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# THE KATHERINE - DARWIN METALLIFEROUS PROVINCE

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## INTRODUCTION

The Katherine - Darwin metalliferous province (Figure 1), is roughly co-extensive with the Pine Creek Geosyncline (Walpole, 1960), and covers an area of about 20,000 square miles in the northwestern tip of the Northern Territory.

Except for coastal plains and river flats, the area has moderate relief with many steep slopes. The height above sea level in most places is less than 1000 feet. The climate is monsoonal with a summer wet season. The average rainfall decreases from about 60 inches near the coast to about 30 inches at Katherine, 200 miles inland. The vegetation, except for small areas of mangrove swamp and rain forest near the coast, is mostly open woodland.

The total population of the area is about 15,000, the main centres being Darwin, Adelaide River, Pine Creek, and Katherine, all of which are linked by the North Australian Railway and the Stuart Highway. The only other centres of importance are the mining settlements of Batchelor, serving the Rum Jungle area, and Moline, serving the South Alligator area.

## GENERAL GEOLOGY

The mineralized rocks of the Katherine-Darwin region include Archaean metamorphics, Lower Proterozoic sediments and igneous rocks, and Upper Proterozoic sediments and volcanic rocks. The main mineralization is concentrated in the Lower Proterozoic.

Archaean metamorphic rocks, including migmatite, gneiss, schist, and altered volcanic rocks, crop out in four main areas - Hermit Hill, Rum Jungle, along the valley of the South Alligator River, and in the Oenpelli area. They unconformably underlie the Lower Proterozoic and at Hermit Hill and Rum Jungle are intruded by Lower Proterozoic granite. Rum Jungle is one of the few places in Australia where the contact of the Archaean with Lower Proterozoic is exposed. The relationship between the rock units of the area is shown diagrammatically in Figure 2 and the lithology of the major units summarized in Table 1.

The Lower Proterozoic rocks occupy the Pine Creek Geosyncline, a composite, fairly shallow, intracratonic structure which developed in stages. Each stage is typified by distinctive facies assemblages which overlap in time and space. The distribution of the main structural elements in which they were deposited is shown by Figure 3. The primary structure or Central Basin was an asymmetrical trough, deepest in the west. Its axis trends south-east, and its margins were at Rum Jungle in the north-west, and possibly near the East Alligator River in the east. Basal beds on the eastern side of the geosyncline include at least 10,000 feet of coarse arkose, arkose conglomerate, sandstone, and siltstone, with dolomite lenses (Mount Partridge Formation), grading westwards into sandier material. On the edge of the trough at Rum Jungle, the basal sequence (Batchelor Group) is similar but only about 4000 feet thick, and the minor dolomite lenses found on the eastern margin are replaced by algal bioherms, calcilutites, and lutites, in two distinct lenticular formations (Celia Dolomite and Coomalie Dolomite), each up to 1000 feet thick.

The bulk of the sedimentation in the primary basin was from the east, and the arkosic assemblage grades vertically and laterally to the west first into a quartz greywacke, carbonaceous siltstone, and siltstone sequence (Masson Formation), and finally into a dominantly carbonaceous siltstone and chert sequence with numerous lenses of pyritic carbonaceous shale (Golden Dyke Formation). Bands, lenses and nodules of dolomite and/or chert (which may originally have been carbonate), and slump breccia are widespread within the carbonaceous shale member of this Formation.

The Golden Dyke Formation and a tongue of the Masson Formation overlap the basal units at Rum Jungle, and the contact between the carbonaceous rocks of the Golden Dyke Formation and the uppermost formation of the Batchelor Group - the Coomalie Dolomite - is the main locus of ore deposition in this area.

The second stage in the development of the geosyncline was vertical movement along the western flank (Western Fault Zone) causing regression of the surface of deposition to the west. These movements resulted in the deposition of the Finniss River Group, a greywacke and siltstone assemblage, about 9000 feet thick, composed largely of turbidity current deposits which lens out to the east. The basal sediments of this group are admixed with Golden Dyke sediments in a number of places, indicating that material derived from the east was still being deposited. Shortly after the development of the greywacke assemblage, a ridge developed along the line of what is now the South Alligator Valley. This appears to have cut off easterly-derived sediments from the central basin and instead deposited them in a secondary structure - the Eastern Trough. The ridge was probably initiated by faulting, and is now marked by a prominent fault zone and by a narrow belt of altered Archaean basalt and basaltic agglomerate. In some places, discontinuous algal bioherms which lens out and up into sediments similar to those of the Golden Dyke Formation were developed on this ridge. These rocks belong to the Koolpin Formation and the carbonaceous members contain the main uranium deposits of the South Alligator field. The Koolpin Formation is overlain by and interfingered with the Gerowie Chert, and lutites of the Fisher Creek Siltstone.

TABLE 1

SUMMARY OF MAJOR LOWER PROTEROZOIC ROCK UNITS

| Age | Unit | General Lithology |
|---|---|---|
| | Unmineralized rocks of Mesozoic, Cambrian and Upper Proterozoic age. | Thin (less than 200 feet) veneer of flat-lying Lower Cretaceous terrestrial and marine sandstone and shale which crop out as residual mesas over most of the region. Lower Cambrian basalt and Middle Cambrian limestone, shale and sandstone up to 2000 feet thick in a shallow basin in the Daly River area and unconformably overlying gently folded sediments and minor volcanic rocks of the Tolmer, Mt. Rigg and Roper [illegible] Groups. |
| Proterozoic (Age uncertain) | Katherine River Group. | Acid volcanics, pyroclasts, volcanic plugs, and minor rudite and arenite at the base (Edith River Volcanics) disconformably overlain by interbedded arenites, rudites and volcanics (Kombolgie Formation). Up to 9000 feet thick. Uranium and gold mineralization in Edith River Volcanics and basal Kombolgie Formation rocks in South Alligator River area. |
| Lower Proterozoic ("Agicondian") | South Alligator Group. | Interfingered algal bioherms, dolomite and nodular carbonaceous pyritic dolomitic shale (Koolpin Formation) chert (Gerowie chert) and siltstone, greywacke siltstone (Fisher Creek Siltstone). |
| | Finniss River Group. | Turbidity current deposits - greywacke, siltstone, minor conglomerate (Noltenius and Burrell Creek Formations), sandstone (Chilling Sandstone). |
| | Goodparla Group. | Arkose, arkose conglomerate, siltstone, sandstone and minor dolomite lenses (Mt. Partridge Formation) grading laterally and vertically into quartz greywacke and siltstone (Masson Formation); and in turn into chert, carbonaceous siltstone and carbonaceous dolomitic shale (Golden Dyke Formation). |
| | Batchelor Group. | Arkose, arkose conglomerate, quartz greywacke (Beestons Creek and Crater Formations), algal bioherms, dolomite, minor siltstone (Celia Creek and Coomalie Dolomite). |
| Archaean | | Gneiss, migmatite, schist, altered basalt and basalt. |

The Lower Proterozoic rocks are probably not more than 20,000 feet thick in the deepest part of the primary basin. They are moderately folded and strongly faulted. Regional dynamic metamorphism is of the low greenschist facies only and in many places is virtually non-existent. Large sills of dolerite and amphibolite intruded the rocks (principally the Golden Dyke Formation) prior to folding, and a later suite of basic to intermediate rocks forms prominent dykes and sills in the South Alligator area. The older sills are commonly magnetic and account for many of the aeromagnetic anomalies in the Brocks Creek area; the younger dykes are not (Bryan, 1962).

Lower Proterozoic acid igneous rocks are mostly granitic plutons. There are few acid volcanics and at least some mapped as Agicondian may in fact be younger. The two largest granite intrusions are the Cullen Granite, a discordant batholith in the centre of the geosyncline; and the Litchfield Complex, intruded along the western margin. A number of small stocks and apophyses are associated with the Cullen Granite, and there are numerous other small intrusions of granite, adamellite, and syenite. Some were thought by earlier workers to be concordant cupolas, for example the Burnside Granite at Brocks Creek, but though they have domed the sediments they have contacts which are discordant in detail. The Rum Jungle Granite has been shown to consist of Archaean basement rocks partly rimmed by arkose and bioherms, and intruded by Lower Proterozoic granite. K/Ar age determinations on the granites range from 1520 to 1720 million years (Walpole & Smith, 1961), but it is uncertain whether or not these numbers represent the absolute ages of intrusion.

Three groups of younger Proterozoic rocks unconformably overlie the Agicondian. The two upper groups (Mt. Rigg. Group and Tolmer Group) are not mineralized. The lower assemblage (Katherine River Group) consists of a mixed volcanic -arenite - rudite sequence up to 9000 feet thick. The basal formation, the Edith River Volcanics, consists of acid volcanic rocks and minor sediments of which one particular member, the Pul Pul Rhyolite, is markedly radioactive. At Coronation Hill in the South Alligator Valley, gold and uranium mineralization is associated with a volcanic plug belonging to the Edith River Volcanics. The Katherine River Group is correlated with the Tawallah Group of the McArthur River area in the Gulf of Carpentaria region which has recently been dated as at least 1500 million years old. (Webb, McDougall and Cooper, 1963).

## MAJOR FACTORS CONTROLLING MINERALIZATION

The Katherine-Darwin region has a record of small mines, and only one deposit (Brown's Lead Prospect at Rum Jungle) can be classed as sizeable. Of the several hundred mineral occurrences, most are in quartz veins, fissure lodes, greisens or pegmatites, all of which can be directly related to the granitic intrusions of the region. They contain gold, tin, copper, lead, zinc, tantalum, tungsten, uranium, and other metallic minerals - the usual suite found in such a geological environment - and are mainly localised on shears and fractures, some within the granites but mostly close to the granite margins. Most of them occur within the greywackes and siltstones of the Finniss River Group, but the abundance in this Group is not considered to have any stratigraphic significance as similar deposits are also found in other units, particularly in the Brocks Creek area.

The deposits in the Brocks Creek area have been described by Sullivan & Iten (1952) and Sullivan (1953). The sediments belong mainly to the Golden Dyke Formation and have been domed by the Burnside Granite. One particular type of sediment, which appears to act as an ore control in this and other areas, is a carbonaceous siltstone, in places pyritic, and containing lenses, bands, and nodules of dolomite or silicified dolomite. It crops out in many areas and is a member of a number of formations. Oxidation of the pyrite in this rock has formed gossanous ironstone cappings in some areas, particularly at Brocks Creek. Trace quantities of copper, and to a lesser extent cobalt, nickel, lead, zinc, and uranium, cause geochemical anomalies in some of them. The available evidence strongly suggests that the anomalies are due to concentration of trace amounts of metals at the surface by lateritic processes. This particular rock also forms the ore bed at the Cosmopolitan Howley and Golden Dyke gold mines.

The Koolpin Formation in the South Alligator area contains a number of beds of this nodular pyritic carbonaceous siltstone, intercalated with lenses of carbonaceous siltstone. The formation as a whole is weakly radioactive and is also known to be auriferous in places (J. Fisher, United Uranium N.L., pers. comm.). In its environment it resembles the Coomalie Dolomite - Golden Dyke assemblage at Rum Jungle, viz. a discontinuous algal reef facies overlain by dolomitic and carbonaceous sediments. Archaean basement rocks also crop out in both areas.

Most of the uranium, copper, lead, and cobalt mineralization at Rum Jungle occurs in the Golden Dyke Formation near its contact with the Coomalie Dolomite.

It is tempting to draw a parallel between the South Alligator and Rum Jungle areas in regard to the main controls of mineralization. The lithology of the Lower Proterozoic rocks in both areas is similar. In both areas the ore lies close to an old Proterozoic land surface, and both areas contain radioactive granite intrusions of similar ages. However, the South Alligator uranium field lies along a major fault zone, and in the area there are volcanic rocks and plugs of the Edith River Volcanics, which are not found at Rum Jungle. The uranium/gold orebody at Coronation Hill in the South Alligator area is, in fact, a volcanic plug, and the Pul Pul rhyolite member of the Edith River Volcanics is markedly radioactive and contains trace uranium. Most other deposits in the area are localized on shears in the Koolpin Formation, but all the known occurrences are near to, and in some cases transgress, the unconformity between the Koolpin Formation and the Katherine River Group. The uranium mineralization therefore seems to be controlled by coincidence of the major fault zone of the area with carbonaceous rocks of the Koolpin Formation; and the Edith River Volcanics. The available evidence therefore suggests that the Rum Jungle deposits are older than those in the South Alligator area.

A most important ore control in a number of deposits in the Katherine-Darwin region is secondary enrichment. Supergene processes of presumed Proterozoic age are important at Rum Jungle and South Alligator. Lateritization, probably in the early Tertiary, was prolonged and intense, and in fact, with the exception of minor marine incursions in the Cambrian and Cretaceous, the area has been virtually stable since the end of the Precambrian. Most of the old gold mines, although

small, were very rich at the surface, and the gold was free milling. Below the water table the grade falls off and much of the ore is refractory, so that most of these mines were abandoned at the water table. Many copper occurrences also show these features; and most geologists who have worked at Rum Jungle agree that the uranium orebodies have been enriched by supergene processes. The iron ore occurrences of the Darwin River, Waterhouse, and Frances Creek areas also appear to have resulted from the supergene enrichment of syngenetic iron-rich beds in the Agicondian succession.

The extreme weathering in the Katherine-Darwin region is characteristic of most of Northern Australia. It has affected susceptible mineral deposits in one of two ways - secondary enrichment at or near the surface which gave rise to rich and easily found ore; or extreme leaching which destroyed all megascopic indications of the presence of an orebody. Brown's lead deposit at Rum Jungle is somewhere between these two extremes. There is a small amount of secondary lead minerals at the surface, and bulldozed costeans show further mineralization below the soil, but there is little surface indication of the presence of a sizeable orebody. Where pyrite is present, it cannot be assumed that a gossan will result and in many areas detailed geochemical and geophysical methods are necessary to detect the presence of ore; and there are large areas, particularly of the Golden Dyke Formation, which still warrant testing for such concealed deposits.

## INDIVIDUAL DEPOSITS

### Rum Jungle

Copper was discovered at Rum Jungle late in the last centuary, but the present importance of the area dates from the discovery of uranium in 1949. Since then,uranium and copper have been produced from two major deposits in the area - White's and Dyson's, and uranium from Rum Jungle Creek South and from a small deposit at Mount Burton. A lead prospect (Brown's), copper anomalies at Area 55, Mount Fitch, and between Brown's and White's, and occurrences of phosphate rock (Castlemaine Hill and other areas) are also currently under investigation (1963).

The uranium and base metal occurrences are disseminated in graphitic shales and slates at White's and Dyson's and in chloritic schist at Rum Jungle Creek South. The main ore minerals are uraninite, torbenite, chalcopyrite and bornite at White's, uraninite and saleeite at Dyson's, uraninite at Rum Jungle Creek South, galena at Brown's. Cobalt is a minor constituent of some ore bodies. All the occurrences lie within the Golden Dyke Formation, commonly close to its contact with the underlying Coomalie Dolomite, and also close to the overlying unconformity. A number of occurrences of phosphatic quartz-hematite breccia also lie at this unconformity. The full extent and grade of these phosphate occurrences have not yet been determined but they are believed to be of minor importance only. The phosphatic breccia is believed to be Upper Proterozoic in age, filling old depressions in the land surface developed on the Lower Proterozoic rocks. The breccia fragments are silicified dolomite; and the phosphate (fluorapatite) and the fragments are both probably derived from the breakdown of phosphatic dolomites and dolomitic shales in the Lower Proterozoic succession. This suggests severe weathering in the interval prior to Upper Proterozoic sedimentation,

evidence for which is also found in the supergene enrichment of the uranium deposits at or close to the unconformity at Rum Jungle.

South Alligator Area.

Uranium and subordinate gold are the main minerals mined in this area to date, but occurrences of phosphatic quartz hematite breccia have also been noted and there are minor deposits of copper and lead. El Sherana, Palette, and Coronation Hill, worked by United Uranium N.L., and Rockhole, until recently worked by South Alligator Uranium N.L., are the most important mines in the area. In addition, there are about twelve other prospects, some of which have yielded small quantities of ore. Most of these orebodies consist essentially of pitchblende with only minor amounts of secondary minerals, and are emplaced in shales of the Lower Proterozoic Koolpin Formation, generally close to contact with the unconformably overlying Upper Proterozoic sandstone. At several localities, the uranium mineralization also extends some distance into this sandstone.

Brocks Creek Area

Occurrences of gold and base metal mineralization in the Brocks Creek area, described by Sullivan & Iten (1952) and by Sullivan (1953), have been further investigated in later years. Three diamond drill holes put down by the Bureau of Mineral Resources on the Cosmopolitan Howley Mine between 1957 and 1959 proved the downward extension of the shoots worked in this mine, the best results being intersections of 3.6 dwt of gold per ton over a true width of 20 feet, 8.6 dwt/ton over 13 feet, and 6.8 dwt/ton over 8 feet, all at vertical depths of about 300 feet (McQueen, 1959). However, no further work has been done on the mine since then.

There is a very clear stratigraphic and structural control to this orebody. The gold occurs in a nodular dolomitic shale (referred to by Sullivan (1953) as "pressure conglomerate"), and the highest values are localised on the nose of a north-plunging dragfold.

Some of the gossanous ironstones of this area have also been re-examined as possible sources of iron ore, but have in general been found to be too small and too low-grade for economic exploitation.

Frances Creek Iron Ore

The largest iron ore deposits known in the Katherine-Darwin area were discovered in 1961 in the Maud Creek - Frances Creek area, about ten miles east of Burrundie railway siding and 120 miles south-east of Darwin. The deposits are tabular and lenticular bodies, with strike lengths of up to 2000 feet and widths of up to 50 feet, and the alignment of the lodes as a whole follows the bedding of the enclosing sediments, which are shales and greywackes of the Lower Proterozoic Masson Formation; over a strike length of about 15 miles. They typically also show some thickening on minor folds. Hematite and limonite in varying proportions are the main constituents, and many of the lodes form prominent outcrops, in places with sheer walls up to 50 feet high.

Generally, the grade falls off in depth, indicative of surface enrichment, which must date from at least pre-Cretaceous times, as the lodes are unconformably overlain in places by Cretaceous sediments. Below the zone of enrichment the lodes passinto sheared and brecciated sediments with only partial replacement by iron oxides.

Mount Bundey (Pritchard's Lode) Iron Ore.

At Mount Bundey, 40 miles north-east of Adelaide River township, a bold ironstone outcrop, known as Pritchard's Lode, can be traced on the surface for about 2000 feet, with an average width of about 40 feet, and several smaller outcrops within a few hundred yards may represent portions of less well exposed bodies. A drill hole put down under the widest outcrop of the lode by the Bureau of Mineral Resources in 1958, passed under it at 300 feet vertical depth. During 1962, a diamond drilling programme by the Mines Branch, N.T. Administration, was undertaken to further test the possible value of this lode as a source of iron ore as well as base metals. This showed that the lode consists essentially of martite to an average depth of 80 feet below the outcrop. Below this, the lode material is essentially magnetite with blebs and veinlets of pyrite and minor chalcopyrite. Sulphur in this section ranges from 1 to about 5 percent, and copper from 0.1 to 0.5 percent.

On the surface, the lode is entirely surrounded by syenite, but the drilling has shown that at least some sedimentary rocks are present on the flanks of the lode. The lode may thus be a magmatic segregation, a partial replacement of a large sedimentary inclusion in the syenite, or the result of a combination of these two processes.

Darwin River and Waterhouse Iron Ore

A number of occurrences of iron ore have been noted in the Darwin River and Waterhouse areas, from ten miles north to about fifteen miles south of Rum Jungle (Dunn, 1962). These range from lenses of massive hematite to hematite - goethite gossans, and, like the uranium deposits, they occur close to quartz-hematite breccias and to the unconformity between the Lower and Upper Proterozoic. They are probably of several types, comprising bedded deposits similar to those at the Frances Creek area, replacement deposits emplaced along shear zones and along the Lower Proterozoic/Upper Proterozoic unconformity, and possibly some deposits resulting from the oxidation of original sulphide lodes. From an economic point of view, deposits of hematite rubble and scree, lying on the flanks of some of these lodes, are probably of greater importance than the lode material itself. All are small and none have, as yet, been tested to the stage where ore reserves can be indicated with any confidence.

Pine Creek - Union Reefs Area.

This area was an important gold mining centre up to about 1920, but there has been little production since then. Since 1961, there has been some revival of prospecting, stimulated by the construction of a Government Battery at Mount Wells, and a geological, geophysical and diamond drilling programme at Union Reefs was compounded in 1963 by the Bureau of Mineral Resources. Most of the production has been from quartz reefs with minor pyrite and rare galena, which occupy major shear-zones sub-parallel to the bedding of the enclosing greywackes and shales of the Lower Proterozoic Finniss River Group.

Grcve Hill - Mount Masson - Mount Harris Area.

This is an area where small deposits of gold, tin and base metals have been intermittently worked for more than 80 years, and where mining on a small scale, particularly for tin, has been revived in the past few years (Hays, 1960). The lodes in this area consist of a large variety of types, including simple quartz cassiterite lodes (Mavis, Mount Harris); similar lodes with minor pyrite and chalcopyrite (Mount Wells, Mount Masson); quartz-limonite-cassiterite lodes which are thought to represent gossanous cappings on pyrite - or pyrrhotite-rich bodies (Jessop's Lode); and complex gold-base metal sulphide lodes in part with minor cassiterite (Mount Bonnie, Iron Blow). There are three separate granite bodies in this area, but the lodes do not show any systematic zonal arrangement with respect to any of them. With the exception of the Mount Bonnie and Iron Blow lodes, which occur in slates of the Golden Dyke Formation, all the remainder occur in greywackes, siltstones and shales of the Masson Formation. Both these formations are of Lower Proterozoic age.

Jessop's lode has a strike length of at least 250 feet and an average width of about 10 feet, and has the largest indicated ore reserves of the tin lodes. Several other mines, notably the Mavis, have good quality ore in sight. The Iron Blow mine was worked for gold and copper to a depth of 200 feet in the early years of this century, and substantial tonnages of low-grade gold-chalcopyrite-galena-sphalerite ore with quartz and pyrite or pyrrhotite gangue are thought to remain below this level. A joint diamond drilling programme has recently been undertaken by the Mines Branch, Northern Territory Administration, and United Uranium N.L., to determine the presence of extensions or repetitions of the known shoots (Dunn, 1961).

Coronet Hill Copper Lode

The group of copper lodes comprising Coronet Hill, Mount Davis, Mount Gardiner and Mount Diamond lies about 30 to 35 miles east of Pine Creek. These mines produced some small but rich parcels of copper ore, mostly from the oxidised zone, during the early years of this century. The lodes are mainly quartz reefs in Lower Proterozoic cherts, slates and greywackes, commonly associated with major faults or shear zones, and close to an apophysis of the Cullen granite. Pyrite, chalcopyrite, arsenopyrite and scorodite are the main mineral constituents. Coronet Hill is the largest of these deposits, and a diamond drilling programme to test the extension of the lodes in depth has been proposed (Ruxton, 1961).

Evelyn Silver - Lead Mine

This mine is situated near Moline, about 25 miles north-east of Pine Creek, and is at present (1963) under investigation by United Uranium N.L. Some small but very rich crushings of silver - lead ore, averaging about 20% Pb and 40 oz silver per ton, were produced from this mine during the late years of the last century (Rowston, 1957). The lodes are tabular bodies, emplaced in a system of shears and tension gashes in limestone and calcareous shale. To a depth of about 100 feet the mineralization consists mainly of galena and oxidised lead and zinc minerals, but below this depth the zinc content increases and sphalerite and pyrite are the dominant ore minerals.

Maranboy and Yeuralba Tin Field.

These areas have been producing tin with minor amounts of wolfram and copper since 1913, but recent production has been small. Most of the production from Maranboy has been from quartz-cassiterite-tourmaline lodes, but that of Yeuralba has been mostly from greisen bodies. The country rock in both areas consists mainly of greywacke, siltstone and tuffaceous sandstone of the Burrell Creek Formation. The area was mapped in detail by the Bureau of Mineral Resources in 1951 - 52 (Walpole, 1958; Walpole & Drew, 1953). Subsequently, the Bureau put down eleven diamond drill holes on the Maranboy field (Mackay, 1960) and one at Yeuralba and some shaft-sinking was carried out at Maranboy by United Uranium N.L. Only three intersections of ore-grade material were made at Maranboy, and no follow-up work was done. The Yeuralba drilling was unsuccessful. In 1961, alluvial deposits in the valley of Sandy Creek, Yeuralba, were sampled by test-pitting, but the results were again disappointing (Hays, 1962).

West Arm - Mount Finniss Tin and Tantalum Field.

The West Arm - Mount Finniss tin and tantalum field lies from 20 to 40 miles south-south-west of Darwin and consists of a belt of numerous small pegmatite and greisen bodies intruded into sandstones, siltstones and slates of the Lower Proterozoic Noltenius Formation (Summers, 1957). The total recorded production is about 580 tons of tin concentrates and 15 tons of tantalite concentrates, but recent activity on the field has been very limited. The occurrence of the main ore minerals, cassiterite and columbite - tantalite, is mainly as small stringers and irregular disseminations in the pegmatites and greisens.

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