BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

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SUMMARY DESCRIPTIONS OF MINERAL DEPOSITS BY COMMODITIES IN THE ALICE SPRINGS 1:250 000 SHEET AREA, NORTHERN TERRITORY

by

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CONTENTS

	Page
Abstract	i
Introduction	1
Geology	1
Mineral deposits	2
Arsenic	2
Asbestos	2
Beryllium	3
Construction materials	3
Copper	4
Oonagalabi group of prospects	4
Mineral occurrences similar to the Oonagalabi group	9
Copper deposits localised in late-stage deformed zones	11
Copper deposits in calcareous host rocks	12
Feldspar	12
Gemstones and specimen material	13
Gold	14
Winnecke Gold District	15
Eastern MacDonnell Ranges	15
Lead and zinc	17
Mica	17
Rare-earth minerals	18
Sillimanite-group minerals	18
Silver	19
Tin, tantalum, and niobium	19
Uranium	19
Vermiculite	19
Bibliography	20
Appendix 1. Mineral deposit localities	31
Appendix 2. Analyses of grab samples	35

ABSTRACT

The known mineral deposits in the Alice Springs 1:250 000 Sheet area are small; successful exploitation has been limited to small ventures.

Commodities mined, reported, or available are arsenic, asbestos, beryllium, construction materials, copper minerals, feldspar, gemstones and mineral specimens, mica, gold, rare earth minerals, sillimanite-group minerals, silver, tin, tantalum, niobium, uranium, and vermiculite. Of these, construction materials are thought to be the most valuable commodity. Mica and gold have previously been important, but there is no production of either at present.

INTRODUCTION

The Alice Springs 1:250 000 Sheet area contains numerous small mineral deposits. Construction materials are being produced at present, and mica and gold have been important in the past. Successful ventures have generally been small operations by groups consisting of a few miners working under primitive conditions.

Individual prospects have been described in numerous short reports. Open-file repots describing work carried out on exploration concessions are held by the Department of Mines and Energy, Northern Territory, and are available for reference at the offices of the Department in Darwin and Alice Springs. Most of the reports deal with evaluation of known prospects, but some also include limited regional geophysical, geochemical, and heavy-mineral surveys. Reviews of mineralisation in the Arunta Inlier, which includes about half the Alice Springs 1:250 000 Sheet area, are contained in Woolley & Rochow (1965), Warren & others (1974), and Stewart & Warren (1977). The geology of the Sheet area is described by Shaw & Wells (in preparation).

In this report Mine is used where ore has been sold, Prospect where evaluation has been carried out, and Occurrence for all other shows of potentially economic minerals. The deposits are listed under commodities and are described in alphabetical order. Details of location (latitude and longitude, and grid reference to the 1:100 000 Sheets) are given in Appendix 1. Details of production (if any) are listed in the text.

The author claims personal knowledge only for the Oonagalabi Group of deposits. For other deposits the reader is referred to previous, more detailed accounts.

GEOLOGY

This text should be read in conjunction either with the second edition of the Alice Springs 1:250 000 geological map or the preliminary editions of the geological maps for the six 1:100 000 Sheet areas (Burt, Laughlan, Alice Springs, Undoolya, Riddoch, and Fergusson Range) that make up the Alice Springs 1:250 000 Sheet area. Detailed accounts of the regional geology are given in Shaw & Wells (in preparation) and Shaw & others (1979).

The rocks of the Arunta Inlier have been grouped into three major divisions on their lithological character. Division 1 consists of metamorphosed rocks, mainly at granulite grade, interpreted as a bimodal suite of volcanic rocks, co-magmatic intrusions, and volcaniclastic sediments. These rocks, together with an overlying suite of pelies and limestones, are assigned to units

within the Strangways Metamorphic Complex. Division II contains more mature, well-layered meta-sediments (Harts Range Group) in the northeast and feldspathic, calcareous, pelitic, and psammatic metasediments in the central part of the Sheet area. Division III consists of mature pelites and psammites. Division II is considered to be younger than Division I, but only the Harts Range Group is known to be unconformable on units of Division I. Division III rests unconformably on Division II units. All are older than about 1800 m.y. (Shaw & Wells, in preparation).

The Arunta Inlier is overlain by the late Proterozoic to mid-Palaeozoic Amadeus Basin sequence which occupies the southern third of the Sheet area. The present (structural) margin of the Amadeus Basin in the Sheet area is situated along a broad zone of severe deformation which formed in the mid-Palaeozoic.

Deep weathering in the Early Tertiary affected part of the Sheet area. In the mid-Tertiary warping produced small basins which were filled by piedmont and lacastrine sediments.

MINERAL DEPOSITS

The mineral deposits are described according to the commodities they contain.

Localities are listed in Appendix 1 by grid reference (metric grid) or by latitude and longitude.

Arsenic

Arsenic is associated with copper and gold in the Excelsior Mine, White Range (Hossfeld, 1940). It occurs as arsenopyrite.

Asbestos

Veins of anthophyllite asbestos are exposed in costeans and pits in serpentine about 3 km south by east of the Spotted Tiger Bore. Narrow veins of cross-fibre, and wider veins (up to 0.6 m) of slip and mass-fibre, are meant, but the quality is poor and there has been no production (McLeod, 1965, p. 58). The country rock is Irindina Gneiss (Division II). A smaller occurrence has been found 1 km along strike to the east-southeast.

Beryllium

Beryl occurs in several pegmatites in the Harts Range. Joklik (1955a) listed the Disputed and Caruso Mines as the chief beryl localities in the Alice Springs 1:250 000 Sheet area. Beryl is localised in the wall and intermediate zones of the zoned pegmatites, where it accompanies potassium feldspar or, less commonly, plagioclase. A small quantity of coarsely crystalline beryl occurs in a quartz-rich pegmatite 2 km west of Joker Flat Dam. No production has been recorded.

Construction materials

Construction materials are extracted as required for local use, and most of the quarries, now abandoned, are relatively close to Alice Springs, the Australian National Railway, the Stuart Highway, or beef roads. Kingdom (1977) has listed all recorded leases and applications for leases covering construction materials. No production figures are recorded.

Sand has been obtained mainly from Recent stream beds and abandoned stream channels south of the MacDonnell Ranges.

Stone for aggregate has been extracted 2.5 km south of Mount Gillen (dolomite) and 2.0 km west of Clough Dam (dolerite). In several abandoned quarries adjacent to the Stuart Highway 1 to 3 km north of Alice Springs, Alice Springs Granite has been extracted, presumably for crushed stone during the initial construction of the highway.

Gravel pits adjacent to the Plenty River Highway 0.25 to 2 km east of Ongeva Creek have been put down in rubbly low outcrops of Irindina Gneiss (Division II) during improvements to the road bed and the construction of causeways. A series of pits on transported laterite north of Burt Creek and south of McGrath Creek adjacent to the Stuart Highway were opened initially to supply ballast for the Commonwealth Railway during the Second World War. Material from these and other workings in laterite at the Thirty Mile post on the Stuart Highway has been taken more recently for road construction works.

Building stone. The buildings at the original Alice Springs Telegraph Station are constructed from local Alice Springs Granite. Local stone was used for many of the older buildings in the region, including the abandoned Arltunga township, miners' huts, and station buildings. Most recent stone buildings in Alice Springs use Arumbera Sandstone and Hermannsberg Sandstone from the Amadeus Basin sequence.

Ornamental stone has been quarried for special local projects. Marble from near Marbles Bore is used in the font of the John Flynn Church, and crushed marble is used in the cement-rendered exterior walls of the church.

Copper

Copper occurrences are grouped into (1) the Oonagalabi group of prospects, which are probably metamorphosed volcanogenic deposits, (2) copper deposits in late-stage deformed zones, and (3) copper deposis in calcareous host rocks.

The Oonagalabi group of prospects

Several small occurrences of copper, with lead and zinc, in the Harts and Strangways Ranges are associated with a distinctive suite of rocks interpreted as metamorphosed chloritic rocks, impure dolomitic marbles and calc-silicate rock, and banded iron formation. Fresh sulphides are commonly present at the surface in carbonate rocks. Oxidised copper minerals stain exposures at all the prospects, but available analyses indicate that zinc is the most abundant metal.

Oonagalabi Prospect is in rugged terrain about 17 km southeast of the Harts Range Police Station. Country rock is the Bungentina gneiss (Strangways Metamorphic Complex), consisting of felsic gneiss, amphibolite, mafic granulite, and rare lenses of anthophyllite granofels or spinel-bearing granofels. The prospect occurs in a synform (probably a syncline) containing interlayered garnet-quartz granofels, anthophyllite* (s.l.) granofels with enclaves of spinel-bearing granofels, forsterite (or diopside) marble, amphibolite, and finely laminated garnet-feldspar-quartz gneiss. Secondary copper minerals (chiefly malachite) stain the anthophyllite rocks, and pyrite, sphalerite, and chalcopyrite occur in the marble. Later basic intrusions cut the layered rocks. All the rocks have been metamorphosed to granulite grade, before being hydrated in the upper amphibolite facies. The sequence in the synform is interpreted as the product of repeated volcanic eruptions - each producing a siliceous and chloritic tuff (garnet-quartz granofels), chlorite-rich tuff (anthophyllite

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* Anthophyllite is used as a field description for light-coloured orthorhombic amphiboles. Analyses almost always show these to be gedrite.

granofels), small lenses of carbonate rock (marble), and shaly tuff (laminated granet-feldspar-quartz gneiss). Oonagalabi lacks an iron-silicate horizon although one is present at the most of the other similar deposits in the Strangways Metamorphic Complex.

Between 1970 and 1975, Russgar Minerals NL mapped the deposit, carried out geochemical and geophysical surveys, cut several costeans, and put down percussion holes (Neilsen, 1973). Results were generally below 1% for both copper and zinc, and very low for lead. The analysis of a grab sample of sulphide-bearing forsterite marble is given in Appendix 2.

Edwards Creek Prospect is in a low curved ridge about 18 km south of Bushy Park homestead. The country rocks are felsic gneiss, felsic granulite, mafic granulite, and cordierite quartzite assigned by Shaw & others (in preparation) to the Yambah Granulite (Division I). Numerous shears cut the country rock and the prospect. The prospect is in spinel-bearing rocks and their retrogressed equivalents, forsterite marble, diopside marble, and calc-silicate granofels, which are adjacent to cordierite-garnet-feldspar-quartz granofels. This cordierite-garnet-feldspar-quartz granofels persists as a marker layer over several square kilometres, cropping out round a syncline and anticline, and is probably repeated about 2 km northeast of the prospect. However, the mineralisation itself extends for only about one kilometre in the west limb and the nose of the syncline. Prominent secondary ironstones in the mineralized rocks have been variously interpreted as pseudogossans over calcareous rocks or gossans over sulphide-rich zones. Prograde metamorphism reached granulite grade, but the outcrops are extensively affected by retrogressive metamorphic events.

Secondary copper minerals stain the spinel-bearing rocks and their retrogressed equivalents. Sphalerite, galena, pyrite, and very rare chalcopyrite occur in impure marble. Analyses of surface grab samples are listed in Appendix 2.

The deposit is interpreted as a volcanogenic deposit formed by one main phase of activity in a centre west or northwest of the prospect.

The prospect is within the area covered by a low-level aeromagnetic survey (Tipper, 1969) and an airborne airtrace and magnetic survey (Barringer Geosurveys, 1973).

Coles Hill Prospect (Red Rock Bore prospect) is 3 km north of Red Rock Bore and adjacent to a low quartzite ridge rising about 3 m above a soil-covered plain. The quartzite, which strikes 130° and dips steeply to the northeast, contains small quantities of magnetite and garnet (Tipper, 1969). Layered

biotite-quartz-potash feldspar gneiss, cordierite-quartz granofels, amphibolite, and ?mafic granulite are poorly exposed north of the quartzite ridge. There is no exposure immediately south of the quartzite ridge, but float consisting of marble and anthophyllite rock stained by copper minerals was apprently dug up during drilling operations. The ground to the south of the ridge also contains secondary calcrete, indicating that calcareous bedrock underlies the soil cover.

Drillholes, Coles Hill 1, 2, and 3 put down by the Northern Territory Mines Branch, were angled to pass beneath the quartzite ridge from the south. All three first intersected well-layered gneisses containing variable amounts of quartz, potash feldspar, biotite, garnet, and sillimanite. Rocks whose protoliths were chloritic include spinel-garnet-phlogopite rocks, and various anthophyllite, phlogopite, chlorite, and enstatite-bearing rocks (Fruzzetti, 1969b).

The metamorphic grade reached granulite facies, but considerable later hydration resulted in the formation of chlorite.

Core from the three holes has been lithologically logged, and the mineralised portions split and analysed for copper, lead, zinc, nickel, and silver (Fruzzetti, 1969b). The highese copper value was 0.88%. Zinc values were as high as 9.9% over 0.6 m in Coles Hill 3, and values in excess of 1% occur in all three holes. Lead values were in excess of 2% in all three holes. Nickel values in excess of 1000 ppm persist beyond the zone of high metal values in Coles Hill 2 and 3, where they generally exceeded copper values. Fruzzetti (1969b) quoted values of approximately 0-1.5 ppm (nil to 1.0 dwt/ton) for gold, but did not give detailed analyses.

Planet Metals NL cut five costeans during their tenure of an exploration concession covering the prospect, and carried out geochemical surveys, ground magnetics, and an IP survey (Lyons, 1975). The prospect was included in a low-level BMR aeromagnetic survey (Tipper, 1969).

Harry Creek Prospect is 5.5 km northwest of Harry Bore at the southern edge of the Strangways Range. The prospect is in a low rise dominated by a quartz-ironstone body, though most of the outcrops are either rocks with chlorite protoliths (spinel-bearing rocks or anthophyllite granofels) or calc-silicate rocks.

The country rocks, assigned to the Erontonga metamorphics, are mainly biotite-cordierite-quartz granofels containing small lenses of calc-silicate granofels and amphibolite. The units strike northwest and dip steeply to the northeast. The rocks surrounding the prospect have been interpreted as a mixed

volcanic and volcaniclastic sequence, in which the orebodies represent a distal volcanogenic deposit (see Moore & Woyzbun, in preparation). The metamorphic grade is upper amphibolite transitional to granulite. Hydration and retrogression are apparent in most outcrops.

Leases were first taken up in the late 1940s. Thomson (1950) carried out a geological and ground magnetic survey, and the area was one of a number covered by low-level aeromagnetic surveys by BMR (Tipper, 1969). One diamond drillhole was put down by the Mines Branch of the Northern Territory Administration and a short report on the results of this was compiled by Fruzzetti (1969a) (see below). The area was subsequently included in an exploration concession by Planet Metals NL, who carried out geological, geochemical, and geophysical investigations over the mineralised outcrops and the surrounding soil-covered plain (Lyons, 1975). The Northern Territory Geological Survey has recently reinvestigated the prospect (Moore & Woyzbun, in preparation).

A drillhole at the western end of the prospect, inclined at 49° on a bearing of 225°, total depth 320' (97.6 m), encountered generally low metal values. The best result was an average of 2% zinc over an interval of about 4.1 m (128'-142' down hole depths) (Fruzzetti, 1969a). Lead over this interval averaged 0.28% and copper 0.21%. The high zinc values may correspond to the base of the oxidised zone.

Johannsens Phlogopite Mine (see also Mica) is in hilly country 6 km north-northeast of Gumtree Bore. The country rock is layered felsic granulite, mafic granulite, and garnet-cordierite granofels of the Erontonga metamorphics. Copper, lead, and zinc minerals occur in granofels containing spinel, anthophyllite, orthopyroxene, phlogopite, cordierite, and sapphirine (Hudson & Wilson, 1966); and in calc-silicate rocks ranging from calcite-rich marble with clinohumite to forsterite-rich, calcite-poor granofels (described by Jensen, 1943b, as igneous peridotite). Layered magnetite-quartz rock is associated with the marbles. Fresh sulphides occur in calcite-filled pockets in calcareous rocks on the dump. Secondary copper minerals (and ?smithsonite) occur in weathered spinel-bearing rocks. Both gold and native copper have been found in samples taken from the workings (Stillwell, 1943).

Regional metamorphic grade is granulite, but hydration has produced upper amphibolite facies assemblages.

The lode is interpreted as a volcanogenic deposit. Possible zones of feeder-pipe alteration indicated by zones of cordierite-rich rock crop out in the wall of the bench cut beside the old shaft and about 150-200 m to the west of the main body.

The Mines Branch, Department of the Northern Territory, put down three inclined drillholes in 1970, when the outcrops were being investigated as a base-metal prospect; detailed results are given in Morlock (1971). A drillhole collared in the north-western outcrops was the only hole to encounter ore minerals. Weathering extended down to about 17 m (true depth) and oxidised copper minerals to 20 m true depth. Zinc values in excess of 1% were obtained from three separate intervals, but both copper and lead values were below 0.2%. Nickel, chromium, platinum, and palladium values are all low, confirming that the lode is not an ultrabasic body.

Johnny's Reward Prospect is in a low hill about 1 km north of Southern Cross Bore on the western edge of the Pinnacles Copper District. Exposure near the prospect is poor. The most prominent exposure is of magnetite-quartz rocks stained with secondary copper minerals. Massive anthophyllite rock crops out close to the main lens of magnetite-quartz rock. Magnetite-diopside rock forms a small, very weathered exposure, and was also intersected in a shallow hole drilled in 1973 to obtain fresh wall rock. Hornblende-quartz-plagioclase-orthopyroxene granofels (?metanorite) crops out about 30 m to the northeast of the main exposure of magnetite-quartz rock. A bend containing copper minerals extends south for about 100 m, ending at a pegmatite intruded along a fault; to the north it thins and lenses out. Country rock to the west is garnet-biotite quartz gneiss (with minor orthoclase and rare gahnite) containing small pods of amphibolite, apparently retrogressed from granulite grade. East of the prospect the country rock is marble. The mineralised band lies at the inferred boundary between the lower and upper Cadney metamorphics. The metamorphism probably reached granulite grade, but the assemblages preserved are generally upper amphibolite facies.

Johnnies Reward was taken up as a copper prospect in the late 1960s. Shallow percussion holes were sunk on the prospect by Kenneth McMahon and Partners Pty Ltd, consultants to Magellan Petroleum (NT) Pty Ltd. Two angled diamond drillholes were also put down. One passed through a thin layer equivalent to the rocks exposed at the surface, the other intersected an estimated 30 m of mineralised rocks, with a maximum copper content of 0.5%. Shaw (1970) reported maximum values in the percussion holes of 1.6% copper, 1.7% lead, and 2% zinc. The highest gold value was 3 g/t. The summarised results quoted by Shaw indicate that this prospect has a higher content of copper than of lead or zinc (unlike the other prospects in the Oonagalabi group).

The area was included in a low-level aeromagnetic survey (Tipper, 1969) and detailed ground geophysical surveys (magnetics, S-P, and IP; Haigh, 1971)

carried out by BMR. The ground surveys indicate that the magnetic body (probably consisting of both the magnetite-diopside rock and the magnetite-quartzite) extends no more than 75 m below the surface.

Gum Tree Prospect is about 2.5 km northeast of Gum Tree Bore. Oxidised copper minerals stain a well-layered hematite-magnetite-quartz rock, interpreted as a metamorphosed banded iron formation. Rocks interpreted as having had chloritic protoliths are poorly exposed north of the hematite-magnetite-quartz. In the field they were described as anthophyllite rocks; however the thin section of 75912686B collected from this layer contains cummingtonite surrounding relic grains of orthopyroxene. The mineralised stratum overlies massive feldspar-quartz gneiss, calcareous rocks, and amphibolite to the north, and is overlain conformably by well-layered quartzose and feldspar-quartz gneiss and calc-silicate rock. The hematite-magnetite-quartz rock persists for about 1 km, lensing out at the western end and ending in a soil-covered plain in the east. The mineralised layer and enclosing rocks are assigned to the Ankala gneiss. The deposit is interpreted as a distal volcanogenic deposit. Metamorphic grade is lower amphibolite, retrogressed from granulite.

The prospect was investigated by Planet Metals NL, who are reported to have found a weak zinc geochemical halo around the prospect.

Mineral occurrences similar to the Oonagalabi group

Several prospects may also belong in the Oonagalabi group of prospects, but have not been examined in sufficient detail to allow definite classification in that group.

Gecko Prospect is 2.5 km south-southwest of Bald Hill in Sliding Rock metamorphics. Mineralisation is in several quartz-hematite-magnetite lenses, up to 100 m long and 3 m wide, near the contact between amphibolite and quartzo-feldspathic gneiss. Both country rock and lode are isoclinally folded about a steep northeasterly plunging axis. Central Pacific Minerals NL put down several drillholes, which encountered values for copper up to 0.5% lead to 1.4%, and zinc to 7.8% over narrow widths.

Rankins Copper Prospect is situated about 5.5 km west of Bald Hill. There are two separate mineralised exposures, considered to be at the same stratigraphic level, within a steeply plunging S-shaped fold.

One consists of quartz-magnetite rock, stained by copper minerals, between quartzofeldspathic gneiss and amphibolite; finely disseminated chalcopyrite occurs at a depth of about 1 m. The grade ranges from 15% copper at the

surface to 4% at the bottom of a shaft 4.5 m deep (BMR grab samples). The other mineralised outcrops about 300 m north of the first, consists of coarse galena (possibly also sphalerite) in marble and calc-silicate rock. Several small unmineralised bodies containing magnetite-garnet-chlorite-biotite-quartz assemblages occur elsewhere in the same layer. Country rock west of the mineralised layer is sillimanite-bearing gneiss interlayered with amphibolite, whereas on the east it is sillimanite-bearing gneiss interlayered with quartzofeldspathic gneiss. The country rock is part of the Sliding Rock metamorphics.

An unnamed occurrence south of Woolanga Bore (LAUGHLEN GR 158463) has been reported by Broken Hill Pty Co. (1977) as 'a small (1m x 0.2 m) lens of schistose garnet-pyroxene-magnetite-rock with minor malachite staining adjacent to corundum-feldspar-magnetite rock in sillimanite granulite'.

West of Mount Milton, Broken Hill Pty Co. (1977) reported a small occurrence of malachite and chrysocolla at 5651-851475 (about 3 km west of Mount Milton). Adjacent rock types are described as garnet-hypersthene granulite, cordierite-hypersthene granulite, and cordierite-garnet-phlogopite rock.

At Tom Brauns Prospect about 4-5 km north-northeast of Yambah homestead (GR 5651-846450) a small prospecting pit has been sunk on a lens of calc-silicate rock and rock with an iron-rich chloritic protolith (hypersthene-garnet rock), but the results were apparently discouraging. Chalcopyrite has been recorded in a garnet-diopside rock in the same area (GR 5651-831461) (R.D. Shaw, BMR, personal communication, 1978).

Selins Deposit, a small copper prospect about 4 km south-southwest of Mount Riddock homestead, consists of atacamite, chalcanthite, and melanterite in anthophyllite rock, garnet-hornblende rock, and calc-silicate rock (Jensen 1943a, 1947). These rock types are typical of the Oonagalabi style of deposit. However, the deposit is in the Harts Range Group, which has a sedimentary rather than a volcanogenic origin. Therefore Selins Deposit was probably formed by the processes that generate chlorite-rich rocks and associated ore deposits in sedimentary sequences. (See Sangster & Scott, 1976, for an account of the genesis of Sullivan, Canada).

Youles (undated report) listed another copper deposit in this area, consisting of bands of chalcopyrite and malachite in amphibolie.

Turners Prospect is 11 km southeast of Bald Hill. Traces of gold, malachite, and chalcocite occur in coarse-grained amphibolite over a distance of 25 m. Central Pacific Minerals NL carried out an IP survey, which revealed no anomaly, and trenching revealed only very sparse, disseminated mineralisation. The amphibolite is within the Sliding Rock metamorphics.

Copper deposits localised in late-stage deformed zones

The Pinnacles Copper Mining District has been described in detail by Shaw (1970). Several small copper-bearing lodes occur in the hills north of Pinnacles Bore. The country rocks, part of the upper Cadney metamorphics, consist of calc-silicate rock, marble, metaquartzite, and quartzofeldspathic gneiss, which are intruded by granite (now orthogneiss), norite (now mafic granulite), and pegmatite.

The lodes (except Johnny's Reward) are narrow copper-bearing quartz veins occupying faults, schist zones, and fractures. The veins contain up to 30% copper and traces of gold, silver, and bismuth. The primary copper mineral is chalcopyrite, but most of the ore has come from the secondary zone, where malachite, chalcocite, bornite, and, more rarely, azurite, chrysocolla, and cuprite have been obtained. All the mines on the field have been low-tonnage operations that extracted rich direct-shipping ore from the oxidised zone. An attempt to set up a leaching plant during the early 1970s was unsuccessful. Estimated production to 1966 was about 165 tonnes of ore averaging 12.4% copper.

The Copper Queen Prospect is about 13 km south of Mount Riddock homestead in the Harts Range. Youles (undated report) described it as consisting of chalcocite-bearing lenses about 30 m long and 1.5 m wide extending over a length of about 300 m in epidote-garnet-calcite-tourmaline rock within a metamorphosed calcareous sequence (upper Cadney metamorphics). The overall grade was estimated as about 1% copper, with 10-15% in the richest zone.

A costean has been cut to expose traces of copper minerals about 1 km north of the Copper Queen. Malachite stains sillimanite-biotite-garnet-feldspar-quartz gneiss immediately adjacent to a quartz-epidote vein in mainly calc-silicate country rocks (upper Cadney metamorphics). A costean was also cut to explore traces of copper minerals in calc-silicate rocks about 3 km north of the Copper Queen. Prospectors report other minor copper mineralisation in this district.

At the Camp Hill Mine, malachite and azurite stain two narrow retrogressed zones of amphibolite which cross-cut basic granulite preserved within the West Bore Retrograde Zone southwest of Joker Flat Dam. Pits have been opened up along the strike of the zones. A small quantity of ore was marketed and some dumped at the nearby camp. Several small copper-rich outcrops were located by prospectors southeast of Joker Flat Dam, but the only development has been a few bulldozed costeans and benches cut to expose the lodes.

Virginia Prospect consists of malachite in a gently dipping shear zone cutting garnet-amphibolite about 12 km southeast of Mount Riddock homestead. A costean exposed traces of mineralisation.

At a prospect southwest of Mount Strangways small quantities of oxidised copper minerals have been exposed in shallow pits along the strike of an amphibolite zone cutting massive basic granulite of the Yambah Granulite. This amphibolite zone is considered to be a retrogressive zone, similar to that at the Camp Hill Mine. The copper grade is very low.

Near Mount John (about 4 km east of Alice Springs township) copper minerals occur along a sheared contact between basement and Heavitree Quartzite.

Tommys Gap Prospect, at the southern edge of the Giles Creek Synform, consists of a number of ffrruginous quartz veins stained with copper minerals. The country rocks are metapelites and calc-silicate rock of the Tommys Gap metamorphics. The Atnarpa Igneous Complex crops out nearby. About 7 tonnes of ore were taken from the workings at the eastern end of the prospective area. Geophysical and geochemical sampling revealed minor anomalous zones associated with quartzites, but subsequent diamond drilling located only pyrite, traces of arsenopyrite and gold, and very low copper values (Shaw, 1967).

Copper deposits in calcareous host rocks

Traces of secondary copper minerals occur about 2 km northeast of the Edwards Creek Prospect in a poorly exposed layer of massive diopside-hedenbergite rock. The layer persists for about 50 m, and is thought to be about 100 m stratigraphically above the level of the Edwards Creek Prospect. Two very small (< 1 m maximum dimension) pits have been dug, presumably on the richest part of the copper-bearing outcrop.

At the Paddys Jump-up Copper Occurrence malachite coats slickensided joints in coarse massive diopside-tremolite rock 3 km south of Paddys Jump-up, (1 km west of Arltunga Bore on the Ross River/Arltunga road). The tremolite forms a mass about 650 m wide in sillimanite-biotite-quartz gneiss of the Hillsoak Bore metamorphics.

Feldspar

Both plagioclase and potassium feldspars occur in coarse-grained pegmatites throughout the Arunta Inlier, especially in the mica-producing districts of the Harts Range. Specimen material excepted, these pegmatites have not been exploited for their feldspar content.

Gemstones and specimen material

No systematic exploitation of the gem and specimen material available in the Alice Springs 1:250 000 Sheet area and surrounding areas has been made. However, the region has supplied numerous and valuable specimens held in museums and private collections throughout the world, and some material is sold as part of the tourist trade in Alice Springs. An increasing number of private collectors are visiting the better known localities to obtain rough semiprecious material and specimens.

The Mud Tank Carbonatite has produced considerable quantities of specimen zircon, most being obtained by fossickers from eluvial material. Specimens ranging up to about 2 kg are held in collections. Gem-quality zircon has yielded cut stones of several carats.

Industrial-quality beryl in euhedral crystals is found in some of the pegmatites, but gem-quality material is very rare. (Aquamarine and common beryl from the dump at the Disputed Mine have yielded some cut stones).

The Irindina Gneiss and, to a lesser extent, the Brady Gneiss, both units of the Harts Range Group, are rich in garnet, but the crystals are usually rounded, fractured, and full of inclusions. Stones of acceptable size and clarity are rare.

Though corundum occurs in some units within the Alice Springs 1:250 000 Sheet area, neither specimen nor gem-quality material have been reported. Specimen-quality material, including ruby, is obtained from localities in the Illogwa Creek 1:250 000 Sheet area.

Rock crystal is the most common of the semiprecious quartz varieties. Many of the pegmatites in the Harts Range contain rock crystal of good clarity, which would give stones of many carats. Smoky quartz is less common and other varieties are rare. Terminated crystals of quartz are uncommon. Senior (1972) reported common opal in the Tertiary units near Georgina Gorge, and Rochow (1960) reported common opal from a quarry near the city of Alice Springs.

Gem-quality cordierite has been found in the Illogwa Creek 1:250 000 Sheet area. Coarse-grained cordierite occurs in some units cropping out in the Alice Springs 1:250 000 Sheet area but is generally fractured, full of inclusions, or opalescent.

Large crystals of feldspar have been obtained from some of the pegmatites in the Harts Range. Gem varieties have not been reported, though poor-quality sunstone is sometimes offered for sale in Alice Springs. Poor-quality moonstone in small fragments is sometimes seen in stream sediments.

Joklik (1955a) listed the gangue accessory minerals in many of the mica (muscovite) pegmatites of the Harts Range as including quartz, biotite, tourmaline, garnet, and some ore minerals. Large cleavage fragments of muscovite and unwanted gangue material from the pegmatites were piled up in large dumps, and, since mica mining ceased, many of the larger and better formed crystals have been removed to collections.

Geological specimen material is commonly procurable from coarser-grained metamorphic rocks of the Arunta Inlier. Johannsens Phlogopite Mine has produced good crystals of phlogopite and magnetite, and fragments of olivine, pyroxenes, clinohumite, and sulphide minerals. Large fragments and crystals of sphene, rutile, sapphirine, kornerupine, geikeilite, crystalline hematite, epidote, pectolite, kyanite, staurolite, magnetite, and anthophyllite are amongst the minerals collected by BMR personnel from the Harts and Strangways Ranges.

Secondary copper minerals in most prospects form only thin skins or fill small voids. Nodules of semi-precious malachite, chrysocolla, and azurite have been found in the oxidised zone at the Centralian No. 9 Prospect, Pinnacles Copper District (Shaw, 1970).

Gold

Many small gold lodes at Arltunga and Winnecke in the Arltunga Nappe Complex lie in or close to zones of severe deformation activated during the Alice Springs Orogeny.

The gold lodes consist of quartz and gold-bearing pyrite, with minor chalcopyrite in places, small quantities of calcite, and rarely siderite. Large bodies of white quartz in the country rocks and in the lodes between the pyritic zones carry no gold. The lodes occur in Arunta basement, in deformed and metamorphosed Heavitree Quartzite, and (rarely) in schistose Bitter Springs Formation. Auriferous quartz reefs are transgressive, tend to be relatively small and regular in size and shape, and are clearly associated with late-stage faulting that postdated the main deformation. In the western Winnecke area pyritic gold-bearing quartz veins lie in the axial planes of late-stage kink folds, which fold the thrust-planes. Similarly, in the White Range Gold Field east of Arltunga the most prominent set of gold-bearing veins is subparallel to the axial-plane of the most prominent set of late-stage kink folds.

Lodes north of the zone of intense deformation (e.g., Wheal Mundi and Mount Chapman) are thought to have the same genesis as those in the Heavitree Quartzite. The most probable source of the gold is in the Arunta basement.

Some of the gold occurrences in the Eastern MacDonnell Ranges are spacially associated with the Atnarpa Igneous Complex.

Winnecke Gold District

Numerous small gold lodes were worked in a zone that extends for about 25 km westward from Georgina Gap. Gold occurred in cellular quartz, limonitic quartz, and pyritic quartz. Local prospectors also report that finely disseminated gold occurred in kaolinitic mica schist in at least one mine. Hossfeld (1940) considered that there was considerable secondary enrichment near the surface, as little payable material was obtained below 12 m, the depth of oxidation.

Production records are available only for the period up to 1905, when the total gold production was about 25 kg (Matthews, 1905b). Sometime before Hossfeld's 1940 report a pocket of ore in Garland's Claim produced 8.5 kg of gold. Local tradition says that much of the production, particularly from alluvial workings, was never recorded.

Eastern MacDonnell Ranges

The gold mining areas in the eastern MacDonnell Ranges were administered from Arltunga (now abandoned), where the battery was set up. Most of the gold was obtained from the White Range Field and other lesser groups of workings, but was treated at Arltunga. Production figures and grades are given by Hossfeld (1937c, p. 4).

The White Range lodes occur on the north and northeast of the White Range, a prominent mass of deformed Heavitree Quartzite. Hossfeld (1937b) described the lodes as quartz-pyrite-chalcopyrite bodies filling tension joints and figgures in a large-scale flexure in the quartzite. Near the surface the pyrite was converted to limonite containing free gold, and the chalcopyrite was converted to oxidised copper minerals.

The mines were small open cuts and shafts, which typically followed the quartz veins down a dip of 60° to a depth of about 20 m. Crushings at the Arltunga Battery up to 1913 produced 360 kg of gold from 6800 tonnes of ore. Hossfeld (1937b) also sampled the mine dumps; the results indicated about 17 kg of gold in 7250 tonnes of ore.

Alluvial gold was obtained from the gullies and stream courses draining the White Range, but production was not recorded.

The Wheal Fortune (and lesser adjacent workings) are about 6 km south-east of Claraville homestead, northeast of the White Range. The mines were put down on steeply dipping reefs of quartz, calcite, siderite, and pyrite. These reefs trend a few degrees east of north, parallel to a major fault (Hossfeld 1937c, p. 12). The gold occurred in pyrite. In the Magdale Mine, to the south, a mineralised zone about one metre wide containing little vein quartz was worked. The country rocks are amphibolite, metapelite, and calc-silicate rock assigned to the lower Cadney metamorphics, which have an east-west strike nearly perpendicular to the reefs. None of the mines produced more than about 15 kg of gold, from ore with a grade of about 4.5 g/t. Alluvial gold was obtained from streams and gullies.

The Wipe Out Mine and nearby Jenkins Mine were the two principal workings in an area, about 4 km south of Claraville, containing quartz-calcite-pyrite reefs trending east-northeast. The Wipe Out Mine was on a single reef in schists formed by retrogression of tonalite belonging to the Atnarpa Igneous Complex. Workings consisted of an open cut about 10 m deep. As well as gold, the ore contained traces of copper. At Jenkins Mine, numerous narrow quartz veins in amphibolite were worked. About 6 kg of gold were produced from the area during 1935-1937. From the presence of quartz rubble and calcrete, Hossfeld (1937c, p. 7) suspected other, undiscovered veins existed in the vicinity of Jenkins Mine.

Numerous quartz reefs occur west of the Wipe Out Mine (about 23°24'S, 134°44'E) in the same retorgrade schist zone. The reefs consist of calcite and quartz without pyrite. The ore should have been free milling. Hossfeld (1937c) considered this area might contain the No Name and Standard Mines described by Brown (1903) and Matthews (1905a, b).

A number of narrow quartz-pyrite veins in dark grey meta-igneous gneiss (deformed Atnarpa Igneous Complex) were mined in the area west of Round Hill (23°25'S, 134°45'E). Gold occurred in limonite after pyrite. The veins were located on the walls of 'pseudodykes', which Hossfeld (1937c) interpreted as indurated joints.

Little is known of the Claraville Mine, a small gold mine probably located about 1 km north of Mount Gordon, (23°25'S, 134°43'E). The ore occurred in narrow quartz veins in micaceous schist and sandstone (Cavenagh Metamorphics) (Matthews, 1905a).

Lead and zinc

Most of the occurrences of lead and zinc are also copper-bearing and have been described previously. There are three additional minor occurrences containing mainly lead minerals.

1. About 6 km south of Woolanga Bore, finely disseminated galena occurs in poorly exposed forsterite marble (upper Cadney metamorphics). The surrounding area is underlain by well-layered calc-silicate rocks.

2. The Glankroil Mine (Pb, Ag, Au; also known as the Gander Mine; Hossfeld, 1937a) is about 6.5 km southwest of The Garden homestead. Two lodes occur in parallel shear faults striking north-northeast in Erontonga metamorphics. Only the eastern line of lode was worked; this extends for about 300 m and ranges from a few centimetres to slightly over a metre wide. There are several shafts and open cuts all less than 12 m deep. The ore was galena (with accessory copper carbonates) under a gossaneous quartz cap. The galena carried considerable quantities of silver; analyses ranged up to 5000 grams silver per tonne, but were generally from 700 to 1200 grams per tonne. The copper carbonate does not seem to have been exploited. Brown (1903) regarded the workings as a gold mine, but Hossfeld (1937a) reported only 3 grams gold per tonne as a maximum value. Incomplete records list 47 tonnes of lead ore.

3. About 2 km north of the Arltunga Battery, Youles (1963) reported galena with some bismuthinite and pyrite in narrow discontinuous quartz veins up to 6 m long by 60 cm wide in a shear zone. Shaw and others (1979) report the country rock as retrogressed Atnarpa Igneous Complex, now a biotite-muscovite schist.

Mica

Most of the mica produced from the area was muscovite from pegmatites in the Harts Range, but some phlogopite was produced from Johannsens Phlogopite Mine in the Strangways Range. Detailed descriptions of many of the Harts Range mica workings and their settings are given by Joklik (1955a, b), and Jensen (1947). The mica mining district extends north, northeast, and east of the Alice Springs 1:250 000 Sheet area. The mica pegmatites are undeformed, zoned, very coarse-grained bodies, the majority of which are in the Harts Range Group, though some near Blackfellow Bones Bore are in Strangways Metamorphic Complex. The country rocks are metapelites (Irindina and Brady Gneisses) or, for the deposits near Blackfellow Bones Bore, metamorphosed felsic units and amphibolites of the Strangways Metamorphic Complex. Most pegmatites are discordant; Joklik (1955a) regarded concordant pegmatites as fortuitous.

On orientation and form, Joklik (1955a, pp. 132-137) divided the pegmatites into four groups:

(1) fissure veins occupying fault planes, shears, and steeply dipping major joint planes;

(2) flat-lying joint fillings;

(3) pipe-like pegmatites - irregular steeply plunging bodies;

(4) multiple-controlled pegmatites in which various parts of the body were controlled by different factors.

Most commericial muscovite came from the wall zones of markedly zoned bodies. The proportion of total muscovite production from within the Alice Springs 1:250 000 Sheet area cannot be assessed. Reserves are unknown and most of the mines are in a dangerous condition.

About 3.6 tonnes of phlogopite was taken from the hanging wall of Johannsen's Phlogopite Mine in the early 1940s. The body was exploited from shafts to about 15 m depth. Much of the phlogopite conains inclusions of euhedral magnetite, rendering it unsuitable for industrial use.

Rare-earth minerals

Monazite and other rare earth minerals are accessory minerals in some pegmatites. Ryan (1957) recorded small quantities of samarskite, with tantalite and columbite, in a pegmatite 6 km north-northeast of Mount Johnstone and at the Black Cat Mine 1.5 km northwest of Blackfellow Bones Bore. Xenotime is a common accessory mineral in the Edwards Creek Prospect.

Sillimanite-group minerals

Sillimanite is a widely occurring rock-forming mineral in the Arunta Block, but enrichment to commercial grade is uncommon. Andalusite has been recognised in the southwestern end of the White Range Nappe, but not at commercial grade. Some of the schist zones contain large nodules of kyanite. Lack of concentrations suitable for large-scale mining, together with transport costs, make viable operations unlikely. A review of the aluminium silicate minerals in central Australia and their potential economic significance is given by Kalix, Forman, & Derrick (1970).

Silver

Silver occurs in some of the copper and base metal prospects. The Glankroil mine produced silver-rich lead ore in the 1930s.

Tin, tantalum, and niobium

Traces of cassiterite and tantalite-columbite were reported in pegmatite from 6 km northeast of Mount Johnstone by Ryan (1957). Traces of niobium have been detected in ilmenite from the Edwards Creek Prospect.

Uranium

Uranium exploration has been concentrated on the conglomerate units at the top of the Amadeus Basin sequence, in the south of the Sheet area. Details of the amount and type of mineralisation have not been published.

The Tertiary cover in the Burt Plain and the Garden Basin have been investigated for uranium, but so far without success.

Vermiculite

The Geological Survey of the Northern Territory have recently investigated the potential of the phlogopite-rich rocks of the Mud Tank Carbonatite as a source of vermiculite. Detailed results have not been released. (Moore, in preparation).

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APPENDIX 1
MINERAL DEPOSIT LOCALITIES

The 1:100 000 Sheet area is shown in the Grid References by the following prefixes:

Burt	5651
Lauchlan	5751
Riddoch	5851
Alice Springs	5650
Undoolya	5750
Fergusson Range	5850

*Approximate only

	Latitude	Longitude	Grid Reference	
ARSENIC				
Excelsior Mine	P.D.		5851	
ASBESTOS				
nr Rex Mine	23°03'	134°55'	5851	945514
BERYLLIUM				
Caruso	23°06'	134°57'	5851	944471
Disputed	23°05'	134°56'	5851	937482
nr Joker Flat Dam	23°03'	134°25'	5751	395505
CONSTRUCTION MATERIALS				
nr Mount Gillen	P.D.		5650	?887737
nr Clough Dam	P.D.		5650/5750 ?	
north Alice Springs	23°39'	133°52'	5650	838828
nr the Stuart Highway	23°17'	133°47'	5651	753250
Marbles Bore	23°16'	134°16'	5751	260273
nr Plenty River Highway	23°02'	134°29'	5751	475476
COPPER				
Oonagalabi	23°08'	134°52'	5851	854424
Edwards Creek	23°01'	133°01'	5751	004554
Coles Hill	23°04'	133°46'	5651	740495

	Latitude and Longitude		Grid Reference	
Harry Creek	23°12'	133°57'	8651	934339
Johannsens Phlogopite Mine	23°13'	134°06'	5751	080306
Johnnys Reward	23°08'	134°13'	5751	196405
Gumtree	23°16'	134°05'	5751	054271
Gecko	23°18'	134°09'	5751	092240
Rankins	23°17'	134°07'	5751	084238
nr Woolanga Bore	23°05'	134°10'	5751	158463
W. of Mount Milton	23°04'	132°52'	5651	851475
nr Yambah HS	23°06'	133°51'	5651	831461
Tom Brauns	23°05'	133°51'	5651	831461
Selins	23°05'	134°38'	5851	634494
Turners	23°19'	134°13'	5751	243188
Pinnacles District				
-	23°17'	134°14'	5751	212421
	23°08'	134°14'	5751	218413
	23°08'	134°14'	5751	216414
	23°08'	134°14'	5751	216411
	23°09'	134°14'	5751	217407
	23°09'	134°14'	5751	217405
	23°09'	134°14'	5751	218401
	23°09'	134°15'	5751	224402
	23°09'	134°15'	5751	224401
	23°10'	134°15'	5751	220396
Polly Boy	23°09'	134°15'	5751	223392
	23°10'	134°15'	5751	220388
	23°12'	134°14'	5751	212356
Jills Penny	23°12'	134°13'	5751	201348
Midland	23°12'	134°13'	5751	201348
Copper Queen	23°10'	134°10'	5851	663399
nr Copper Queen	23°09'	134°10'	5851	663400
nr Copper Queen	23°08'	134°09'	5851	420647
Camp Hill	22°03'	134°24'	5751	382516
nr Camp Hill	23°04'	134°25'	5751	
nr Camp Hill	23°05'	134°25'	5751	

	Latitude and Longitude		Grid Reference	
Virginia	23°06'	134°46'	5851	
nr Mount Strangways	23°02'	133°47'	5751	755516
nr Mount John*	23°43'	133°53'	5680	866755
Tommys Gap	23°36'	134°37'	5850	618890
nr Edwards Creek	in Alcoota			
Paddy's Jump-up	23°32'	134°36'	5850	605976
FELDSPAR				
No specific localities				
GEM AND SPECIMEN MATERIAL				
Mud Tank	23°02'	134°16'	5751	244538
Disputed	23°04'	134°56'	5851	933479
Centralian No. 9	23°09'	134°14'	5751	218401
(Pinnacles Copper District)				
GOLD				
Sliding Rock	23°18'	134°13'	5751	212223
Sloans Gully	P.D.		5751	
Turners Prospect	23°21'	134°16'	5751	243188
Coronation	23°20'	134°21'	5751	328191
	23°20'	134°22'	5751	334195
Black Eagle	23°20'	134°23'	5751	349190
	23°20'	134°24'	5751	378186
	23°19'	134°24'	5751	376185
	23°19'	134°24'	5751	378184
	23°18'	134°23'	5751	345219
Wheal Fortune	23°44'	134°24'	5851	796119
Magdale	23°44'	134°48'	5851	794114
Wipe-out	23°44'	134°43'	5851	741123
Jenkins	23°44'	134°45'	5851	761116
Wheal Mundi	23°24'	134°47'	5851	784120
Round Hill	23°25'	134°45'	5851	747101
White Range	23°27'	134°45'	5851	746005
Claraville Reef	23°25'	134°41'	5851	690108

	Latitude and Longitude		Grid Reference	
LEAD AND ZINC				
nr Woolanga Bore	23°05'	134°11'	5751	187471
Glankroil	23°18'	134°22'	5751	348214
nr Arltunga Bore	P.D.		5851	
Kennys Prospect	23°17'	134°22'	5751	346230
MICA				
Black Cat	23°03'	134°28'	5751	456505
Kong	23°03'	134°37'	5851	607513
Blackfellow Bones	24°06'	134°31'	5851	505463
Stones	23°04'	134°50'	5851	829483
Benstead	23°02'	134°52'	5851	856520
Central	23°02'	134°58'	5851	967533
Spotted Tiger	23°03'	134°54'	5851	902496
Oolgarinna	23°05'	134°56'	5851	934477
Caruso	23°06'	134°57'	5851	934471
Billy Hughes	23°05'	134°56'	5881	933479
Disputed	23°04'	134°56'	5851	937482
Spotted Dog	23°05'	134°56'	5851	938478
Kismet	23°03'	134°55'	5851	922494
White Lady	23°09'	134°43'	5851	387708
RARE-EARTH MINERALS				
nr Mount Johnstone	23°05'	134°22'	5751	360475
Black Cat Mine	23°03'	134°28'	5751	456505
SILVER				
Glankroil	23°18'	134°22'	5751	348214
TIN, TANTALUM, AND NIOBIUM				
nr Mount Johnstone	23°05'	134°22'	5751	360475
URANIUM	Location not known			
VERMICULITE				
Mud Tank Carbonatite	23°02'	134°16'	5751	244538

APPENDIX 2. ANALYSES OF GRAB SAMPLES (PPM)

	Sample	Cu	Pb	Zn	Ni	Bi	Mn	Ag	Se	Hg(ppb)
Oonagalabi	73912651	5200	1450	7000	5	<10	10000	5	4	<4
Edwards Creek	75912666D	950	520	45000	5	<10	3210	<1	4	<4
	75912671	1310	1900	2000	5	<10	7200	1	2	<4
	75912672A	300	47000	27000	5	<10	3280	16	4	25
	75912672B	60	370	6500	5	<10	2620	<1	<2	<4
	75923673	6100	3910	4850	12	<10	910	1	2	<4
	76912747	4200	800	100	5	1670	110	7	19	<4
	76912748	4750	2180	1400	8	35	1570	1	<2	<4
	76912749	36500	560	23500	38	<10	350	2	100	<4

All analyses are from AMDEL Report AN 3566/76.