibly controlled by epeirogenic movements in an early stage of the evolution of the Pine Creek Geosyncline. The first phase involved local uplift of the land mass and corresponding sinking of the adjacent basin floor, resulting in deposition of the Beestons Creek Formation.

This formation contains abundant arkose indicative of rapid deposition in a near shore environment. The algal reef deposits and dolomitic sediments of the Celia Creek Dolomite accumulated after the initial clastic deposition had ceased.

Deposition of the Celia Creek Dolomite was terminated by rejuvenation of the source area and the deposition of the clastics of the Crater Formation. These sediments contain abundant conglomerate and felspathic material, and again are the result of rapid deposition in a near source environment. The algal reefs and dolomitic sediments of the Coomalie Dolomite succeeded the Crater Formation.

Beestons Creek Formation

The Beestons Creek Formation is the basal unit of the Batchelor Group. It crops out in the dome structure about the Rum Jungle Granite and to the east of the Waterhouse Granite. It lenses out to the north and is not present around the northern margin of the granite or between Mt. Fitch and Batchelor (Plate 24).

The formation is named from Beestons Creek in the Tumbling Waters 1-mile area, at Lat. 12°55'S, Long. 130°58'E. Fairly good exposures are also found approximately 6 miles east-north-east of Batchelor, at Lat. 12°58'S, Long. 131°5'E.

The Beestons Creek Formation consists of arkose, arkosic conglomerate, quartz greywacke, quartz sandstone, greywacke and siltstone. Only arkose and siltstone are present in the Beestons Creek area. The thickness of the formation cannot be accurately measured, because of the paucity of outcrop, but is about 1,000 feet.

Arkose is the most abundant rock type, and constitutes more than 50% of the succession in the Beestons Creek area. The arkose is commonly composed of coarse, angular grains of felspar and quartz in a kaolinitic matrix.

An arkosic conglomerate which crops out 6 miles north-east of Batchelor contains rounded pebbles of jaspilite, quartz and quartzite, up to 2 inches in diameter. The matrix contains coarse, angular fragments of felspar and quartz, and is partially silicified.

Siltstone is common, particularly in the Beestons Creek area, but crops out in only a few places. In some places, the siltstone has been metamorphosed to mica schist.

A partly silicified, heavy-mineral sandstone forms a prominent outcrop near the south-east margin of the Rum Jungle Granite. This rock type was not seen elsewhere in the formation.

Quartz greywacke and greywacke are common near the top of the formation. They are medium to coarse grained and are commonly felspathic. The highest member is a bed of brown, micaceous greywacke current-bedded in places, which crops out $3\frac{1}{4}$ miles due east of Rum Jungle mine. This bed is directly overlain by the Celia Creek Dolomite.

A white, friable, superficially hardened quartz sandstone crops out east of the Waterhouse Granite. This bed is correlated with the Beestons Creek Formation. It is overlain by silicified dolomite and dolomitic breccia of the Celia Creek Dolomite, which is overlain by sediments of the Crater Formation.

Celia Creek Dolomite

The Celia Creek Dolomite crops out in the domal structure about the Rum Jungle Granite and east of the Waterhouse Granite. It is markedly lenticular and crops out in an area similar to that occupied by the Beestons Creek Formation.

The formation is well exposed in the Batchelor 1-mile area, 1 mile north-west of the Batchelor Road at a point 2 miles from the Stuart Highway. The formation is named after Celia Creek in the Mamaloo

1-mile area (Lat. 12°53'S, Long. 131°3'E.). In the Celia Creek area, it crops out in a synclinal embayment in the north-west margin of the Rum Jungle Granite.

The formation consists of silicified dolomite and dolomitic breccia. In places, the dolomite occurs as a coarsely crystalline, silicified marble. Sheared and silicified specimens of Collenia sp. were collected at one locality and indeterminate algal structures were seen in several places. The formation is partly a reef facies.

The Rum Jungle Granite has metamorphosed the dolomite in places, particularly in the vicinity of Batchlor, where the formation consists mainly of tremolite schist and calc-silicate hornfels.

The Celia Creek Dolomite crops out in most places as scattered tors and boulders. The thickness of the formation ranges up to a maximum of about 1,000 feet.

Crater Formation

The Crater Formation is the most extensive unit in the Batchelor Group. It crops out in the domal structures about the Rum Jungle and Waterhouse Granites, and in the core of a closed anticline east of the Stuart Highway near Manton Dam. It lenses out north of Mt. Fitch on the western flank of the Rum Jungle dome and on the northern flank a few miles west of Manton Dam. The formation conformably overlies the Celia Creek Dolomite.

The Crater Formation (Dodd, 1953) was named because of the presence of wartime bomb craters in its area of outcrop near Batchelor. This name has been in common use for several years. The type area is located north of the Batchelor Road, approximately 3½ miles east of Batchelor (Lat. 13°2'S., Long. 131°4'E.).

The Formation is about 2,000 feet thick. It consists of quartz greywacke, felspathic greywacke, arkose, quartz pebble and fine conglomerate, quartz sandstone and siltstone. A silicified, pyritic, carbonaceous, dolomitic shale with chert lenses and nodules, in places slumped and brecciated, and interbedded with pyritic siltstone, forms a distinctive marker horizon in the formation. This rock type was referred to (Dodd, 1953) as "Hematite Boulder Conglomerate". In the type area, this unit is about 80 feet thick and consists of slump breccia conglomerate containing rounded pebbles and cobbles of quartz. A quartz pebble conglomerate deposited on top of the marl was apparently involved in the slumping and was partly included in the resultant rock type.

The Formation crops out around the Waterhouse Granite but is not well exposed in this area and is probably less than 1,000 feet thick.

Quartz greywacke is the most abundant rock type. A typical specimen contains 10 to 20% of felspar, has a chloritic or sericitic matrix and ranges from medium to coarse in grain size. It grades into fine quartz conglomerate and quartz pebble conglomerate with increase in particle size. Greywacke, arkose and quartz sandstone crop out in the formation in many places and constitute possibly 15% of the succession. Siltstone, in places hematite-rich, is fairly abundant in the top 400 feet of the formation in the type area.

The coarse grained sediments are sheared and sericitised in places. Sericite schist is present in the formation near Manton Dam Metamorphosed greywacke and "Hematite Boulder Conglomerate" overlie the Rum Jungle Granite south of Mt. Fitch. Quartz tourmaline veining and replacement of minerals by tourmaline is common in the formation where it crops out around the southern and eastern flanks of the Waterhouse Granite

Weak radioactivity is associated with some lenses of quartz pebble conglomerate in the Crater Formation. Detrital thorite and monazite are present in the matrix of these conglomerates and are the

source of most of the radioactivity. However, it is not certain that there is sufficient thorium present to account for all the radioactivity.

Coomalie Dolomite

The Coomalie Dolomite is the topmost unit of the Batchelor Group. It conformably overlies the Crater Formation and interfingers with it in the area east of the Waterhouse Granite. The type area is located around the headwaters of Coomalie Creek, approximately 2 miles south-east of Batchelor (Lat. 13°4'S., Long. 131°3'E.).

The formation crops out in a flat pitching syncline between the Rum Jungle and Waterhouse Granite and around the adjacent margins of the granites. It overlies the Crater Formation in the anticlinal structure north-east of Manton Dam, where it crops out as isolated and commonly silicified or lateritized outcrops.

The Coomalie Dolomite is somewhat more restricted than the Crater Formation. It lenses out to the south and is not present overlying the Crater Formation around the south-west margin of the Waterhouse Granite.

The formation consists of silicified dolomite, in places coarsely crystalline, silicified dolomitic marl and slump breccia, black calcilutite and siltstone. Algal bioherms are present in the formation in the type area. The Rum Jungle Granite has metamorphosed the dolomite to tremolite schist and coarse marble in many places.

Black calcilutite and siltstone crop out at the top of the formation. They pass upwards conformably into the interbedded quartz and carbonaceous siltstone and silicified marl of the Golden Dyke Form

The outcrop of the Coomalie Dolomite consists mainly of scattered tors and boulders, protruding from deep alluvium, and the thickness of the formation can only be estimated at about 1,000 feet.

The Mt. Partridge and Masson Formations.

The Mt. Partridge and Masson Formations constitute a shelf-slope facies assemblage deposited around the northern and eastern margin of the geosyncline. The Mt. Partridge Formation was deposited in a shelf environment on the edge of the geosyncline. It thus occupies a position similar to that occupied by the Batchelor Group on the western margin.

The Masson Formation extends further into the geosyncline. It consists largely of redistributed material originally deposited on the shelf.

Mt. Partridge Formation

The only outcrops of the Mt. Partridge Formation in this area consist of a few, small exposures of white silicified sandstone found in the north-east portion of the Humpty Doo 1-mile area (Plate 6). The sandstone is medium grained, well sorted and bedded and the individual beds are approximately 2 feet thick.

Masson Formation

The Masson Formation crops out in an area extending from Coomalie Creek to Knuckey's Lagoon, 12 miles east of Darwin (Plates 2, 4, 5 and 6), and south-west of the Rum Jungle Dome (Plate 4).

These outcrops of the Masson Formation are part of a large tongue, the Acacia Gap Tongue, which overlies the Batchelor Group and part of the Golden Dyke Formation. This tongue is approximately 2,500' thick near the Batchelor Road-Stuart Highway junction (Plate 2), and approximately as thick near Manton Dam (Plate 5). It lenses out about 3 miles south-east of Batchelor (Plate 2) and is represented by isolated lenses at Mt. Burton and Mt. Fitch (Plate 4), south-west of the

Rum Jungle Dome. This tongue lenses out to the south-west and was apparently derived from a source to the north-east.

The Masson Formation also crops out in the eastern part of the Marrakai 1-mile area. These outcrops are part of the main extent of the formation along the eastern flank of the Pine Creek Geosyncline. In that area, the Masson Formation is conformably overlain by the Golden Dyke Formation.

The Acacia Gap Tongue consists of quartz sandstone, in places pyritic and silicified, quartz siltstone and carbonaceous siltstone. The Masson Formation is not well exposed in the eastern part of the area where it consists of quartz greywacke, quartz sandstone and siltstone, the siltstone being by far the most abundant rock type.

Quartz sandstone, and subordinate quartz greywacke, are the characteristic rock types in the Masson Formation. They are commonly silicified and constitute the bulk of the outcrop in the formation, as well as the highest topographic relief in the area. The sandstone is typically massive and consists of poorly sorted, subangular quartz grains. In places, a white, thin bedded fine-grained quartz sandstone crops out, but bedding is commonly obscured by the silicification. Pyrite casts and some crystals, up to $\frac{1}{4}$ inch long, are common.

Siltstone, commonly pyritic, constitutes probably more than half of the Masson Formation but a much smaller proportion of the outcrop. In places, it crops out as thinly interbedded black quartz siltstone and white, leached carbonaceous siltstone.

Golden Dyke Formation

The Golden Dyke Formation was deposited in the trough zone of the Pine Creek Geosyncline. It crops out around the Rum Jungle and Waterhouse Domes, and in small scattered exposures further north. The area of outcrop extends in a semicircular arc to the northeast and delineates the northern limit of the main trough zone of the geosyncline. The formation is approximately 6,000 feet thick south-east of Batchelor.

The Golden Dyke Formation conformably overlies the Coolmalie Dolomite. A single, large tongue of Masson Formation overlies the basal portion of the Golden Dyke Formation, but is overlain by the remainder. The boundaries between this tongue and the Golden Dyke Formation are fairly sharp and little minor interfingering of the two formations was observed.

The formation consists of interbedded quartz and carbonaceous siltstone, in places pyritic, limonite-rich greywacke siltstone, chert, silicified dolomite and marl, and silicified dolomitic slump breccia.

The absence of coarse clastic material and the abundance of chemical deposits reflect the quiet conditions under which the Golden Dyke Formation was deposited. Chert, silicified dolomite and marl, and silicified dolomitic slump breccias constitute 10 to 15% of the succession in this area. The chert and dolomite are usually interbedded with siltstone. Massive chert was observed in one place, east of the Waterhouse Granite.

Silicified dolomitic slump breccias constitute the bulk of the outcrop of the formation west of Stapleton Siding. North of Stapleton Siding, a slump breccia was traced for about 4 miles from Mt. Minza. The breccias are reddish or brown in colour and contain angular fragments of recrystallized quartz in a siliceous, in some places, sandy, matrix.

Quartz and carbonaceous siltstone constitute probably more than 50% of the formation. They are usually thinly interbedded and crop out as black or red and white banded rocks.

Limonite-rich greywacke siltstone crops out in many places south-east of Batchelor. It is typically a yellow or brown rock, containing flecks or clots of limonite. In some specimens, the flecks of iron oxide were found to show relict crystalline structure, indicating

an igneous origin.

Metamorphic rocks occur in the Golden Dyke Formation. In some places, particularly the embayment area at Rum Jungle, the sediments have been metamorphosed to andalusite-mica-schist, chiastolite schist, talc schist and phyllite. The metamorphism is due in part to the contact effects of the Rum Jungle Granite and in part to shearing associated with the Giant's Reef Fault. Uranium, copper and lead mineralization is present in the basal sediments of the Golden Dyke Formation in the embayment area.

Stapleton Formation

The type area of the Stapleton Formation is located in the Batchelor 1-mile area, approximately 1½ miles north of Stapleton Railway Siding (Lat. 13°10'S., Long. 131°3'E). The formation is very restricted, lensing out to the north within a few miles, and to the south-west within 6 miles of the type area.

The Stapleton Formation overlies and interfingers with the Golden Dyke Formation. It includes several bodies of silicified dolomitic slump breccia which are part of the Golden Dyke Formation. In most cases the bodies are tongues directly connected with the Golden Dyke Formation.

Quartz greywacke is the most abundant rock type in the Stapleton Formation. It may contain up to 15% of felspar. A black quartz greywacke forms the topmost unit of the formation in the type area. It contains red and yellow clots of iron oxide up to a few millimetres in diameter. In places, it grades into a quartz pebble conglomerate.

Greywacke, commonly felspathic, and greywacke conglomerate constitute up to 20% of the succession. The greywacke conglomerate contains pebbles of quartz, quartzite, siltstone and other rock fragments in an argillaceous greywacke matrix.

A bed of arkose, containing angular grains of pink felspar crops out near the top of the formation in the southern part of its area of outcrop. This bed overlies a quartz pebble conglomerate bed.

The Noltenius and Burrell Creek Formations.

The Noltenius and Burrell Creek Formations constitute a lateral facies assemblage. The Noltenius Formation contains coarse clastic material, for the most part deposited in a near shore environment. The Burrell Creek Formation consists of finer clastic material which was transported farther into the trough zone. These two formations are more or less contemporaneous. The boundary between the two is virtually a horizontal transition with some interfingering of the two formations.

Part of the Noltenius Formation was redistributed basinwards by turbidity currents. The turbidity current deposits consist of extensive, thin tongues of relatively coarse material overlying and interfingering with the Burrell Creek Formation.

Noltenius Formation

The Noltenius Formation Crops out along the western edge of the Pine Creek Geosyncline. In the Darwin-Adelaide River area, it extends north from the Tolmer Plateau to Darwin Harbour. Scattered outcrops of the formation occur east of the Tolmer Plateau. They occur in basins, overlying the Burrell Creek Formation or as tongues interfingering with that formation.

The formation consists of fine, pebble and cobble conglomerate, quartz greywacke, quartz sandstone, greywacke and siltstone. It is approximately 3,000 feet thick in the Tumbling Waters 1-mile area.

Fine, pebble and cobble conglomerate constitute 10-20% of the formation. The conglomerates contain rounded to subangular fragments of quartz and quartzite commonly in a ferruginous greywacke matrix. The cobbles are disc shaped and range up to 4 inches in diameter. The smaller fragments are more spherical though less well rounded. Cobble conglomerate, in places silicified, is restricted to the western portion of the formation's area of outcrop, where it produces the most prominent topographic features. Elongation of quartz cobbles parallel to the axis of folding is developed around the noses of some folds in this western area. The elongation results in the recrystallized quartz cobbles, now plate-like in shape, lying at angles up to 90° to the bedding.

Quartz greywacke, with quartz sandstone and subordinate greywacke constitute about 40% of the succession. The quartz greywacke is a medium to coarse grained rock with an argillaceous or ferruginous matrix. Muscovite is present in the finer grained greywacke. Silicification, particularly of the sandstone, occurs in places.

Siltstone constitutes approximately half the formation though only about 10% of actual outcrop. It includes quartz siltstone, greywacke siltstone, and minor carbonaceous siltstone, and varies in grain size from coarse siltstone to claystone. The colour is variable, in places red, in others banded green and black or brown.

Andalusite - and cordierite-mica schist, mica schist, spotted hornfels and phyllite are present in the formation within a zone of regional shearing and metamorphism. This zone extends from the Tolmer Plateau, near Bamboo Creek, to Port Darwin. Pegmatite veins bearing tin, tantallite and columbite intrude the formation in this zone.

In general, a better degree of sorting is displayed in the Noltenius Formation than in the Burrell Creek Formation. Graded bedding and "cut-and-fill" structures, characteristic of density current deposition, are present in many of the lenses of quartz greywacke and pebble conglomerate. Shallow water structures, including ripple marks, are present in the formation at a few places.

Organisms, as yet undescribed and apparently of two different kinds, were collected at three localities in the Noltenius Formation. The organisms at two of the localities bear some resemblance to Atikokania Walcott (Sleeprock Formation, Ontario.) (Oral communication - Miss J. Gilbert Tomlinson).

The first of these localities is a few miles south of the Darwin-Adelaide River area. It is about ½ mile west of the George Creek Uranium prospect in the Burnside 1-mile area. The organisms occur in massive greywacke and cover most of the exposed surface of the bed. They are roughly circular in plan, range from 6 inches to a foot in diameter and are slightly convex upwards. They possess a more or less well developed radial structure about a central feature, apparently the top of a tube or column. The organisms are preserved in a reddish-purple, fine grained, micaceous quartz greywacke and are overlain by micaceous siltstone,

The second locality is in the Tumbling Waters 1-mile area, approximately 9 miles north-west of Rum Jungle. The organisms at this locality are similar in plan view to those at the George Creek locality. They show a well developed tube or column descending from the central feature of the organism. This tube is up to one foot long and and extends into the rock at right angles to the bedding. The organisms are preserved in a bluish-buff coloured, medium grained quartz greywacke.

The second kind of organism was collected from a hillside south of the North Australia Railway, 1¾ miles north of Adelaide River.

These are small, oval bodies, rarely exceeding 2 inches in length. They are convex upwards and possess a concentric structure about a central depression. These organisms are preserved in a reddish-brown micaceous siltstone. Similar organisms have been collected in the Warramunga Group, near Tennant Creek (oral communication - Miss J. Gilbert Tomlinson).

Burrell Creek Formation

The Burrell Creek Formation overlies the Golden Dyke and Stapleton Formations with no apparent unconformity. However, it overlaps the Golden Dyke Formation around the southern margin of the Waterhouse Granite. The sediments of the Burrell Creek Formation cropping out in the south-east of the Darwin-Adelaide River area were deposited in the main trough zone of the geosyncline. The line of outcrop of the Golden Dyke Formation, curving to the east from Coomalie Creek (Plate 2 and Plate 5) marks the northern limit of outcrop of the Burrell Creek Formation in the main trough.

Sediments of the Burrell Creek Formation crop out extensively to the west of the Waterhouse Granite, in the structure known as the Finniss Graben (Plates 3 and 4). The relationships between these sediments and the Noltenius Formation indicate that both were derived from a source area to the west.

The Finniss Graben is a downfaulted area, bounded on the east by the north striking Mt. Fitch Fault. It is virtually a secondary trough occupied by sediments of the Burrell Creek and Noltenius Formations.

The Burrell Creek Formation consists of siltstone, greywacke siltstone and greywacke. Lenses of silicified, calcareous greywacke and conglomerate crop out in a few places. The absence of shallow water structures, the poor sorting and lack of bedding and graded bedding in the sediments, and the predominance of the silt fraction are characteristic of the formation. It has its maximum thickness in this area south-east of Batchelor where it is approximately 6,000 feet thick.

Siltstone is the most abundant rock type. It is red, brown or yellow coloured in outcrop, and is commonly sheared or lineated. It crops out as blocks or slabs, bounded by shear planes, protruding from shallow soil cover. These outcrops are very susceptible to soil creep. Bedding may be revealed by colour banding. In composition, the siltstone commonly has an argillaceous matrix containing irregular quartz grains, mica flakes and flecks of iron oxide and chlorite. The siltstone grades into greywacke siltstone with an increase in the percentage of chert and other rock fragments.

Massive greywacke constitutes much of the outcrop of the Burrell Creek Formation. The grainsize of the greywacke is typically fine to medium but there is usually a wide range in size of the individual grains. Coarse grained greywacke is not widespread throughout the formation, but is common in the transition zones to the Noltenius Formation. The greywacke commonly contains subangular to rounded grains of quartz, quartzite, chert, slate and rare siltstone in a chloritic or sericitic matrix. Fine quartz grains and clay particles may be present in the matrix. Felspar is uncommon.

Silicified, calcareous greywacke constitutes a small proportion of the formation. It is an extremely resistant, grey-blue to dark coloured rock and crops out as large slabs, protruding from the soil. In places, it grades into quartz pebble conglomerate. The course fraction of the greywacke consists of subangular to angular fragments of quartz, felspar, calcite, chert and rock fragments. The matrix is extremely fine grained, is commonly sericitic and siliceous, and may contain some calcareous material. Thelenses of greywacke commonly show slump structures and may have migrated to their present position by means of-submarine sliding.

Metamporphic rocks crop out in the Burrell Creek Formation in a few places, particularly in a zone extending north from the Tolmer Plateau. Andalusite-, sillimanite- and cordierite-mica schist and

phyllite crop out in this area. Andalusite-mica schist, containing andalusite crystals up to 6 inches in length, crops out in some places. The metamorphism is due to regional shearing stress coupled with intrusion of igneous bodies and of numerous pegmatite veins throughout the area.

Chilling Sandstone

The Chilling Sandstone conformably overlies the Noltenius Formation, in the vicinity of Fletchers Gully, south of the area mapped. This formation represents a final phase in the evolution of the geosyncline. It consists essentially of sandstone, deposited over a wide area in a shallow water, shelf environment.

Two isolated exposures of the formation were mapped in the area. The first of these is located north of the Finniss River mouth, in the Fog Bay 1-mile area. It consists of 500 feet of course grained, sheared greywacke, quartz greywacke and quartz pebble conglomerate at the base overlain by 1,000 feet of white, ripple marked quartz sandstone and quartz greywacke. The second exposure is at Murrenja Hill in the Peron Island 1-mile area. The sequence consists of quartz sandstone and minor sheared pebble conglomerate.

Upper Proterozoic

Tolmer Group

The Depot Creek Sandstone Member of the Buldiva Sandstone is the basal unit of the Tolmer Group. It is the only Upper Proterozoic unit in the area. The unit is well exposed in the Tolmer Plateau where it has a maximum thickness of nearly 1,000 feet. It crops out as scattered outliers, unconformably overlying the Lower Proterozoic sediments, around the Waterhouse Granite and in the vicinity of the Rum Jungle mine. These outliers are found as far north as the Berry Springs road, in the Humpty Doo 1-mile area.

The Depot Creek Sandstone consists mainly of pink, ripple marked quartz sandstone, in places friable, in others silicified. The sandstone is generally a well sorted and bedded, medium to coarse grained rock. Fine grained sandstone is found near the base of the unit in some places.

Lenses of conglomerate occur in the member near the north-west margin of the Tolmer Plateau. The lenses are restricted to the vicinity of conglomerate beds in the underlying Lower Proterozoic sediments and the pebbles and cobbles are apparently derived from these rocks.

Lenses of silicified breccia are present in the outliers of the Depot Creek Sandstone. The breccia consists of angular fragments of chert, recrystallized quartz and glassy quartz in a siliceous, hematite-rich fine grained sandy matrix. The breccia grades into pink quartz sandstone. It commonly is found overlying the Coomalie Dolomite and the Golden Dyke Formation. The fragmental material is probably derived from these formations, both of which contain abundant silicified dolomite and chert.

The outliers of the Depot Creek Sandstone were apparently deposited in irregularities in the Lower Proterozoic basement, which has resulted in their preservation from erosion. In some places, the Upper Proterozoic outlier is surrounded by topographically higher Lower Proterozoic rocks.

Palaeozoic

Cambrian

No Cambrian sediments crop out in the area mapped. However, the morphology and soils developed south of the Reynolds River in the Mt. Tolmer 1-mile area are similar to those developed on the Middle Cambrian Daly River Group, which [illegible]. The Lower Group is probably present in the area though it does not crop out.

Permian

The coastal area south of Pt. Blaze is included in the area of outcrop of the Port Keats Group, on the basis of photo pattern and morphology. The Port Keats Group is Upper Permian to Triassic in age (G.A. Thomas - personal communication).

Mesozoic

Cretaceous

Eroded sediments of the Mullaman Beds crop out over much of the Cape Hotham, Koolpinyah, Darwin and Southport 1-mile areas. The Mullaman Beds are well exposed in coastal cliff sections around Darwin and on the flanks of a few, laterite capped mesas in the area. They consist of flat lying, marine and freshwater sediments, including siltstone, sandy siltstone and radiolarian shale. Freshwater conglomerate and sandstone occur at the base of the sequence, in the southern part of the area.

In many places, the top part of the section consists of "porcellanite", a tough, fine grained, silicified clay-shale. The "porcellanite" is white, yellow-brown or mottled in colour, depending on the distribution of limonitic staining. This rock type is thought to be of pedological origin. It is the silica enriched pallid or mottled zone of a laterite profile, now exposed, in many places, by the erosion of the ferruginous zone of the laterite profile.

The Mullaman Beds are approximately 60 feet thick at Pt. Charles in the Darwin 1-mile area (Noakes, 1949). They exceed 200 feet in thickness south of the area. The age of the Mullaman Beds is not definitely established but is most probably Lower Cretaceous, though deposition may have commenced in the Upper Jurassic.

Tertiary

Laterite Deposits

Laterite deposits cover much of the northern part of the area. They are part of a laterite profile which originally covered most of the Katherine-Darwin Region. The laterite was developed during Tertiary time on subhorizontal Mullaman Beds. The lateritised, Tertiary peneplain was differentially uplifted about the close of the Tertiary. The uplifted peneplain sloped up from 60 feet above sea level at Darwin to 1,000 feet above sea level near Pine Creek. This initiated a cycle of erosion which has stripped off most of the laterite. The complete profile was apparently about 50 feet in thickness, but usually considerably less than this is preserved.

Quaternary

River and coastal plain alluvial deposits constitute the bulk of deposition during the Quaternary. The great coastal plains were produced during a period of higher sea level, when clay, silt and gravel deposits were built up in drowned river valleys. These have since been exposed by a recent drop in sea level of approximately 20 feet. Some rivers, such as the Mary and Reynolds Rivers, have insufficient head to cut through the coastal plains into the sea. These rivers drain into swamps in the coastal plains and deposit large quantities of silt and mud in them. Extensive alluvial deposits are also being built up in the floodplains of such rivers as the Adelaide River.

Some laterite and other ferruginous deposits have accumulated in various parts of the area, since the close of the Tertiary. A concretionary iron oxide deposit covers much of the Fog Bay 1-mile area. This ferruginous material is not part of a laterite profile and crops out on a plateau, about 80 feet above sea level.

Ferruginous greywacke conglomerate crops out on the banks of creeks and in gullies at the present level of erosion. This material consists of fragments of Lower Proterozoic and other rocks cemented in a ferruginous sandy matrix.

STRUCTURAL GEOLOGY

Folding

The dome structures about the Rum Jungle and Waterhouse Granite are the two most prominent structural features in the area. They are reflected through more than 8,000 ft. of sediments overlying the granites. The fold structures in the Lower Proterozoic sediments in the map area are not particularly tight. Dips are generally less than 70° and plunges of 30° to 50° are quite common. However, the folding is much tighter in the area of outcrop of the Noltenius Formation in the Tumbling Waters and Southport 1-mile areas. There, the dips are 80° or more and the flanks of folds are commonly parallel or nearly so.

The fold axes strike 15° west to 15°east of north in most parts of the area. A marked-swing in the strike of fold axes is noticed in the north-east part of the Marrakai 1-mile area where they strike north-east.

Large and complicated dome and basin structures, outlined by resistant beds of the Masson Formation, were mapped east of the Stuart Highway in the Marrakai and Humpty Doo 1-mile areas. Other basin structures were mapped south and west of the Rum Jungle and Waterhouse Domes. In some cases, the basin structures contain a core of Noltenius Formation surrounded by Burrell Creek Formation.

The Upper Proterozoic sediments cropping out in the area mapped are generally horizontal or shallow dipping. Steeper dips, up to 30°, are present in the outliers of the Depot Creek Sandstone Member. These dips are probably depositional features, due to irregularities in the basement on which the member was deposited. Faulting has resulted in steeper dips in some places.

The only post-Proterozoic sediments cropping out in the area belong to the Mullaman Beds. These are sub-horizontal.

Faulting

Most of the faults mapped in the Darwin-Adelaide River area strike north-east. The most prominent of these is the Giants Reef Fault. This is a tear fault with a horizontal displacement of approximately 3 miles, the west block moving north. It has little vertical displacement. The movement took place about the close of the Proterozoic as it displaced the Upper Proterozoic Tolmer Group but not the Cambrian sediments. The Adelaide River Fault, the Stapleton Fault and many other minor shears were associated with the Giants Reef movements.

Other north-east trending faults occur near the north-west edge of the Tolmer Plateau. Some of these have displaced rocks of the Tolmer Group and are probably about the same age as the Giant Reef movement.

A number of north trending faults were mapped in the area. The most important of these is the Mt. Fitch Fault which marks the eastern boundary of the Finniss Graben. It probably became active while deposition was continuing and resulted in the development of the Finniss Graben as a secondary trough.

North-west trending faults were mapped in a few places. The most important of these is located in the Marrakai 1-mile area, east of the Adelaide River. This fault has displaced rocks of the Burrell Creek Formation against the Golden Dyke Formation, but probably only a small, mainly vertical, movement was involved.

IGNEOUS INTRUSIVES

Dolerite sills intruded the Lower Proterozoic sediments, and were folded with them. The majority of these sills have since been affected by varying degrees of uralitization and autometamorphism, and weak regional metamorphism.

Some of the sills now have the composition of a quartz diorite. They consist of laths of andesine, ophitically distributed in hornblende pseudomorphs after pyroxene, with quartz, magnetite and apatite as accessory minerals.

More extensive uralitization is apparent in the sills which crop out near Batchelor. These consist of approximately 50% calcite, occurring as grains and fine aggregates, 30% fine aggregates of euhedral quartz and variable quantities of iron oxide, sphene, leucoxene and kaolin.

In many places, these altered sills have been subjected to very deep weathering. The final product may consist of highly altered amphibole, quartz, sericite and chlorite with iron oxide and kaolin. In most cases these rocks exhibit some relict textural features indicating their intrusive origin. Commonly, such features are the crystalline shape or skeletal outline of the iron oxide grains.

Rum Jungle and Waterhouse Granites

The Rum Jungle and Waterhouse Granites intrude the Lower Proterozoic sediments in the vicinity of Batchelor. They occupy the cores of two adjacent dome structures and may be connected at depth. These granites are largely concordant with the sediments, though the Rum Jungle Granite transgresses the two basal formations of the Batchelor Group between Mt. Fitch and Batchelor.

Waterhouse Granite

The Waterhouse Granite is a coarse grained, red-brown, in places gneissic rock, containing numerous oriented feldspar phenocrysts, up to 4 cm. long. It consists of approximately 30% quartz, 35% potassic feldspar, 25% plagioclase, usually in the albite range, and 10% of muscovite, sericite and chlorite. (Hasan, 1958). The phenocrysts consist of albite, orthoclase, microcline and microperthite. The groundmass consists of fine aggregate of equidimensional grains of quartz, microcline and albite with abundant fine grained muscovite and chlorite. Accessory minerals, include calcite, tourmaline, pyrite, magnetite, leucoxene, sphene and hematite.

Sericitization of granular albite and of the albite fraction of the microperthite is common. Marginal granulation of feldspar crystals, replacement of feldspar by granular quartz and zones of granulation transecting large feldspar crystals are visible in some sections.

The Rum Jungle Granite

The Rum Jungle Granite is a pink to dark grey, coarsely crystalline, porphyritic granite. It commonly shows some signs of deformation, ranging from marginal granulation of the feldspar phenocrysts to complete crushing and recrystallization of the rock. The phenocrysts range up to 3 cm. in length and are oriented, in places.

It contains 35 to 40% quartz, 50 to 60% microcline, microperthite and plagioclase, and up to 10% biotite, chlorite, sericite and epidote (Hasan 1958). The plagioclase ranges from albite to acid andesine, and is commonly sericitized.

The fine grained fraction consists of equidimensional, interlocking grains of quartz, albite, microcline, mica and chlorite. Accessory minerals include iron oxide, muscovite, calcite, apatite, zircon, fluorite and sphene. Epidote is present where complete crushing and recrystallization of the rock has taken place.

The proportion of potassic feldspar to plagioclase varies widely and the Rum Jungle Granite varies accordingly from "sodi-potassic granite" to "albite granite". Sufficient biotite is present in some specimens for the rock to be termed a biotite granite. However, at least part of this biotite is not of primary origin.

HERMIT HILL COMPLEX

Granodiorite, granite and metamorphosed basic intrusives crop out in the western part of the area, in the Fog Bay, Peron Island, Mt. Tolmer and Tumbling Waters 1-mile areas. They are separated from the Lower Proterozoic sediments cropping out to the east by a number of north trending faults. They extend west from the Tolmer Plateau to the coast and north, as far as Port Patterson. These rocks are marked by a typical granite soil pattern and have been mapped largely by photo-interpretation. Outcrops are commonly massive tors, protruding from deep soil cover.

These igneous rocks are considered to be part of the Hermit Hill Complex which was first named in the Daly River area, in 1955 (Walpole, 1956). Radioactive age determinations on the granodiorite from this area and on the granite from the Hermit Hill area yielded results of approximately 1,800 million years. This is about the same age as that determined for the Rum Jungle, Waterhouse and other Lower Proterozoic Granites.

The Hermit Hill Complex, however, contains some metamorphic rocks structurally at variance with the Lower Proterozoic trends. The complex is thus considered to include elements of both Archaeozoic and Proterozoic age. Lack of outcrop precluded any attempt to sort out these elements.

Only intrusive rocks were mapped in the complex in the Darwin-Adelaide River area. These are probably all of Lower Proterozoic age. Granodiorite is the most abundant rock type. It is a grey coloured, medium to coarsely crystalline rock and consists of approximately 40% plagioclase, in the oligoclase-andesine range, 20% microcline, microperthite and orthoclase, and 30% quartz. Magnetite, apatite and zircon are the main accessory minerals. Garnet is present as sporadially distributed grains up to 2 mm. across.

A two-mica granite crops out in a few places. In overall composition and texture, it is similar to the granodiorite. It differs in containing a greater proportion of alkali feldspar and appreciable quantities of muscovite and biotite.

Amphibolite and epidiorite which are probably altered basic igneous rocks also crop out in this area. The amphibolite consists of 50 to 60% green hornblende, a small proportion of pyroxene, partly pseudomorphed by amphibole, and small quantities of quartz and albite. Magnetite, iron oxides, sericite and chlorite are the accessory minerals.

The epidiorite consists of 45% plagioclase, in the andesine-labradorite range, 35% amphibole and 10% quartz. Chlorite, sericite, magnetite and iron oxides are the accessory minerals.

A small body of garnetiferous granodiorite intrudes the Noltenius Formation 1-mile east of the Goodwill Mine (Plate 3). This granodiorite is related to the Hermit Hill Complex, which crops out about 10 miles to the west. It has a medium grained, granitic texture and consists of approximately 40% plagioclase, in the oligoclase-andesine range, 20% microcline, orthoclase and patch-perthite, 20% quartz, 15% muscovite and appreciable amounts of biotite, tourmaline and garnet. Quartz-tourmaline-feldspar-muscovite pegmatite occurs in the granodiorite in blebs and patches. Dr. G.A. Joplin of the Australian National University (personal communication) considers this may be indicative of deep-seated intrusion. This is one of the main differences between this intrusive and the Rum Jungle or Waterhouse Granites. Both the latter are apparently shallow depth intrusives.

ECONOMIC GEOLOGY

The Katherine-Darwin region was the scene of considerable mining activity during the latter part of the nineteenth century. The first gold discovery was made in the Darwin-Adelaide River area in 1869, when

alluvial gold was found in the Blackmore River at Tumbling Waters. However, despite the volume of prospecting, this area produced only a negligible quantity of gold.

Copper production was slightly more important than gold production. Approximately 750 tons of copper ore were produced, the bulk of which was from small mines in the vicinity of Rum Jungle.

The most valuable mineral products of the area, prior to 1950, were tin and tantalite won from pegmatite veins in the Bynoe Harbour-West Arm fields. The total production was approximately 520 tons of tin and 20 tons of tantalite (Summers, 1957). A survey of the area was carried out by the Bureau of Mineral Resources to assess the potential of the area as a source of tin, tantalite, niobium and columbium. The results of this survey were not encouraging.

In 1950, uranium, copper and lead mineralization was discovered at Whites Deport Rum Jungle. This was the first ore body of any size to be found in the area. The deposit is being worked by open cut methods and has been in production for the past five years. In the same vicinity, a potentially large lead orebody has been located. This deposit is still being investigated.

The mineral potential of the area seems to lie in the possible existence of further lead, copper or uranium deposits in the Rum Jungle area.

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PLATE 1.

KATHERINE-DARWIN AREA

NORTHERN TERRITORY

PROGRESS MAP

REGIONAL GEOLOGY

Bureau of Mineral Resources, Geology and Geophysics, Canberra.

REFERENCE

Geological Information to December 1957

QUATERNARY	Qa	Alluvium, soil cover, ferruginous deposits	
LOWER CRETACEOUS	Kbm	Unconformity Mullaman Beds - Undifferentiated. Sandstone, siltstone, conglomerate, fresh water and marine sediments	
PERMIAN	Pk	Unconformity Port Keats Group - Undifferentiated. Sandstone, siltstone, limestone	
MIDDLE CAMBRIAN	Cmd	Unconformity Daly River Group - Undifferentiated	
	Cmo	Oolloo Limestone - Silicified limestone with Girvanella	
	Cmj	Jinduckin Creek Formation - Ferruginous sandstone with sulfide casts and limestone lenses.	
	Cmu	Manbulloo Limestone - Flaggy limestone with sandstone lenses	
	Cmg	Douglas Limestone - fossiliferous limestone with chert nodules and bands; glauconitic in places.	
LOWER CAMBRIAN (?)	Cel	Unconformity Beswick Group Leight Creek Volcanics - Basalt flows, sandstone.	
	Cjk	Dook Creek Limestone - Flaggy glauconitic limestone brecciated in places, greybilly, siltstone.	
	Cem	Margaret Hill Conglomerate - Boulder beds, conglomerate, sandstone	
	Cza	Antrim Plateau Volcanics - Basalt, agglomerate, tuff.	
	Cew	Witchwai Conglomerate - Boulder beds, conglomerate, sandstone.	
UPPER PROTEROZOIC	Rut	Unconformity Tolmer Group - Undifferentiated	
	Rug	Waterbag Creek Formation - Ferruginous sandstone, siltstone with dolomite lenses.	
	Rsh	Hinse Dolomite - Dolomite with Collenia reefs	
	Rsu	Bulldiva Sandstone - Undifferentiated	
	Rwy	Stray Creek Sandstone - Quartz sandstone, Flaggy siltstone, shale.	
	Rso	Depot Creek Sandstone - Quartz sandstone with lenses of calcareous breccia and pebble congl.	
	Rwc	Chambers River Beds - Sandstone, shale and siltstone and volcanics	
	Ruq	Unconformity Victoria River Group Coolamon Beds - Silicified medium grained quartz sandstone with lenses of silicified limestone.	
	Ruf	Fitzmaurice River Beds - Coarse to fine ripple marked and cross-bedded quartz sandstone.	
	Ruj	Angalarri Siltstone - Ferruginous in places - siltstone and calcareous siltstone.	
	Rux	Palm Creek Beds - Ripple marked and cross-bedded medium quartz sandstone, silicified limestone lenses near base.	
	Rsk	Katherine River Group Kombolgie Formation - Alternating arenaceous and volcanic rocks.	
	xRun	Undifferentiated volcanics	
	xRuh	Kenwood Creek Volcanics - Basic lavas with pyroclastics	
	xRuh	Mc Addens Creek Volcanics - Amygdaloidal basalt, acid lavas, pyroclastics	
	xRuh	Birdie Creek Volcanics - Andesite	
	xRuv	West Branch Volcanics - Intermediate basic amygdaloidal volcanics with lenses of sandstone.	
	xRud	Dinner Creek Volcanics - Rhyolite, andesite, basalt.	
	Ruu	Kurrundie Member - Tuffaceous sandstone, tuff, conglomerate, greywacke.	
	xRue	Edith River Volcanics - Acid lavas and pyroclastics with local arenaceous members.	
	Rul	Phillips Creek Member - Greywacke, conglomerate with pyroclastic lenses.	
PROTEROZOIC	Pf	Fergusson Volcanics - Rhyolitic flows and porphyries	
		Unconformity	
IGNEOUS INTRUSIVES	γpg	Grace Creek Porphyry	
	γmg	Mount Goyder Syenite	
	γgc	Cullen Granite	
	γga	Allia Creek Granite	
	γgb	Burnside Granite	
	γgr	Reynolds River Granite	
	γgf	Fenton Granite	
	γgg	Margaret Granite	
	γgh	Mount Shoebridge Granite	
	γgj	Jim Jim Creek Granite	
	γgm	Maranboy Greisens and Porphyries	
	γgk	McKinlay Granite	
	γgl	Litchfield Granite	
	γgm	Middle Creek Granite	
	γgo	Coopers Creek Granite	
	γgp	Prices Springs Granite	
	γgr	Rum Jungle Granite	
	γgs	Soldiers Creek Granite	
	γgt	Waterhouse Granite	
	γgu	Mount Bundey Granite	
	γgw	Wolfram Hill Granite	
	γgy	Yeuralba Granite	
	γgx	Intermediate to basic dykes and plutons	
	γgo	Basic sills and dykes	
PROTEROZOIC	Rch	Chilling Creek Sandstone - Quartz sandstone, conglomerate, greywacke	
	Rza	South Alligator Group - Undifferentiated	
	Rzf	Fisher Creek Siltstone - Siltstone, greywacke, siltstone.	
	Rzw	Gerowie Formation - Siliceous siltstone, chert and impure chert	
	Rzc	Koolpin Formation - Banded carbonaceous pyritic siltstone with chert nodules and lenses, pyritic carbonaceous siltstone, algal reef dolomite, reef breccias, silicified in places	
	γRz	Berinka Volcanics - Rhyolites and pyroclastics	
	Rzb	Burrell Creek Formation - Siltstone, greywacke, siltstone, greywacke.	
	Rze	Stapleton Formation - Arkose, greywacke, greywacke conglomerate, siltstone.	
	Rzn	Noltenius Formation - Quartz greywacke, siltstone, conglomerate, sandstone	
	Rzs	Golden Dyke Formation - Quartz siltstone, carbonaceous siltstone, pyritic carbonaceous dolomitic marl, dolomitic breccia, chert, thin-bedded dolomite	
	Rzm	Masson Formation - Quartz greywacke, conglomerate, siltstone, carbonaceous siltstone, banded pyritic dolomitic siltstone.	
	Rzp	Mount Partridge Formation - Arkose, conglomerate, quartz greywacke, sandstone, siltstone.	
	Rzo	Batchelor Group Coomalie Dolomite - Silicified dolomite with Collenia, dolomitic slump breccia, tremolite schist.	
	Rzr	Crater Formation - Greywacke, conglomerate, siltstone, pyritic carbonaceous dolomitic marl, stilolites and brecciated in places.	
	Rzl	Celia Creek Dolomite - Silicified dolomite with Collenia, tremolite schist.	
	Rzb	Beestons Creek Formation - Arkose, greywacke, conglomerate, siltstone.	
		Unconformity	
ARCHEAN	A/Pt	Undifferentiated - Archean metamorphics intruded by Lower Proterozoic garnetiferous granite.	
	As	Stag Creek Volcanics - Altered basalt and basaltic agglomerate.	
	Am	Magela Creek Metamorphics - Muscovite schist, quartz biotite schist, garnetiferous hornblende schist.	

Geological boundaries
- Established boundary, position accurate
- Established boundary, position approximate
- Inferred boundary

Bedding
Strike and dip of strata
- Inclined, showing angle of dip
- Inclined, showing direction of dip
- Trend lines
- Dip <15° (Air photo interpretation)
- Dip 15°–45° (Air photo interpretation)
- Dip >45°

Folds
- Direction of plunge

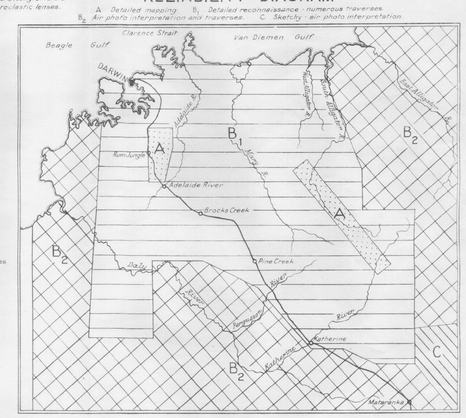
Faults etc.
- Established fault, position accurate
- Established fault, position approximate
- Thrust fault
- Shear zone
- Joint pattern
- Quartz reef
- Schist

Mine or prospect
- (U) Uranium
- (Au) Gold
- (Ag) Silver
- (Cu) Copper
- (Pb) Lead
- (Sn) Tin
- (W) Wolfram

- Railway
- Main road
- Vehicle track
- Township
- Railway station or siding
- Homestead
- (A/D) Aerodrome
- Swamp

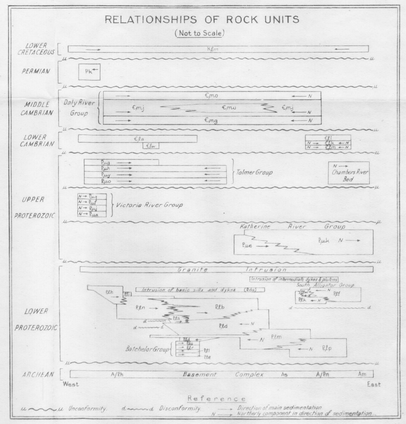
RELIABILITY DIAGRAM

A Detailed mapping. B_1 Detailed reconnaissance: numerous traverses.
B_2 Air photo interpretation and traverses. C Sketchy: air photo interpretation.



RELATIONSHIPS OF ROCK UNITS

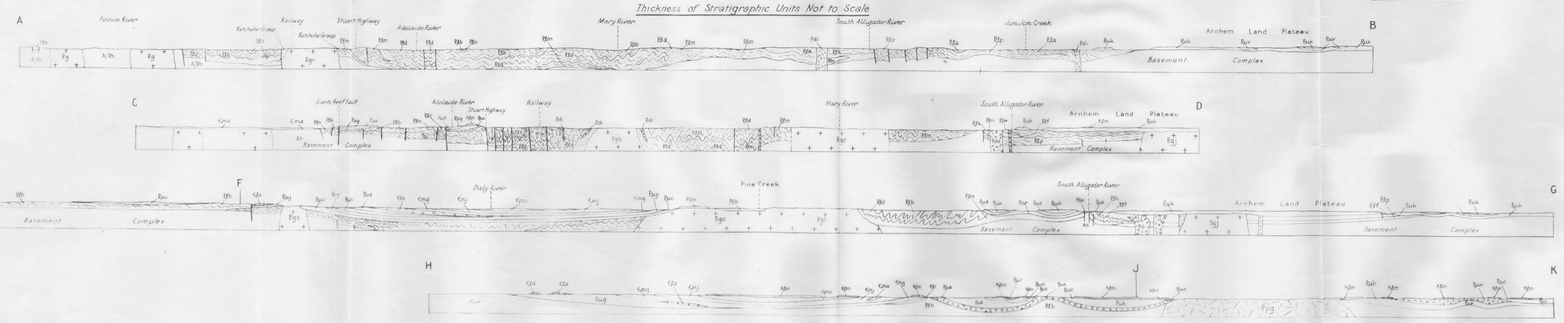
(Not to Scale)



WB
16 July 1958

DIAGRAMMATIC CROSS SECTIONS

Thickness of Stratigraphic Units Not to Scale



SCALE

10 5 0 10 20 30 40 Miles

NTC 22/6

BATCHELOR

PLATE 2

FIELD SHEET ONLY ——— NOT FOR PUBLICATION

APPROXIMATE SCALE:- ONE MILE TO ONE INCH

REFERENCE

QUATERNARY

Soil and alluvium.

UPPER PROTEROZOIC

Tolmer Group

Buldiva Sandstone

Depot Sandstone Member — Pcd — Pink, ripple-marked quartz sandstone; minor grit conglomerate and salt-arenite breccia. Hematite-rich salt-arenite breccia, silicified in places, grading into hematite-rich, ripple-marked sandstone, quartz sandstone and quartz conglomerate.

LOWER PROTEROZOIC

Waterhouse Granite — Pgw

Rum Jungle Granite — Pgr

Altered base rocks.

Finniss River Group

Noltenius Formation — Pfn — Undifferentiated quartz conglomerate, quartz greywacke, siltstone and quartz siltstone. Quartz conglomerate.

Brocks Creek Group

Burrell Creek Formation — Pfb — Undifferentiated siltstone, greywacke siltstone, greywacke. "Rimfalstone" calcareous greywacke.

Stapleton Formation — Pfs — Arkose, feldspathic greywacke, quartz greywacke, greywacke conglomerate.

Golden Dyke Formation — Pfd — Undifferentiated carbonaceous siltstone, quartz siltstone, fine-bedded dolomite and dolomitic siltstone, pyritic siltstone, limonite-rich greywacke, carbonaceous greywacke. Dolomitic slump breccia, silicified in places.

Acacia Gap Formation — Pfa — Undifferentiated quartz greywacke, pyrite and silicified rudites, quartz sandstone, pyritic siltstone, siltstone.

Batchelor Group

Coomalie Dolomite — Pfo — Silicified and metamorphosed dolomite with Collenia; calcilutite, siltstone — undifferentiated. Dolomite slump breccia, silicified in places.

Crater Formation — Pfr — Undifferentiated quartz greywacke, feldspathic grey wacke, pebble conglomerate, siltstone. "Banded Iron Formation". Pyritic carbonaceous, dolomitic marl with chert lenses and nodules, in places slumped and brecciated and interbedded with pyritic siltstone. Quartz pebble conglomerate. Quartz sandstone.

Celia Creek Dolomite — Pfl — Dolomite with Collenia, silicified and metamorphosed in places, tremolite schist.

Beestons Creek Formation — Pfe — Arkose, greywacke, siltstone, conglomerate.

Strike and dip.

Vertical dip.

Folds showing direction and angle of plunge.

Quartz veins.

Established fault — position accurate.

Established fault — position approximate.

Probable fault.

Geological boundary — position accurate.

Geological boundary — position approximate.

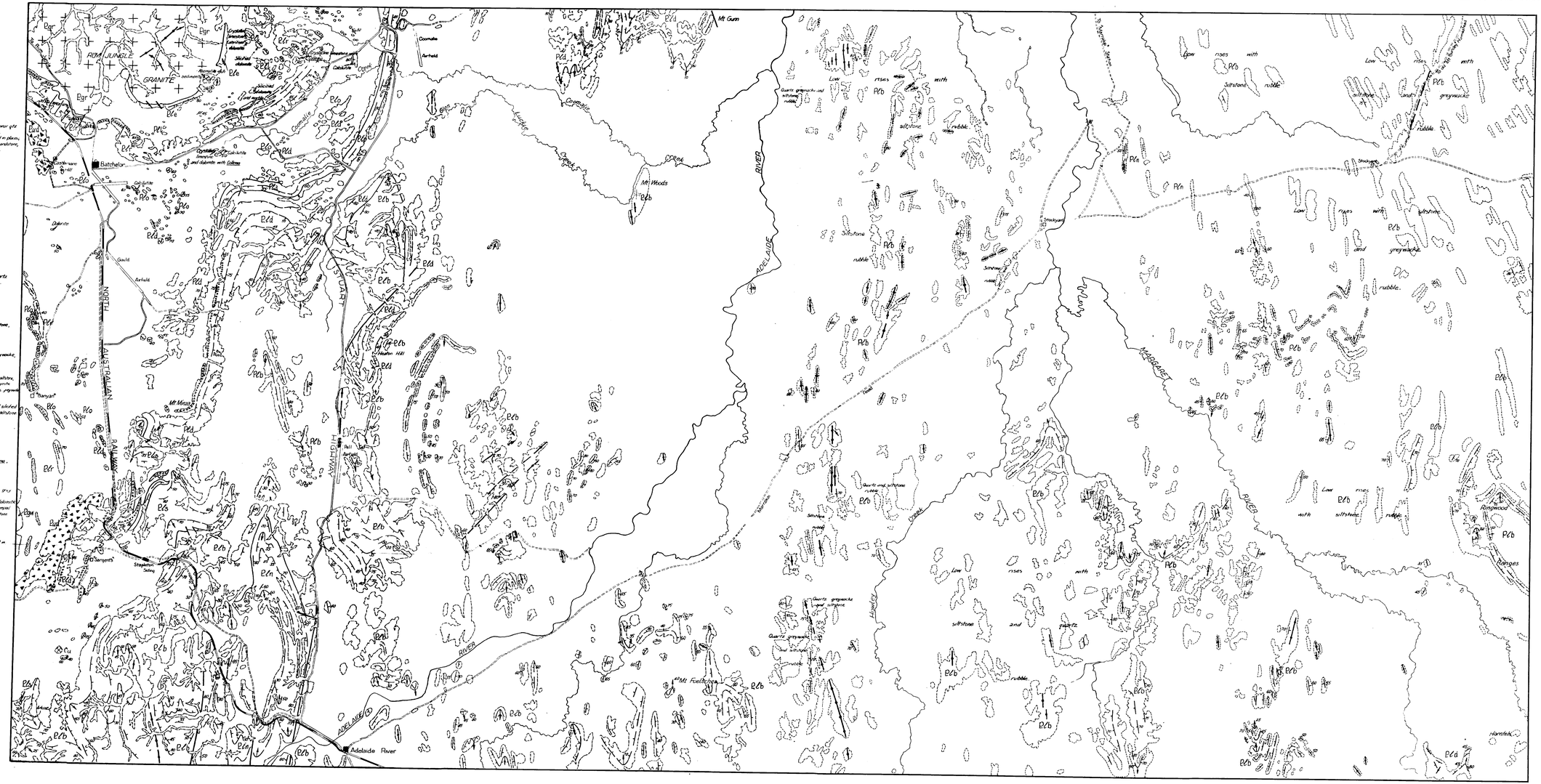
Cu — Mine with type of ore produced. Au = Gold; Cu = Copper.

Road.

Vehicle track.

Railway.

Homestead.



MT. TOLMER

APPROXIMATE SCALE: ONE INCH TO ONE MILE

FIELD SHEET ONLY

LEGEND

QUATERNARY

- Soil and alluvium
- Ferruginous deposit

UPPER PROTEROZOIC

TOLMER GROUP — BULDIVA SANDSTONE

- Bud — DEPOT SANDSTONE MEMBER: Pink, ripple-marked, friable quartz sandstone with conglomerate beds near base. Hematite-rich, silicified calcarenite breccia grading into the pink sandstone.

LOWER PROTEROZOIC

FINNISS RIVER GROUP

- Bln — NOLTENIUS FORMATION: Qtz-pebble conglomerate, quartz-greywacke, siltstone, phyllite, mica schist, andalusite mica schist. Qtz pebble conglomerate

BROCKS CREEK GROUP

- Blb — BURRELL CREEK FORMATION: Siltstone, siltstone greywacke, greywacke. "Tombstone" calcareous greywacke.
- Bld — GOLDEN DYKE FORMATION: Carbonaceous siltstone, quartz siltstone, silicified marl.

BATCHELOR GROUP

- Bls — STAPLETON FORMATION: Arkose, felspathic greywacke, qtz greywacke, greywacke conglomerate. Quartz pebble conglomerate.
- Blo — COOMALIE DOLOMITE: Silicified dolomite with Collenia, calcilutite, siltstone.
- Blr — CRATER FORMATION: Greywacke, pebble conglomerate, siltstone, felspathic greywacke. "Banded Iron Formation". Quartz sandstone.

ARCHAEAN

- Ah — HERMIT HILL COMPLEX: Garnetiferous granite, granodiorite, diorite, dolerite

IGNEOUS ROCKS

- Granitic rocks
- Quartz vein
- Pegmatite vein

REFERENCE

GEOLOGICAL SYMBOLS

- Strike with direction and angle of dip.
- Vertical dip.
- Folds showing direction and angle of plunge.
- Geological boundary, position accurate.
- " " " approximate.
- Established fault, position accurate.
- " " " approximate.
- Probable fault.
- Alluvium boundary.
- Schist.

OTHER SYMBOLS

- "Goodwill" (Sn) — Mine with name and type of ore produced. Sn: Tin; U: Uranium.
- Vehicle track, not graded.
- Railway.

TUMBLING WATERS

PLATE 4

APPROXIMATE SCALE 1 MILE TO 1 INCH

NOT FOR PUBLICATION

FIELD SHEET ONLY

REFERENCE

QUATERNARY

- Qal — Soil and alluvium.
- Qf — Ferruginous deposits, incremental debris, hardpan etc.

MESOZOIC

Mullaman Group — K/m — Friable medium- to coarse-grained quartz sandstone, ferruginous sandstone, greywacke conglomerate.

UPPER PROTEROZOIC

Tolmer Group

Buldiva Sandstone

Depot Sandstone Member — Pud — Pink friable medium-grained ripple-marked sandstone with quartz conglomerate lenses. Haematite-rich silicified calc-arenite breccia grading into pink friable quartz sandstone with quartz conglomerate lenses.

LOWER PROTEROZOIC

Rum Jungle Granite — Pgr

Finniss River Group

Nolfenius Formation — P/n — Undifferentiated quartz conglomerate, quartz greywacke, siltstone, phyllite, mica schist, amphibolite mica schist. Mica schist, andalusite mica schist. Quartz pebble conglomerate.

Brocks Creek Group

Burrell Creek Formation — P/b — Undifferentiated siltstone, siltstone, greywacke, greywacke. Mica schist, andalusite mica schist. "Tombstone" calcareous greywacke.

Golden Dyke Formation — P/d — Carbonaceous siltstone, quartz siltstone, silicified marl. Banded Iron Formation: Pyritic carbonaceous dolomite marl with chert lenses and nodules, in places slumped and brecciated and interbedded with pyritic siltstone.

Acacia Gap Formation — P/a — Quartz greywacke, pyritic argillite, sandstone, siltstone.

Batchelor Group

Coomalie Dolomite — P/o — [illegible] metamorphosed dolomitic with [illegible], calcitic siltstone.

Crater Formation — P/r — Quartz greywacke, felspathic greywacke, pebble conglomerate, siltstone. Banded Iron Formation: Pyritic carbonaceous dolomite, marl with chert lenses and nodules, in places slumped and brecciated and interbedded with pyritic siltstone.

Celia Creek Dolomite — P/l — Dolomite with [illegible] sheeted and metamorphosed in places, tremolite schist.

Beestons Creek Formation — P/e — Arkose, greywacke, siltstone, conglomerate.

ARCHAEAN

Hermit Hill Complex — Ah — Garnetiferous granite, granodiorite.

- Geological boundary — position accurate.
- Geological boundary — position approximate.
- Established fault — position accurate.
- Established fault — position approximate.
- Probable fault.
- Quartz vein.
- Pegmatite vein.
- 45 Strike and dip.
- Vertical dip.
- Folds showing plunge.
- Sn Mine.
- Road.
- Vehicle track.
- Railway.

MARRAKAI

FIELD SHEET — NOT FOR PUBLICATION.

PLATE 5

APPROXIMATE SCALE ONE INCH TO ONE MILE.

REFERENCE

QUATERNARY

- Soil and alluvium.
- Ferruginous deposit, recemented debris, hardpan etc.

UPPER PROTEROZOIC

Tolmer Group

Buldiva Sandstone

Depot Sandstone Member — Pud — Pink rock-marked quartz sandstone, with quartz conglomerate lenses. Hematitic rock-splotched sub-arenite breccia, grading into pink, friable quartz sandstone with quartz conglomeratic lenses.

LOWER PROTEROZOIC

Rum Jungle Granite — Pgr

Finniss River Group

Noltemius Formation — P£n — Undifferentiated quartz conglomerate, quartz greywacke, siltstone and quartz sandstone. Quartz pebble conglomerate.

Brocks Creek Group

Burrell Creek Formation — P£b — Undifferentiated siltstone, siltstone greywacke, greywacke.

Golden Dyke Formation — P£d — Undifferentiated carbonaceous siltstone, quartz siltstone, rhythmic-bedded dolomite and carbonaceous siltstone, limestone-rock greywacke, carbonaceous greywacke. "Banded iron formation". Pyritic, carbonaceous dolomitic marl with chert lenses and nodules, in places slumped and brecciated and interbedded with pyritic siltstones. Dolomitic slump breccia, brecciated in places.

Acacia Gap Formation — P£a — Undifferentiated quartz greywacke, pyritic and siliceous in places quartz sandstone, pyritic siltstone, siltstone.

Goodparla Group

Masson Formation — P£m — Quartz greywacke, sandstone, siltstone.

Batchelor Group

Coomalie Dolomite — P£o — Undifferentiated siliceous and multicoloured dolomite with Collenia, oncolites, siltstone. Dolomite slump breccia, brecciated in places.

Crater Formation — P£r — Quartz greywacke, felspathic greywacke, pebble conglomerate, siltstone. "Banded iron formation". Pyritic carbonaceous dolomitic marl with chert lenses and nodules, in places slumped and brecciated and interbedded with pyritic siltstone. Quartz pebble conglomerate.

Celia Creek Dolomite — P£l — Dolomite with Collenia, siliceous and metamorphosed in places, intercalated with schist.

Beestons Creek Formation — P£e — Arkose, greywacke, siltstone, conglomeratic, arkose conglomerate.

- Geological boundary — position accurate.
- Geological boundary — position approximate.
- Established fault — position accurate.
- Established fault — position approximate.
- Inferred fault.
- Inferred fault — concealed by alluvium.
- Established fault — concealed by alluvium.
- Strike and dip.
- Vertical dip.
- Folds showing plunge.
- Quartz vein.
- Broadribb (Th) — Mine or prospect.
- Road.
- Vehicle track.
- Railway.
- MARRAKAI — Homestead.

FIELD SHEET ONLY —— NOT FOR PUBLICATION

HUMPTY DOO

PLATE 6

APPROXIMATE SCALE 1 INCH TO 1 MILE

REFERENCE

QUATERNARY

- Soil and alluvium
- Ferruginous sand and gravel with occasional ferruginous outcrops
- Observed Ferruginous outcrops

MESOZOIC

Mullaman Group — K/m — 'porcellanite', ferruginous sandstone lateritized in many places, white friable sandstone with fossil plant impressions, current bedding.

UPPER PROTEROZOIC

Tolmer Group
Bukkiva Sandstone
Depot Sandstone Member — Euo — Hematite-rich silicified oolitic arenite breccia grading into pink friable quartz sandstone with quartz pebble conglomeratic lenses.

LOWER PROTEROZOIC

Finniss River Group
Noltenius Formation — P/n — Siltstone and greywacke showing current bedding and graded bedding.

Brocks Creek Group
Golden Dyke Formation — P/d — Undifferentiated carbonaceous siltstone, quartz siltstone, thin bedded dolomite, dolomitic siltstone. 'Banded iron formation' - Pyritic carbonaceous dolomitic marl with chert lenses and nodules in places slumped and brecciated and interbedded with pyritic siltstone.

Goodparla Group
Masson Formation — P/m — Undifferentiated quartz greywacke, pyritic and siliceous in places, quartz sandstone, pyritic siltstone, siltstone.
Mundogie Sandstone — P/u — White silicified sandstone.

- Geological boundary — position accurate.
- " " — position approximate.
- Alluvium boundary.
- Established fault — position approximate.
- Strike and dip.
- Strike with vertical dip.
- Folds showing plunge.
- Quartz blow.
- Freshwater fossil locality.
- Road.
- Vehicle track.
- Railway.

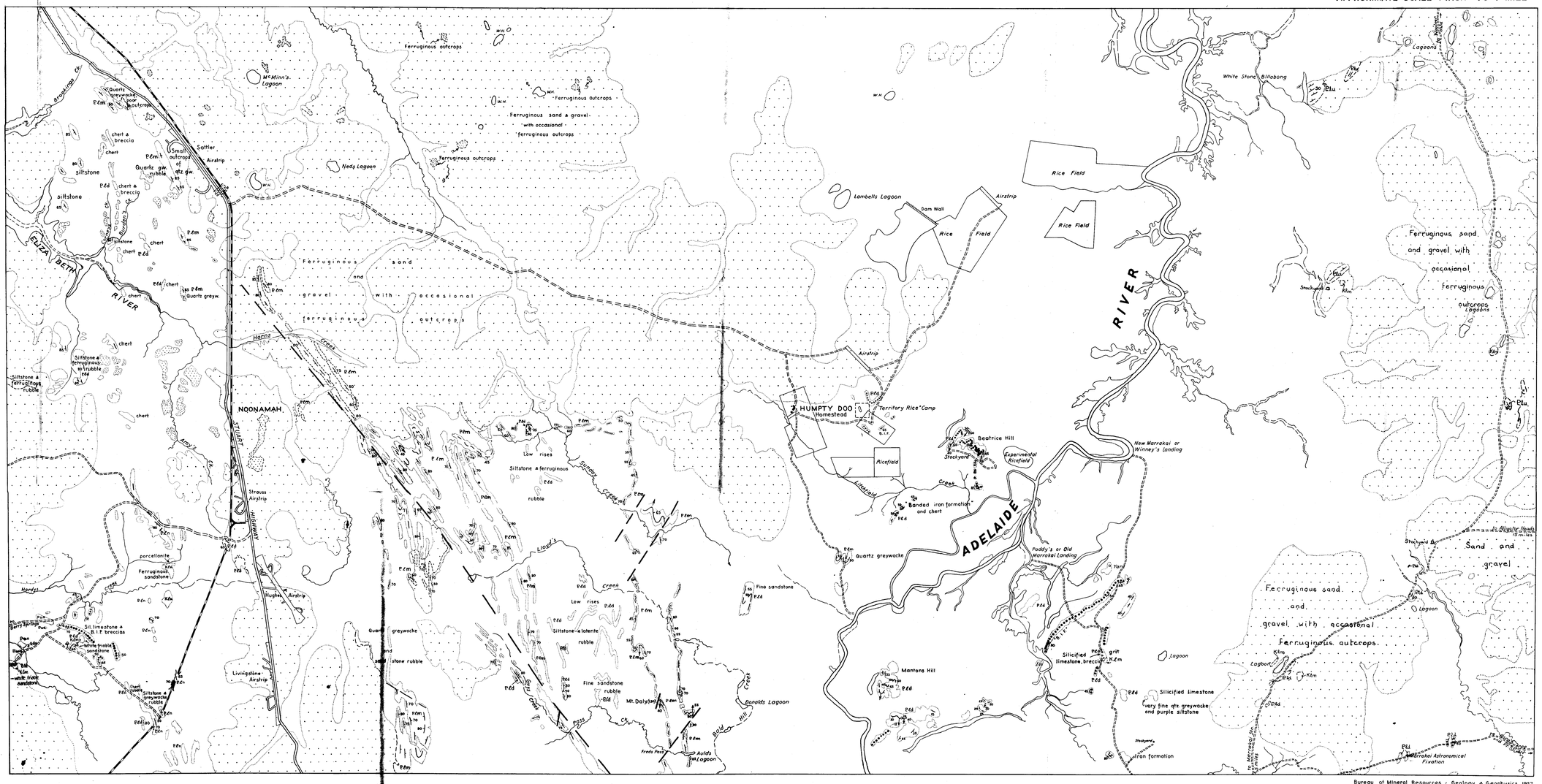


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PLATE 7

NOT FOR PUBLICATION

FIELD SHEET ONLY

SOUTHPORT

Approximate Scale 1 inch to 1 mile

REFERENCE

QUATERNARY

- Soil and alluvium /
- Ferruginous deposits.
- Ferruginous gravel and sand.

MESOZOIC

Mullaman Group

- Km — Arcosic, ferruginous sandstone, coarse-grained white sandstone with red inclusions, patches of sandy conglomeratic containing boulders of Lower Sandstone.

UPPER PROTEROZOIC

Tolmer Group

Buldiva Sandstone

Depot Sandstone Member.

- Bvd — Red, friable, cyclothemic quartz sandstone with minor quartz conglomeratic lenses. Hematite-rich silicified oolitic-oncolitic breccia grading into pink friable quartz sandstone with quartz conglomerate lenses.

LOWER PROTEROZOIC

Finniss River Group

Noltenius Formation

- Pfn — Undifferentiated quartz monzodiorite, quartz greywacke, siltstone, phyllite, meta schist, andalusite-mica schist. Quartz pebble conglomerate.

Brocks Creek Group

Golden Dyke Formation

- Pdd — Siltstone, phyllite. dolomite, Silicified, highly ferruginous laminated/slump breccia.

- Geological boundary — position accurate.
- Geological boundary — position approximate.
- Alluvium boundary.
- Established fault — position accurate.
- Probable fault — position concealed by alluvium.
- Strike and dip.
- Vertical dip.
- Folds showing plunge.
- Trend lines.
- Quartz veins.
- Pegmatite veins.
- Mine or prospect.
- Vehicle track.
- Mangrove.

PORT PATTERSON

PORT DARWIN

EAST ARM

MIDDLE ARM

HAYCOCK REACH

BYNOE HARBOUR

TURNBULL BAY

Ferruginous Deposits overlying Km

Sand and Ferruginous Gravel

Sand and Ferruginous Gravel with Occasional Ferruginous Outcrops

Ferruginous Deposits overlying Pfn

Ferruginous Deposits

GAP IN AIR-PHOTO COVERAGE

Bureau of Mineral Resources, Geology and Geophysics. 1956

DARWIN

PLATE 8

FIELD SHEET ONLY – NOT FOR PUBLICATION

APPROXIMATE SCALE : ONE INCH TO ONE MILE

LEGEND

QUATERNARY

- soil and alluvium
- Ferruginous sand and gravel with occasional ferruginous outcrops
- Ferruginous deposits

MESOZOIC

CRETACEOUS

Mullaman Group — Klm — DARWIN FORMATION — Porcellanite

PRE-CAMBRIAN

LOWER PROTEROZOIC

Finniss River Group — P1n — MALAKOOL FORMATION — quartz greywacke, siltstone, phyllite, mica and andalusite mica schist

Burrells Creek Group — P1a — ACACIA GAP FORMATIONS — Undifferentiated quartz greywacke, pyrites and silicified in places, quartz sandstone, siltstone, pyritic siltstone.

REFERENCE

- Strike and dip
- Vertical dip
- Fold showing direction and angle of plunge
- Geological boundary – position approximate
- Alluvium boundary
- Sealed highway
- Railway
- Track

Bureau of Mineral Resources, Geology and Geophysics, January, 1957

KOOLPINYAH

PLATE 9

FIELD SHEET ONLY

APPROXIMATE SCALE 1 inch to 1 mile

NOT FOR PUBLICATION

REFERENCE

QUATERNARY

- Soil and alluvium
- Ferruginous deposits.
- Sand and ferruginous deposits.

MESOZOIC

Mullaman Group — Km — Porcellanite

LOWER PROTEROZOIC

Goodparla Group

Mason Formation

Acacia Gap Member — Ela — Sandstone and quartz greywacke.

- Geological boundary — position accurate.
- Geological boundary — position approximate.
- Strike and dip.
- Mangrove swamp.
- Vehicle track.
- Road, surfaced.
- Railway

HOPE INLET

CHAMBERS BAY

TIDAL INLET

SALT WATER ARM

BROAD REACH

HOWARDS PENINSULA

HOWARD RIVER

ADELAIDE RIVER

Tree Point

Castle Point

Lake Finniss

Ferruginous Deposits

Sand and Ferruginous Deposits

Sand & Ferruginous Deposits

Sand & Ferruginous Deposits With Occasional Ferr Outcrops

MUD AND BLACK SOIL FLATS

BLACK SOIL FLATS

Bureau of Mineral Resources Geology and Geophysics 1956

CAPE HOTHAM

PLATE 10

FIELD SHEET ONLY

APPROXIMATE SCALE: 1 inch to 1 mile.

NOT FOR PUBLICATION