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## MINERAL DEPOSITS IN CENTRAL AUSTRALIA

by

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# MINERAL DEPOSITS IN CENTRAL AUSTRALIA


## SUMMARY

Four mining prospects in Central Australia are described. It is concluded that the lead deposit in Cambrian carbonate sediments at Box Hole Bore is probably syngenetic, though some mobilisation and redistribution may have occurred. No over-all estimate of the grade of the deposit can be made due to the leaching of surface material and to the lack of significant drill hole intersections.

The copper and lead deposits in Cambrian sedimentary rocks in the Waterhouse Range area are thought also to be syngenetic. The mineralisation is widespread but of very low grade.

Low prices have caused a halt in the mining of mica from Archaeozoic pegmatites in the Harts Range-Plenty River area.

The copper and lead deposits in the Precambrian Arunta Complex of the Jervois Range are of hydrothermal origin, possibly related to the intrusion of nearby granite. Oxidised ore extends to a depth of about 90 feet and crops out intermittently over a strike length of 7 miles. Primary ore is mostly of low, but apparently consistent, grade.


## INTRODUCTION

This article has been prepared for inclusion in the second edition of the "Geology of Australian Ore Deposits", to be published by the Eighth Commonwealth Mining and Metallurgical Congress, 1965.

Very little mining has been done in Central Australia, since 1950 but detailed investigations of several mineral prospects have been made by the Bureau of Mineral Resources and by private companies. Three of these (Jervois Range copper-lead deposit, Box Hole lead deposit, and Waterhouse Range copper-lead deposit) together with the Harts Range mica deposits, are discussed here in relation to their geological setting. Mining ceased on the Harts Range mica field in 1960.

## GEOLOGY

Rocks which occur in Central Australia can be arranged in three broad groups, based on age and lithology. These groups are:

(a) Permian to Recent Sediments, which are mostly flat lying or with low dips, but generally compacted.

(b) Upper Proterozoic to Upper Palaeozoic sedimentary rocks, which have been gently to moderately folded and faulted.

(c) Undifferentiated Precambrian rocks, including gneiss, schist, granite, and basic igneous intrusives.

### PERMIAN TO RECENT

Quaternary and Pleistocene deposits (sand, alluvium, soil and evaporites) cover a large area of Central Australia. Salt has been mined on a very small scale from some of the larger salt lakes, but no other mineral deposits are known.

Tertiary sediments (mainly sandy clay), which have low dips, generally less than 5 degrees, occur over a wide area.

Their total extent is not known because there are very few exposures, and most of the information available at present has come from drilling operations in the vicinity of Alice Springs. Thin beds of lignite are present in the sequence, but it is unlikely that these will be of economic importance.

Permian and Mesozoic rocks (sandstone, shale, siltstone) occur extensively in the southern part of Central Australia. They have not been folded and generally have dips of less than 5 degrees. Ochre deposits in Rumbalara Shale (Cretaceous) were mined on a small scale for a short period, but no other mineral deposits are known.

UPPER PROTEROZOIC TO UPPER PALAEOZOIC (Quinlan 1962, Prichard and Quinlan 1962)

A thick sequence of sedimentary rocks of Upper Proterozoic to Upper Palaeozoic age has been preserved in three structural basins. The sequence is continuous from Upper Proterozoic to Middle Ordovician; Upper Devonian sandstone rests unconformably on the Lower Palaeozoic rocks. Sandstone, quartz greywacke and siltstone are dominant, but important calcareous formations occur in the Upper Proterozoic, Middle to Upper Cambrian and Lower Ordovician. The rocks have been moderately folded, but have not been subjected to regional metamorphism or igneous intrusions. Minerals have been found in several formations in the sequence (listed below) but no deposits of commercial importance have been located.

| Formation | Age | Mineralisation |
|---|---|---|
| Bitter Springs Limestone | Upper Proterozoic | Pyrite, Pyrolusite, Salt, Gypsum |
| Jay Creek Limestone | Middle Cambrian | Galena |
| Goyder Sandstone | Upper Cambrian | Chalcopyrite, Azurite, Malachite |
| Arrinthrunga Formation (dolomite and limestone) | Upper Cambrian | Galena, Cerussite |
| Stairway Sandstone | Middle Ordovician | Phosphate |

Two mineral prospects in this group of rocks have been examined in some detail. They are the Box Hole lead deposit and the Waterhouse Range copper-lead deposit.

### Lead deposit at Box Hole Bore

(Phillips 1960, Woolley and Rochow 1961)

#### Introduction

This deposit consists of galena-bearing lenses in silicified Cambrian carbonate sediments and is situated 230 miles by road north-east of Alice Springs (see Fig.1). Limited mining of surface outcrops was begun in the early part of 1960 by a prospector, with the assistance of several natives. In the same year, some investigation drilling was carried out by a company which took out an option over the lease. However, the drilling results were disappointing and the option was relinquished.

#### General Geology

Lead minerals have been found along both flanks, but mainly along the southern portion of the eastern flank of a gently dipping synclinal structure in cherts, silicified algal limestone, intraformational breccias, and silicified dolomite of the Upper Cambrian Arringhrunga Formation. The syncline is closed at the northern end and can be traced southward for about 4 miles.

The southern part of the syncline is bounded on the east by a fault, dying out to the north, which truncates the mineralised zone (east block down). A similar but less pronounced structure along the western flank has downthrown the western block relative to the syncline.

The minerals are in the form of abundant disseminated cubes of galena ranging from $\frac{1}{8}$ inch to 1 inch in size, with some irregular crystal aggregates up to 3 inches long, and occur within lenses of silicified carbonate rocks of the following types:

(a) Massive: Mostly random distribution of galena in rock which has no visible internal structure.

(b) Thinly Laminated: Galena commonly concentrated along lamination planes.

(c) Intraformational breccia: Distribution apparently random, with some cubes of galena transgressing the boundaries of the breccia fragments.

(d) Algal: Random distribution of galena.

Silicification generally prevents the differentiation of dolomite and limestone in the field. Minor amounts of barite and sphalerite are commonly associated with the galena.

The main mineralised lenses vary greatly in thickness but are confined to one stratigraphic interval over the whole length of outcrop on the eastern flank. Near the centre of this belt the mineralisation pinches out completely, thus forming two main shoots which locally break up into several lenses occupying a stratigraphic interval of 10 to 15 feet. The individual lenses seldom attain 2 feet in thickness. Drilling near the synclinal axis indicated pinching out of the mineralisation down dip.

The lead occurrence in the area is thought to be syngenetic, but a certain amount of mobilisation and redistribution may have taken place.

No over-all estimate of the grade of the deposit can be made as the surface material is leached and no significant intersections of ore were encountered in the drill holes.

## Copper and Lead Deposits of the Waterhouse Range

(Ivanac 1953, Mackay 1955)

These deposits are 40 miles south-west of Alice Springs (Fig.1), and were first examined by the Resident Geologist (Northern Territory Administration) in 1953. In 1954, geological mapping, geo-chemical prospecting, and diamond drilling of the deposits were carried out by the National Lead Company.

The minerals occur within the sedimentary rocks of Cambrian age which are exposed in the Waterhouse Range Anticline. This structure is an elongated dome, about 25 miles long, which strikes east. The core of the anticline has been eroded, leaving a flat low-lying central area surrounded by escarpments formed by the more resistant Ordovician and younger rocks. The sedimentary succession exposed in the structure ranges from Lower Cambrian to Upper Palaeozoic, but known mineralisation is restricted to two formations of Cambrian age. These are:

(1) The Jay Creek Limestone, of Middle to early Upper Cambrian age. It consists of biostromal (algal) and oolitic limestone, with minor shale beds. Thickness in this area is approximately 1000 feet.

(2) The Goyder Formation, which is Upper Cambrian and conformably overlies the Jay Creek Limestone. The formation is quartz greywacke, with thin interbedded quartz sandstone in the upper half. Glauconitic beds are also present. The formation was deposited under shallow water marine conditions, and is approximately 1000 feet thick.

limestones in the lower half and inter-bedded

Copper minerals are generally restricted to the Goyder Formation. At the surface, a process of lateritisation has resulted in the formation of small gossanous bodies, whose width decreases rapidly with depth. Copper mineralisation at the surface generally occurs as malachite-azurite stainings in these bodies. Small parcels of hand picked ore, assaying up to 20% copper, have been won by prospectors from this secondary ore. Drilling of the prospect, on the northern flank of the Waterhouse anticline, where the beds dip at 45 degrees to the north, failed to intersect significant concentrations of copper and no assay results higher than 0.5% copper wer obtained. These very low values indicate that surface enrichment, rather than surface impoverishment, has taken place. This is in contrast to the ore bodies of the Rhodesian Copper Belt to which the Waterhouse Range deposits have been compared in type (Ivanac 1953).

It appears therefore that small amounts of copper sulphide minerals are distributed unevenly through the formation, but that there are no major concentrations of ore grade.

Lead minerals occur mainly in the Jay Creek Limestone. Assays up to 0.1% lead have been obtained in drill cores, but no mineralisation has been found at the surface.

The rocks which are host to these deposits are part of the sedimentary sequence of the Amadeus Basin. Although tectonic activity has occurred since their deposition, no igneous activity younger than Precambrian is known in the area. This, together with the widespread dissemination of very low grade mineralisation, indicates that the deposits are probably of syngenetic origin.

UNDIFFERENTIATED PRECAMBRIAN

Large areas of Central Australia are underlain by rocks of undifferentiated Precambrian age. These are mainly quartz-feldspar-mica gneiss and schist, and probably originated as sedimentary rocks with some volcanic interbeds (Quinlan 1962).

After folding and metamorphism, they were intruded by granite and by basic igneous rocks. Intrusions of pegmatite are widespread, and in the Harts Range-Plenty River area many of these carry commercial quantities of muscovite, with various accessory minerals including biotite, tourmaline, garnet, beryl and apatite. Minor quantities of cassiterite are associated with pegmatites in the Anningie area (approximately 150 miles north-west of Alice Springs). Quartz reefs, commonly developed along fault lines, are very prominent in some areas; their best development is on Jinka Plain, north-east of the Plenty River mica field. Open boxworks are present in some of the reefs but no other evidence of mineralisation has been found in them.

Practically all mineral production from Central Australia to date has come from Precambrian rocks. The two most important occurrences are the Harts Range-Plenty River mica field, and the Jervois Range copper-lead deposit, which are described below.

## Mica deposits of the Harts Range - Plenty River Area

(Joklik 1955, Woolley, 1959, Rochow, 1962)

### Introduction

These deposits lie within an area of 5,000 square miles, centred about 120 miles north-east of Alice Springs (see Fig.1). Production of mica began in 1892, and to 1960 when mining ceased, the area had yielded approximately 1000 tons of mica. Relatively low prices resulted in a rapid decline in activity after 1954, and production ceased in 1960 when the Commonwealth Mica Pool stopped buying mica. Production for the period 1954 - 1960 is as follows:

| | |
|---|---|
| 1954 | 85,570 lbs. |
| 1955/56 | 49,615 " |
| 1956/57 | 29,900 " |
| 1957/58 | 33,044 " |
| 1958/59 | 33,955 " |
| 1959/60 | 15,170 " |

Most of this production came from established mines, and no new mines of any significance were opened up during this period.

### Geology

The mica was won from pegmatites which "occur in rocks of the Harts Range Group, which is a complex of metamorphosed igneous and sedimentary rocks probably of the Archaeozoic age" (Joklik, 1955). In the Harts Range area the majority of mica mines are within the Irindina Gneiss, which is a garnet-mica-feldspar rock. The host rock in the Plenty River area is similar to the Irindina Gneiss, but its relationship to the Irindina Gneiss is not known.

The pegmatites range from a few inches to 150 feet thick, and from a few feet to many hundreds of feet long. Quartz and feldspar make up the total rock in many cases, but many contain abundant muscovite and biotite. Mining activities have been confined to those pegmatites which contain concentrations of muscovite. Tourmaline is also abundant, and crystals up to two feet long occur; other minor accessory minerals are beryl, garnet and apatite.

Most of the pegmatites are discordent, and many of them are zoned and have a quartz core. These features are regarded as being favourable for the presence of commercial quantities of muscovite (Joklik 1955).

## Copper and Lead Deposits of the Jervois Range

(Robertson 1959, Hughes and Ward 1962)

### Introduction

These deposits are 230 road miles east-north-east of Alice Springs, at latitude 22 degrees 40 minutes south and longitude 136 degrees 15 minutes east approximately (Fig.1). Although they have been known since 1929, their isolation and the general low level of development of the surrounding area prevented serious investigations until the last few years. A few small parcels of hand picked ore have been carted from the deposits, particularly during the period 1948 to 1956, when 2840 tons, averaging 14% copper, were sent to Mt. Isa.

In 1957, the leaseholder constructed a leaching plant designed to produce 1 ton of copper sulphate per day, from 9 tons of secondary ore. This was unsuccessful, due mainly to dust contamination in the open evaporation tanks, and only a few tons of copper sulphate were produced. Subsequent attempts to treat the secondary ore on the site have met with only limited success, and little significant production has been achieved.

Detailed investigation of the deposits was undertaken by the Bureau of Mineral Resources in 1958 (Robertson, 1959) and New Consolidated Goldfields (Aust.) Pty. Ltd. in 1961-1962 (Hughes and Ward 1962).

## Geology

The area in which the deposits occur is underlain by steeply dipping schist, skarn and calcareous silicate rock of the Precambrian Arunta Complex. To the West, these are overlain by the gently dipping Upper Proterozoic sandstone and siltstone which form the Jervois Range.

The copper and lead deposits occur along the steeply dipping flanks of a north plunging syncline and are localised in lenses of skarn and in shear zones between competent and incompetent beds. The lead mineralisation is confined to the skarn lenses, with rich shoots occurring near the contacts with barren schists. Some copper occurs with the lead in the mineralised skarns, and this mineralisation is regarded as being of metasomatic origin. This type of deposit occurs at the northern end of the field.

The copper deposits in the southern portion of the field have a late stage hydrothermal origin, and were introduced along permeable fault lines and shears.

The mineralisation of the field is probably related to the intrusion of the granite which crops out to the south, south-west and east of the southern-most extension of the deposits.

The oxidised ore, which has provided the entire production from the field to date, extends to about 90 feet below the surface, and occurs intermittently over a strike length of seven miles. It changes gradually to primary ore from about 50 feet below the surface and no zone of secondary enrichment is present. Primary ore is mostly of low grade, but there are some small rich shoots and the overall grade does not appear to decrease at depth.

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