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EL 856

BLINMAN

PROGRESS REPORT TO LICENCE EXPIRY/SURRENDER FOR THE PERIOD 20/7/1981 TO 19/1/1982

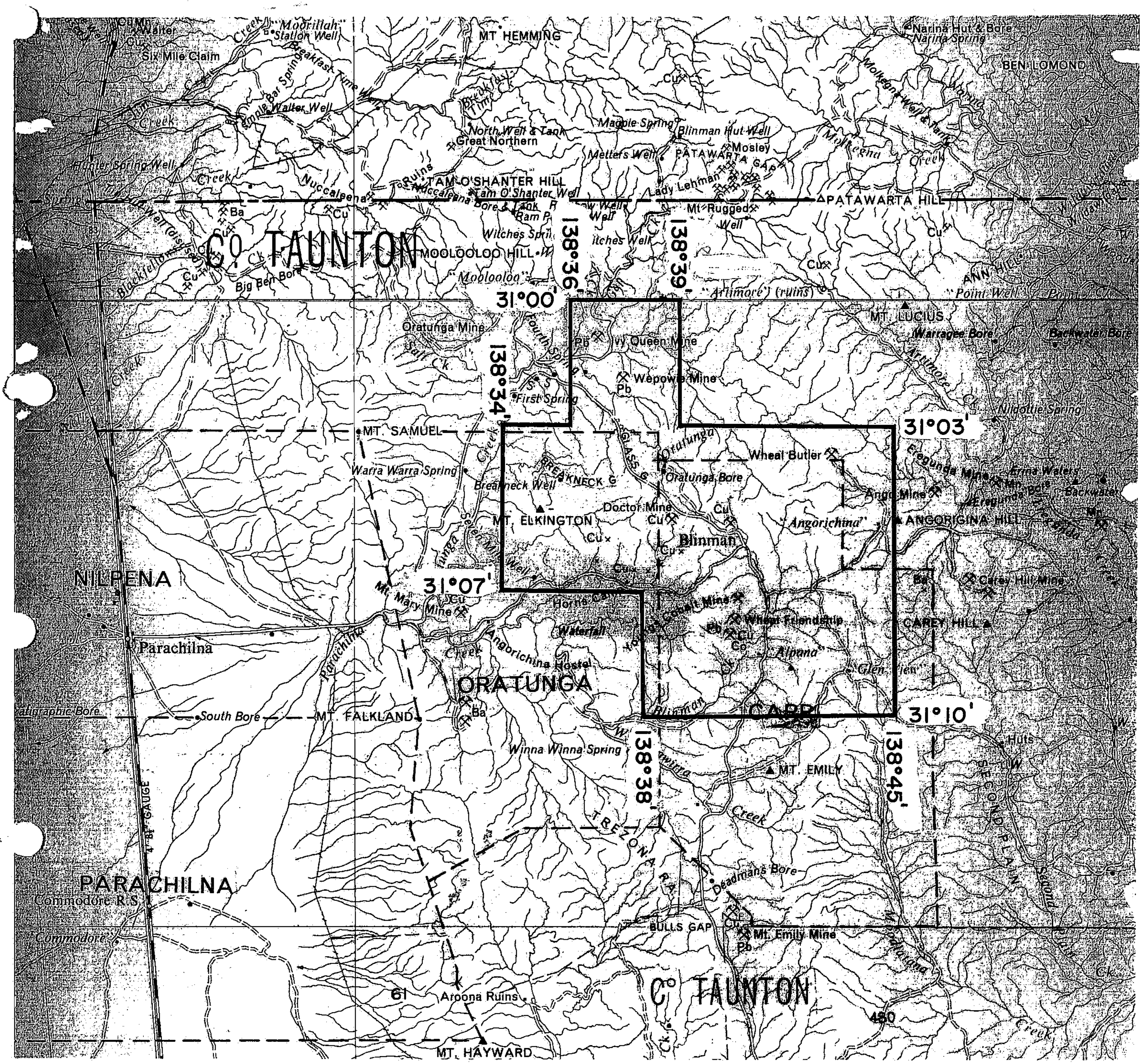
Submitted by
Key Resources Pty Ltd
1981

Enquiries: Customer Services Branch
Minerals and Energy Resources
7th Floor
101 Grenfell Street, Adelaide 5000

Telephone: (08) 8463 3000
Facsimile: (08) 8204 1880

Government of South Australia
Primary Industries and Resources SA

SCHEDULE A √



SCALE 1:250,000

KILOMETRES 5 0 5 10 15 20 25 KILOMETRES

APPLICANT: KEY RESOURCES PTY. LIMITED

EXPIRED

DM: 691/80 AREA: 217 square kilometres

1:250 000 PLANS: PARACHILNA

LOCALITY: BLINMAN AREA

DATE GRANTED: 20·7·81 DATE EXPIRED: 19·1·82

EL No: 856

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TENEMENT: Exploration Licence 856

TENEMENT HOLDER: Key Resources Pty. Ltd.

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GEOLOGICAL APPRAISAL

EXPLORATION LICENCE NO. 856

BLINMAN DOME.

Key Resources Pty Limited
Suite 504, 203 New South Head Road,
Edgecliff, N.S.W. 2027.

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INTRODUCTION.

After a study of possible exploration areas for precious and base metals in South Australia, two Applications for Exploration Licences were lodged by Key Resources Pty. Limited. One of these included an area surrounding the Blinman and Oratunga Diapirs. Exploration Licence No. 856 was granted on 20th July, 1981 for six months.

There are a number of old mines and prospects in this E.L. including the Ivy Queen (copper, lead), Wepowie (lead), Blinman (copper, lead, barytes), Youngs (cobalt, copper, nickel, silver), Cobalt (cobalt, copper), Wheal Friendship (copper).

LOCATION AND TITLE DESCRIPTION.

The Exploration Licence is situated in the North Flinders Ranges and is centred 25 km ENE from Parachilna and east of Lake Torrens and west of Lake Frome. (Fig. 1). It has an area of 217 sq. kms, and an exploration commitment for the first six months of Aus.$10,000.

The Exploration Licence No. 856 is located on the Parachilna 1:250,000 series SH 54-13 and the Blinman 1:50,000 series 6635.

Hawker lies at the northern end of the sealed section of National Route 83 which continues on the north through Parachilna. Northerly from Hawker a main road goes through the Flinders Ranges via Wilpena Pound to Blinman.

TOPOGRAPHY.

The Blinman area is 610 m above sea level close to the main divide between the Lake Torrens and Lake Frome drainage basins. Upthrust Sturtian sedimentary rocks form a roughly elliptical-shaped ridge around the diapir where a more subdued relief is characterised by low undulating hills alternating with low bluffs or ridges according to the nature of the brecciated rocks. The

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gentle undulating hills usually consist of diapiric breccia, while steep narrow ridges often consist of siltstone or silty quartzite. Many of the dolerites form craggy tumuli.

The Diapir is drained by several southward and westward flowing creeks which are dry for most of the year. Due to relatively recent uplift of the Flinders Ranges, a mature topography has been subjected to rejuvenation, and the creeks are incised, with numerous short deeply cut tributaries.

CLIMATE.

The climate is semi-arid and most of the region receives less than 25 cm rainfall per annum on the average. Maximum and minimum temperatures on average for January and July are respectively 15°C and 4°C.

VEGETATION.

The area is either bare of vegetation or covered with mallee shrub or dwarf pines.

GEOLOGY.

The Blinman Diapir is one of several large piercement structures which intruded Adelaidean and Cambrian sequences in the Flinders Ranges. Approximately 180 diapirs define a 500 km belt coincident with the Flinders - Mount Lofty Ranges.

Primary control of diapir distribution in the trough can be related to fracture patterns in the pre-source-bed rocks.

Outcrop of diapiric material is distinctive over a wide area and may be accentuated by patterns of vegetation. Weathering is deep and intense but cap rock or solution megabreccias are absent.

Breccia zones, considered by Dalgarno & Johnson (1965) to be diapiric structures, are common in the Flinders Ranges. Although the structures have affinities with salt doming, evaporites are not recognised in the clastic breccia, which often appears to be composed of the lowest recognised Adelaidean sediments (Callana Beds). Tucker and Brown, 1970. Plugs, dykes and blocks of dolerite and other basic igneous rocks are common in the diapiric breccia.

Thomson (1970) supposed that the diapirs lie over the deepest part of the geosyncline and showed that they follow a strong northerly trend. The diapirs appear to be influenced by the N-NW-trending and NE-trending surface faults evident in the area. Dalgarno and Johnson (1965) suggested that the diapirs lie near basement faults.

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The diapir is made up of a polymict breccia with a carbonate matrix (calcite, minor dolomite, quartz, muscovite and traces of anhydrite) and includes several large blocks up to 3 km in length. The dominant clast lithology is quartzite and siltstone frequently ripple marked and with salt casts. Other stratigraphically significant raft lithologies, identifying the dismembered sequence as coming from the Callana Beds low in the stratigraphic column, are basalt (Wooltana Volcanics) and granite and granite gneiss plucked from an underlying crystalline basement. The diapir was rising at the time of sedimentation, as evidenced by detritus in the Sturtian rim sediments. A small gravity low coincides with the structure (Mumme, 1961). The South Australia Department of Mines and Energy is currently doing additional gravity work across this area. Anomalies are present just east of Doctors Copper Mine, Alpana area and around the Blinman Mine area. A grid of 24 lines, 100 m apart and 14 stations and 50 m intervals is currently under use for a more intensive survey of the negative anomaly east of Doctors Copper Mine.

The majority breccia body components are similar to rocks of the Willouran Series occurring elsewhere in stratigraphic sequence. The breccias are dismembered elements of these rocks which had been forcibly intruded into the overlying sediments as piercement or diapiric structures.

A plot of known copper, silver, lead and gold occurrences clearly shows a close association of mineralisation with Willouran rocks and in particular with diapiric structures. (Coates, 1964).

The Blinman Dome consists of a central core made up essentially of a polymict breccia but also containing many large dismembered blocks of various rock types. The core complex is rimmed by sediments in stratigraphic sequence.

Mumme (1961), who carried out gravity and magnetic traverses over the Blinman Dome, concluded that a small gravity low was associated with the core of the structure. There was however, no significant regional magnetic anomaly.

Mumme concluded that the gravity results show that the rocks of the core are, as a whole, less dense than those of the surrounding sedimentary sequence and supported the idea of a diapiric structure. The absence of a significant regional magnetic anomaly disproved the presence of the large concealed basic igneous body within the core.

STRATIGRAPHY OF THE RIM ROCKS. (modified from Coates, 1964).

Sturtian Series.

The sedimentary sequence is referred to the Sturtian Series but Marinoan equivalents may be included in the upper part of the section. This subdivision

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depends on the recognition of the Brighton Limestone, the defined boundary between these units, within the sequence.

Laminated Silty Shales.

This unit is the lowest formation exposed around the margins of the core complex. It consists essentially of a monotonous sequence of dark laminated silty shales. The lowest beds of the silty shale sequence are finely laminated, dark (carbonaceous?) shales. Limonite staining occurs in some laminations, probably as an alteration product of former sulphide. Thinly bedded, yellow weathering dolomites occur within this unit. The finely laminated shales have a maximum thickness of 9.2 m and have been observed in contact with the core complex on the southern side of the diapir, east of Mount Elkington and at a locality 0.8 km west of Oratunga H.S. Local pockets of gritty and pebbly greywacke, occurring between these shales and the core complex are remnants of the lower glacial sequence.

Lenticular sedimentary breccias are interbedded with shale in the lower part of the sequence and may be seen in a tributary of the Parachilna Creek. These breccias contain angular fragments of dolomite, siltstones, basic rocks and diapiric breccia identical with rock types occurring in the underlying core complex. Strong crumpling and slumping of the enclosing silty shales has occurred on the southern side of this block indicating transport from the north. The matrix of the sedimentary breccias is a massive fine grained siltstone or silty mudstone similar in appearance and composition to mud slurries associated with turbidity or density current. The breccias are slump breccias and are caused by positive movements of the Blinman Dome during sedimentation. Thick beds of sedimentary breccias occur in contact with the core complex at the above mentioned locality but become thinner and recur less frequently away from the core complex.

The laminated silty shale formation includes a siltstone-greywacke member which forms a prominent topographic high around the structure. Mount Elkington is situated on this unit. The proportion of greywacke in the silty shale formation is noticeably greater on the southern side of the diapir.

The laminated silty shales become increasingly calcareous towards the top of the sequence eventually passing to grey limestones. Some beds of this limestone unit contain abundant oolites and collenias while some are gritty, containing grains of quartz and red jasper.

Well Bedded Dolomites.

This unit consists of repetitions of thin yellow and brown weathering dolomites, with interbedded green dolomitic silty shales and dolomitic greywackes.

The thickness of this sequence varies considerably, locally interfingering with the silty shale formation. In the southwest of the mapped area it occurs as two separate beds while northeast of Blinman, it lenses out completely over a distance of 2.4 kms.

To the east of Blinman, a massive brown weathering dolomite occurs at the base of this unit. This dolomite has an irregular contact with the underlying silty shales and shows a slight angular discordance in strike with these beds. Significantly these structures coincide with the axis of upturning of the beds at this point. This is a local unconformity caused by uplift of the Blinman Dome with consequent erosion of the underlying beds prior to the deposition of the dolomites. The non-deposition of the dolomites to the northeast of Blinman may also be attributable to this upwarp.

STRATIGRAPHY OF THE CORE COMPLEX.

The elements occurring within the core complex consist of dismembered fragments of a great variety of rock types, some of which can be matched with units of the Willouran Series occurring elsewhere in stratigraphic sequence. Minor remnants of sediments comparable with members of the Sturtian Series and granitic rocks similar to the older granite suite of the Mount Painter area also occur. However, no rock types diagnostic of the Torrensian Series have been recognized in the core complex. The remnant blocks show a great variation in size, the largest measuring 3.2 kms by 1.6 kms.

Sturtian Series.

Laminated Silty Shales.

This unit which resembles the laminated silty shales of the rim rocks outcrops only as a few remnants. The largest of these occurs 3.2 kms east of Mount Elkington as a large synclinal remnant, and consists of well laminated buff silty shales underlying quartzites and chert breccias. Other outcrops of this unit consist of dark laminated siltstones and slates, sometimes containing interbedded limestones and quartzites.

Massive Boulder Tillite.

Only two small remnants of this rock type are known to outcrop within the core complex, namely 2.8 kms north-northwest of Blinman and 1.2 kms west-northwest of Alpana H.S. At the first locality, the tillite consists of abundant boulders of quartzite, granite and gneissic rocks set in a green schistose greywacke matrix. Minor interbedded siltstones also occur. It resembles the massive boulder tillite of lower glacial sequence occurring in sequence in the nearby Oraparinna Dome.

Probable Equivalents of the Willouran Series.

The Willouran age for these units is based on lithological similarity to rock types of this series occurring elsewhere in stratigraphic sequence. The melaphyres and their associated sediments are similar in appearance and identical in chemical and mineralogical composition to the volcanics occurring at Wooltana. In addition pseudomorphs after halite, which are a feature of the Willouran as developed in the Willouran Ranges, occur commonly in some sediments of the core complex at Blinman.

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Grey Siltstones.

This unit is the most common rock type occurring as remnants in the core complex. It is often interbedded with red micaceous siltstones and heavy mineral laminated quartzites.

The grey siltstones are characterised by their colour, an abundance of pseudo-morphed halite (recognizable by its cubic form and "Hopper" structure) and a "wispy" heavy mineral laminated, aqueous cross bedding.

These sediments are locally irregularly dolomitised.

Red Micaceous Siltstones.

These siltstones occur most abundantly as remnants in the western part of the core complex. They are generally well bedded and are characterised by their red colour and flakes of mica which occur along the bedding plane. Pseudo-morphs after halite occur only rarely.

Massive Greywacke and Siltstones.

Only a few remnants of these rock types are known to outcrop in the core complex. They are usually green in colour with bedding absent or only poorly developed.

Laminated Ferruginous and Siliceous Ribbon Slates and Siltstones.

These rocks are characterised by broad rhythmic laminations. They are often pyritic and iron stained in weathered outcrop. Some rock types are siliceous, resembling banded cherts, while some are dolomitic.

Green Laminated Ferruginous Phyllite.

Outcrops of this rock type occur only in the southeast of the core complex where they overlie heavy mineral laminated, conglomeratic quartzites. They are characteristically olive green in colour, phyllitic and ferruginous in outcrop.

Blue Slates and Siltstones.

The unit consists of laminated slates and siltstones, generally dark blue or blue grey in colour. Some remnants contain thin, interbedded sandstones and dolomites.

Purple Shales, Siltstones and Slates.

These rock types are often laminated but may be massive. They sometimes contain granules of red jasper and occasionally thin interbeds of sandstones and dolomites. These dolomites closely resemble those found at the Blinman Mine and are also copper bearing. The purple shales, siltstones and slates may be tuffaceous in part.

Well Bedded Dark Grey Siltstones and Slates.

This unit forms a number of scattered remnants, the largest occurring at the Blinman Mine. The siltstones and slates are well bedded, dark grey in colour and are possibly carbonaceous. In all known outcrops they are associated with a fine grained dense dolomite and dolomitic siltstones, (the host rocks of the Blinman Mine). These carbonate rocks are therefore referred to as the mine type dolomite. The mine type dolomite is also well bedded, weathers to a buff or yellow colour, is usually siliceous and sometimes ferruginous in outcrop.

In all outcrops the mine type dolomite carries copper mineralisation which occurs as primary sulphides and rich secondary carbonates and sulphides. The associated siltstones and slates are only weakly mineralised. In addition to the Blinman Mine occurrence, twelve remnants of the mine type dolomite have been located, in most cases near the margin of the core complex. The largest of these remnants occurs east of Breakneck Gorge, west of the Wheal Friendship and at two localities on the northern side of the Blinman - Parachilna road approximately 4 kms southwest of Blinman.

Dolomites undifferentiated.

They include massive and bedded types some of which are undoubtedly of sedimentary origin: however the dolomites occurring as rims to some remnants (for example west of the Wheal Friendship) and at the contact of the core complex with the rim rocks (between Mount Elkington and Breakneck Gorge) are considered to have originated in a different way. The latter dolomites contain breccia fragments of various rocks, comparable with types occurring in the diapiric carbonate breccia. The rock fragments have a parallel orientation to the "bedding" of the dolomites. The dolomites are considered to have originated as a result of metamorphic differentiation of dolomitic material from the carbonate breccia. At the same time rock fragments occurring in this breccia were incorporated in the dolomite and aligned parallel to the "bedding". The apparent bedding is a flow structure. The differentiation of the dolomitic material and the directional fabrics are considered to have originated as a result of stresses set up by differential movements during the emplacement of the diapir.

Calc - Silicate Metasediments.

Only five small remnants of these metamorphic rocks outcrop in the core complex. One of these occurring adjacent to the Moolooloo road, 1.6 kms northwest of Blinman, is well bedded and is composed of approximately 65 percent calcic garnet 20 percent diopside, 10 percent quartz and minor magnetize. Copper mineralisation is associated with this particular occurrence.

The calc-silicate metasediments probably represent metamorphosed dolomitic sediments.

Quartzites and Sandstones Undifferentiated.

They include both massive and well bedded sandstones and quartzites and include some fine grained types.

Well Bedded Heavy Mineral Laminated, Pitted Quartzites.

This unit which comprises several large remnants, is restricted in outcrop to the eastern and southeastern section of the core complex.

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It comprises well bedded, heavy mineral laminated quartzites which often display small scale, aqueous cross bedding. Some quartzites contain gritty and pebbly developments, the elements consisting largely of quartz and red jasper. Ripple marks are a feature of this unit often with rare pseudomorphs after halite occupying the troughs of the ripples. Rectangular pitting which is a feature of these sediments may indicate the former presence of anhydrite.

Melaphyres (altered basalts) and Associated Sediments.

The melaphyres are represented by fine grained amygdaloidal and non-amygdaloidal rock types. They are recognized as volcanics because of their amygdaloidal and sometimes scoriaceous structure, together with their association with tuffaceous sediments. The non-amygdaloidal types superficially resemble the dolerites but are distinguishable from these rock types by their finer grain and their conformable relationship with associated sediments.

Age Uncertain.

Dolerites.

The dolerites are massive, fine to medium grained, dark green rocks. In common with the melaphyres, they show universal alteration of the mineral constituents, involving saussuritisation, chloritisation and uralitisation. This alteration, however, is not sufficiently advanced in most cases to destroy the original textures. Saussuritisation has resulted in the decalcification of the original basic plagioclase (which is sometimes preserved) with the production of a more acid variety. This decomposition has resulted in the liberation of large quantities of epidote and calcite with lesser zoisite. Augite is preserved in some rocks showing various stages of alteration to an amphibole (uralite). The secondary amphibole may have a sodic composition. Masses of blue asbestos (crocidolite) which are commonly associated with the dolerites are considered to have originated by this alteration process. Olivine is only rarely preserved but its former presence may be deduced by pseudomorphs of serpentine, talc and magnetite, which often preserve the original crystal form of this mineral.

Analyses confirmed the similarity of the volcanic rocks at Blinman with those occurring at Wooltana and in the Oraparinna diapir. They also approximate very closely to published analyses of trachybasalts. Assuming therefore that there has been no appreciable loss or addition of chemical constituents during the alteration of these rocks, they are correctly classified as basic rocks.

The melaphyres are invariably altered, the original minerals being rarely preserved.

The sediments interbedded with the volcanics are blue slates, dark siltstones, greywackes, arkosic grits, cherts, tuffs and minor purple slates.

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At Blinman, the dolerites are restricted to the core complex, occurring as circular, elliptical, curved or collinear bodies. Many of the dolerites appear to be related to circular fractures, occurring as circular plugs at the centre of these circles, as arcs of concentric circles or as collinear bodies occupying structures radiating from the centres of these circles.

Stressed Gabbros and Basic Gneisses.

The gabbros are characteristically coarse grained, mottled rocks composed of uralite hornblende pseudomorphing pyroxene, saussuritised plagioclase, epidote, magnetite and chlorite. The original rock fabric and constituent minerals have been considerably deformed and altered.

The basic gneisses are fine to medium grained gneissic rocks associated with the gabbros. They are similar in composition to the gabbros and are considered to be highly stressed equivalents of these rocks.

Breccia.

The bulk of the core complex is composed of breccia, consisting of angular and slabby fragments of a great variety of rock types. There is a large variation in size of these breccia elements, ranging from remnant blocks up to 3.2 kms by 1.6 kms to fragments of microscopic size. A feature of the breccia is the high carbonate content of the matrix, which consists essentially of calcite with subordinate dolomite. Accessory constituents are quartz, muscovite and anhydrite. The origin of the carbonate in the matrix of these breccias remains unsolved.

Granites.

A variety of granitic rocks occurring as small remnants have been recognized. These include rapakivi type granite,granite porphyry, quartz felspar porphyry, granodiorite and granite gneiss.

The granitic rocks have been described by Howard as "a late phase of extreme differentiation of a basic magma"; however, their brecciated contacts and the striking similarity to rock types of the older granite suite of the Mount Painter area (pre-Willouran) indicate that they are not intrusive but have been mechanically emplaced by diapirism.

The essentially conformable relationship between the rim rocks and the core complex may be a reflection of the unconformity existing at this time. However, it is clear that limited local intrusion of the rim rocks above the stratigraphic level of this unconformity has also occurred. This is shown by the occurrence of Sturtian remnant blocks within the core complex and the offsetting of the axis of upturning by radial faults. It is not clear if this represents a continuing phase of the Sturtian diapirism or whether the movements are considerably younger.

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In other areas diapirs are known to intrude much younger sediments as for example the Wirrealpa diapir, the youngest movement of which post dates the Oraparinna Shales of Lower Cambrian age. Detritus eroded from the core complex of the Frome diapir in Marinoan flaggy limestones and basal Pound Quartzite is suggestive of diapiric activity during the deposition of these sediments.

MECHANICS OF DIAPIRISM

The Blinman Dome diapir exhibits some of the characteristics of salt dome diapirs. The features common to both structures are as follows:-

1. The intrusive nature of the core material
2. The steep upturning of the rim (overburden) sediments
3. A radial fracture pattern developed over the structure in the overburden
4. A density contrast between the overburden and the core material.

MINERALISATION OF THE RIM ROCKS

Mineral occurrences in the rim rocks conform to two main types, in particular the deposits which are essentially conformable with the host rocks and those which occur in cross cutting veins.

Conformable Type.

The erosion of the existing diapir occurred during the deposition of the Sturtian rim rocks. This implies that mineral outcrops in the core complex at this time would also be eroded and transported, either as detrital fragments or in solution. Thin conformable beds of hematite, occurring in the silty shale formation 4 kms southwest of Blinman and 0.8 kms north of the Blinman - Parachilna road, may be of this origin. The iron rich volcanics and the heavy mineral laminated quartzites provide an obvious source of iron for this mineralisation. Lead deposits (galena) which are associated with the well bedded dolomite unit at two localities may have also originated in this way. These occurrences are 1.6 km southwest of Alpana, and 100 m east of the Blinman - Oraparinna Road. The age of the lead may provide a clue to its origin.

Vein Type.

All the copper occurrences observed in the rim rocks in the vicinity of the Blinman Dome diapir are of the vein type. The minerals of economic interest comprise disseminated chalcopyrite, pyrite and magnetite in coarsely crystalline, cross cutting calcite or siderite veins. These veins are most abundant in the rim rocks close to contact with the core complex. In some cases they can be treated back into the diapir, clearly having their origin within the structure. Mineralised veins of this type occur at Mount Elkington and Breakneck Gorge. The grade of primary sulphide mineralisation is usually low.

Mineralisation origin within the core complex is uncertain. The carbonate veins of the rim rocks are identical with those associated with the dolerites and melaphyres which are considered to be derived by the alteration of these rock types. The absence of visible mineralisation from the carbonate breccia of the core complex suggests that this was not a source for the metalliferous minerals occurring in the carbonate veins.

MINERALISATION OF THE CORE COMPLEX

The mineral occurrences within the core complex are associated essentially with three specific rock types. These are dolomites (in particular the mine type dolomite), melaphyres and dolerites.

Dolomites.

The mine type dolomite consists of a well bedded, fine grained, siliceous or ferruginous dolomite together with dolomitic siltstones. The occurrences of bedding within these rocks and their constant association with the dark grey siltstones show that they are of sedimentary origin and not a carbonate replacement associated with hydrothermal mineralisation.

The primary mineralisation in the mine type dolomite occurs as small discrete blebs of chalcopyrite, bornite and pyrite distributed along individual bedding planes. The conformable character of the deposit suggests that the mineralisation may be of sedimentary origin. The occurrence of narrow cross cutting veins of primary sulphides, may indicate a mobilisation of the original minerals during metamorphism. The richer mineralisation (both primary and secondary) is restricted to the mine type dolomite in all occurrences with only weak copper staining occurring in the associated sediments. Some copper mineralisation is known to occur in dolomites which are not associated with the mine type sediments, in particular with grey siltstones and purple siltstones. However, they are strikingly similar in appearance to the mine type dolomite. Other Willouran dolomites occur within the core complex but are unmineralised. It appears therefore that the copper occurrences are uniquely associated with a dolomite of a certain composition.

Melaphyres.

In the melaphyres at Blinman, secondary copper occurs as coatings on joints faces, as infillings of amygdales and occasionally as primary sulphides in carbonate veins. At one locality, 3.2 kms southwest of Blinman a number of pits have been sunk on copper showings associated with a dark heavy mineral banded siltstone which is interbedded with the melaphyres. The copper minerals occurring in the amygdales of the melaphyres and with the associated sediments are believed to have formed during the extrusion of the original basic lava. The mineralisation of the carbonate veins is considered to have occurred during the alteration of the melaphyres as the ground mass also contains abundant carbonates derived from the decomposition of the original mineral constituents. It is not certain however, whether the alteration occurred during extrusion or is associated with a later metamorphic event. The fact that the dolerites, which apparently post-date the latest diapirism, show the same type and degree of alteration indicates that the decomposition of the melaphyres with the liberation of its inherent minerals may also have occurred during this metamorphism.

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The common association of copper deposits with melaphyres at Blinman suggests that the mineralisation was a primary feature associated with the extrusion of these rocks. It is also a feature that copper occurrences in Willouran sediments are more common where these sediments are associated with volcanics, as for example at Mount Painter. There is a similar close relationship of copper with the Wooltana volcanic suite at Wooltana. It would appear therefore that the Willouran volcanics were a source of copper and possibly contributed some of this metal to the environment of deposition of the succeeding Willouran sediments.

Dolerites.

Metallic minerals associated with the dolerites occur as disseminations in coarsely crystalline carbonate bodies. These bodies occur either as veins in the dolerites or as a halo at the contact of the basic rock with the diapiric breccia. The latter type may be seen at the mineralised dolerite at South Blinman.

The alteration of the dolerites has resulted in the liberation of great quantities of secondary calcite, siderite and magnetite which occur both in the ground mass of the rock and as carbonate-magnetite veins. As with the melaphyres, there is no clear cut evidence to indicate whether this is an original (deuteric) alteration or is the result of later metamorphism.

Recorded metals associated with the Blinman dolerites are copper, silver, lead, cobalt, nickel and iron.

The association of iron ore with dolerites is a widespread feature. Two outcrops of iron ore are known from the Blinman diapir, the larger occurrence, Brown and Farghers Iron Prospect (M.C. 3335), is situated 5 kms northwest of Blinman. This body contains an estimated 200 (tons per vertical foot) of high grade iron ore (67 percent iron). The iron occurs chiefly as granular martite containing relicts of magnetite. The occurrence of magnetite and carbonate in the ore body suggests derivation of the iron minerals from a basic rock. The intimate association of iron ore elsewhere with dolerites supports the conclusion that the latter rocks were the source of this iron.

The Blinman Diapir illustrates the more important features of diapirism notably the marked upturning of the surrounding sediments of the Umberatana Group, the complete dismemberment of the Callana sediments and volcanics, the development of a crude radial fracture pattern with a tendency towards graben and horst development in the NE and SW quadrants and the intrusive relationships of the core complex. The remnant blocks exhibit a crude preferred orientation, parallel to the diapiric contact. A marginal foliation is also evident in the breccia. The directional fabrics are interpreted as flow structures produced by differential movement between the diapiric core and the rim rocks. The breccia matrix which forms the bulk of the core complex is largely calcite with lesser dolomite. The origin of these carbonate remains an enigma. The

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occurrence of diapiric detritus as slump breccias in the Sturtian rim sediments demonstrates clear evidence of uplift and erosion of the Blinman diapir during the deposition of this sequence.

PREVIOUS WORK.

R. Hare and Associates in 1966 (for Metals Exploration), conducted an I.P. survey and located three major anomalies; with magnetics and geochemistry proving inconclusive as exploration techniques. The object of the survey was to locate anomalies which could be due to a large low grade ore deposit. The anomalous patterns in two anomalous areas were compared with a similar effect obtained over the Copper Mountain Orebody, near Quebec, which is a large low grade (0.9% copper) orebody. Anomalies of significance found were the Oratunga Anomaly which is a succession of deep anomalies or a zone of anomalies that are deep seated, with the anomalous zone occurring just to the south of a contact between high and low resistivity rocks near the margin of the dome structure. McPhar Geophysics made comparisons of this anomalous zone with known results of large low grade copper deposits elsewhere and suggested that the effects could be due to 2 to 5% metallic mineralisation. An anomalous zone of 458 m length, 305 m indicated width and 125 to 230 m plus below the surface source was indicated.

The Alpana Anomaly was also defined. It is broad and shallow and as the I.P. effects are not great, metallic mineralisation was considered to be in the range of 2% to 5%. The area is covered by alluvium.

Another I.P. anomaly was indicated near the center of a major gravity low. Since the anomaly is broad, fairly weak and deep seated, it was difficult to interpret the source of such an anomaly which had been classified as "probable" by McPhar Geophysics.

Other minor anomalies were located in and around the structure.

Readings over the Oratunga I.P. anomaly showed a 100 gamma increase. Where readings were taken over basic igneous rocks, spot high values occur, up to a maximum of 1600 gammas.

The I.P. Survey therefore delineated two definite anomalies - Oratunga Anomaly and the Alpana Anomaly. The formers' source was relatively narrow and at depth and is located within rim rocks east of Oratunga Homestead.

A drill hole was collared and drilled at 50° depressed on Magnetic North bearing to test the anomaly. The hole passed through shales to 210 m, then siliceous greywacke to the end of the hole at 350 m.

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There were a few traces of pyrite and chalcopyrite very widely scattered from one another. A section average 0.21 percent copper from 335 m to 340 m.

The hole did not clearly indicate the source of the anomaly, but as graphite was identified on joint planes and shears in the shales, the anomaly was put down to that cause.

The core has been left stored in good order near the Oratunga Homestead. The Metals Exploration logging was checked throughout by Noranda, 1967. No graphite was positively identified. The almost complete absence of sulphide mineralisation from the core is confirmed.

When the line plot at Section 15,500 East (Fig.2) is examined, it is seen that with electrode spread of 750 feet and maximum separation of n = 4, the highest recorded metal factor of 98, with percentage frequency effect of 4.0 and apparent resistivity of 41 (lowest value for n = 4) all lie on 27,250 North. (Noranda, 1967). This is 153 m south of the drill hole at this depth, and prompts the query whether the notation on the Metals Exploration section "centre of anomaly" is in fact correct. (Noranda, 1967). It would be advisable to query whether additional work, both at 16,000 East and 16,500 East, and repeating 15,000 East and 15,500 East with 305 m electrode spread, might clarify the effectiveness of this drill hole. The amount of graphite visible in the core is very slight and, as an explanation of the anomaly, does not appear entirely satisfactory. (Noranda, 1967).

Due to the discouraging results from the drilling the 2 remaining holes were cancelled.

No significant magnetometer readings can be correlated with I.P. results.

281 soil samples were taken at each magnetometer station from a uniform depth of soil and assayed for copper, lead, zinc and cobalt. No broad or continuous areas of possibly anomalous metal values were indicated. The variable nature and depth of alluvium and colluvium is such as to render this type of survey ineffective.

Ground magnetometer traverses were carried out along the N-S section lines of their grid at Blinman, the lines being spaced 1550 m apart and readings taken every 155 m. The levels are fairly uniform and mean levels are from 100 to 400 gammas with a slight gradient from W to E.

The Alpana Anomaly is a wide shallow flat anomaly centred about 12,000 North 40,000 East, close to the Alpana Homestead. Very little surface geology can be seen as the area is covered by alluvium.

McPhar recommended surveying a cross line at 11,000 North, and also trying to determine the approximate depth to source by resurveying Line 400 East with 61 m and 30.5 m electrode spreads. Doing this might have located the source more precisely than with the 93 m and 152 m spreads used for the original survey. This additional work was not carried out. (Noranda, 1967).

Drill Hole No. 2 was collared at 11,755 North 40,020 East, and drilled vertically to 92 m through a sandstone-siltstone-shale sequence containing very common heavy mineral bands.

A feature of the core was its extremely broken nature and the low bedding angles displayed. No mineralisation was encountered. The steepness of the sandstone siltstone block may indicate that this particular rock does not occupy more than a small proportion of the anomaly area. Most of the siltstone blocks in the Dome are long and relatively narrow.

The anomaly was attributed by Metals Exploration to the heavy minerals, mainly hematite, encountered in the siltstone-sandstone sequence. (Noranda, 1967). Moreover, they attributed the source of many minor anomalies elsewhere in the Dome to the presence of the same mineral hematite in blocks of silty sediments. The inconsistency of this explanation lies in the absence of other large anomalies attributable to the same cause. Coats' geological map shows that siltstones with interbedded heavy mineral laminated sandstones are relatively common and large anomalies would have been expected on 20,000 East line, for example, which cuts a very large block of these sediments.

The presence of hematite does not seem to provide an entirely satisfactory explanation of this anomaly.

This is a flat shallow anomaly that could be tested by percussion holes or percussion drilled to 61 m cased, and diamond drilled.

A central anomaly between 15,000 North and 17,000 North on line 22,500 East is mentioned in Metals Exploration Progress Report No. 1 of March 1966. This is not alluded to in McPhar's Report of the same month. It is however indicated as a "probable" on the 610 m scale Anomaly Plan.

The testing of an anomaly is often satisfied by a single drill hole, where an adequate explanation is revealed as to the nature of the anomaly source. In view of the lack at Blinman of any large-scale surface mineralisation, it becomes particularly important not to neglect any subsurface possibilities.

Neither anomaly at Blinman appears to have been entirely satisfactorily explained by the results of the two drill holes, and it is considered that expert geophysical opinion should be sought in the matter.

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It is clear that the Metals Exploration programme was intended to search only for a very large body of mineralisation. The 1520 m spacing between traverse lines could have resulted in lesser and possibly worthwhile deposits being missed.

The exploration target in the Flinders Ranges area was a large, disseminated, "porphyry copper deposit" located in, or associated with, diapiric breccia.

The I.P. reconnaissance surveys at Blinman and Oraparinna detected a number of moderate intensity anomalies. The Alpana anomaly at Blinman was the nearest approach to the I.P. effects associated with "porphyry copper" deposits and subsequent drilling has disproved the presence of copper mineralisation in this anomaly and, furthermore, it has shown that the heavy mineral siltstone sequence which is common in both diapirs has probably caused other I.P. anomalies not yet tested. In many cases, heavy mineral siltstones are in close proximity to these anomalies. However, some of the anomalies cannot be interpreted this way, notable exceptions being:-

(a) "Oratunga" anomaly, where the drilling has revealed that the anomaly is caused by the development of graphite along shear planes.

(b) "Melaphyre" anomaly at Oraparinna, located in a large melaphyre outcrop. This anomaly is very small and geochemical surface sampling gives no anomalous metal values.

No anomalous values were found over any mines, including the Blinman Copper Mine.

As a result of the work carried out there is no evidence to contradict the concept that a large low grade orebody may be present within the dome structure and occurring at depth. (Hare & Assocs., 1966). The induced polarisation results have yielded a few anomalous areas that could be indicative of low grade mineralisation.

Sparse mineralisation has been noted to occur throughout the dome, though the only economic occurrence, the Blinman copper mine, was located in one of the dismembered blocks within the breccia core complex. Minor copper mineralisation has been noted to be associated with basic rocks within the dome. It is believed that these basic rocks were mineralised prior to formation of the diapiric structure.

The fact that a significant gravity low is located in the middle of the structure suggests that brecciation is intense in the central portion of the dome and, further, that no major basic or ultrabasic intrusive occurs at depth. It is possible, however, that an acid intrusive is located in depth and if this is the case, the brecciation that is evident at the surface and above the intrusive would be a favourable environment for ore occurrence. The "Central" and "Alpana" IP anomalies could be indicative of ore occurrence at depth in such an environment.

Similarly, the significant "Oratunga" IP anomaly could be located within the breccia zone, and indicate a large mineralised block as found at the Blinman mine, even though it is close to the margin of the structure. Alternatively, the source of the "Oratunga" anomaly could be located within the rim rocks adjacent to the dome and in such case be compared with base metal occurrences that are known to exist around disseminated mineral deposits as in the south-west United States.

It is believed that exploration techniques other than diamond drilling are not going to yield much more information that can resolve the concepts once and for all. (Hare and Assocs., 1966). Therefore, a programme of diamond drilling is recommended to test the sources of the three most interesting IP anomalies and such a programme will also provide much needed geologic information at depth.

60/35 (1965) Sampling of Creek Sands associated with Flinders Ranges Diapirs.

- samples of sand to determine if such minerals as pyrochlore and microlite were present and whether the diapirs carried a mineral assemblage allied to the carbonatites were collected.

At Blinman the distribution of abundant opaque minerals for the entire range of 19 samples is hematite, magnetite and goethite all over 10% and ilmenite ranging between 1 and 10% with a trace of chalcopyrite.

Asarco, 1965 found widespread copper mineralisation within the Oraparinna Diapir (south of Blinman) by reconnaissance stream sediment sampling.

Subsequent reconnaissance mapping and surface sampling led to detailed mapping, sampling and diamond and hammer drilling of four specific copper prospects in which disseminated copper sulphides and their replacement minerals occur in a layered sequence of hydrothermally altered igneous rocks.

Three major aspects of copper sulphide mineralisation in igneous rocks of the Oraparinna Diapir are its

1) disseminated nature
2) broadly stratiform control
3) close relation to the alteration process which has affected the igneous rocks.

66/166 (1968) Report on Aeromagnetic studies of Diapirs.
Flinders Ranges, S.A.

	%Magnetite	Intensity background (gammas)	Peak Intensity (gammas)
Oratunga	-	40	2090
Blinman	>10%	180	2330

The intense, magnetically anomalous nature of the Blinman diapir is consistent with the magnetite content indicated.

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66/161 (1968) Mineral Exploration of Diapirs in The Adelaide Geosyncline - P.J. Binks (S.A.D.M.E.).

Gravity surveys over the Blinman and Lyndhurst Diapirs indicate that the breccia is less dense than the intruded country rock thus providing a possible explanation for the diapiric habit of the breccia.

It was recommended that a programme of geochemical drainage sampling over unprospected and part prospected diapirs proceeded and that geophysical surveys (resistivity or I.P.) should be undertaken over diapirs unsuitable for geochemical methods.

Summary of work done at Blinman to Dec., 1967.

	S.M.L.	Feature	Date	Geology	Geochem.	Geophys.	Drilling
Metals Exploration	86	Porphyry Copper	June 1965 May 1967		SS -	M + IP -	D
Noranda	162	Copper	Nov. 1967	-	SS		
Dept. of Mines		Base Metals	Oct. 1967 Dec. 1967		DS +		

- minor contribution
+ major contribution
M magnetic survey
IP Induced Polarization
D Diamond
DS Drainage Survey.
SS Soil Survey

S.A.D.M.E. carried out a drainage survey in late 1967. A total of 429 drainage samples were collected, embracing most of the creek systems in the Core complex at intervals of about 400 m. Copper values varied independently of any other metal, and levels for cobalt, zinc, nickel and lead were low.

Noranda Australia Limited. (1967).

A programme of work was carried out which included examination of the old Blinman Copper Mine, at surface and underground, a silt sample drainage survey of the Blinman Dome, and geological examination of all the recorded copper occurrences in the Dome. No new evidence was found of any large scale mineralisation. A possibility exists of proving additional tonnage of ore near the surface at the north end of the mine, and a drillhole was proposed. It was considered that the sources of the Oratunga and Alpana I.P. anomalies have not been entirely explained by the two drillholes completed by Metals Exploration N.L.

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A characteristic of stream silt samples in the particular environment at Blinman was the lack of persistence downstream. The sample density used was 42 per (square mile). In all 618 additional silt samples (to that of S.A.D.M.E.) were collected and assayed for copper.

382 soil samples were taken from depths of hole ranging up to 2 m.

All geochemical anomalies were investigated. It was considered by Noranda, 1967 that more time should be allocated to further checking of anomalous creek levels. In particular, any of the anomalous areas related to rocks other than basic ones should be checked. The Rim Rocks were not sampled.

Noranda recommended in 1968 to -

(1) Re-examine the widespread association of copper with the basic igneous rocks particularly those associated with Anomalies B and C and with the Young Cobalt Mine.

(2) Re-examine the Oratunga and Alpana anomalies areas, mapping the localities in some detail, with a view to deciding whether any prospects of copper mineralisation still remain.

(3) Drill one 153 m 50° depressed diamond drill hole to test the northern dolomite bed at the Blinman Copper Mine at a depth of 93 m below surface.

The objectives of the 1969 work of Noranda were to examine the association of copper with basic rocks particularly those associated with Anomalies B and C (Noranda, 1967) and with the Young Cobalt Mine, and to examine the Alpana geophysical anomaly outlined by Metals Exploration during an earlier tenure of the area. Neither project led to the discovery of economic mineralisation.

A reappraisal of anomalies B and C was prompted mainly by consideration of the discovery, by Asarco (Aust.) Pty. Ltd., at Oraparinna (a diapir to the south of Blinman) of stratiform copper sulphides in an environment of basic igneous rocks including volcanic and intrusive types in large rafts within the diapiric breccia. The geological environment of Anomalies B and C appeared to have a superficial resemblance to that at Oraparinna and the stream sediment values in the north and westward flowing creeks were consistently high for an appreciable distance down stream. From inspection of the Oraparinna prospect by Noranda, it became evident that at Blinman all the basic igneous rocks in the anomaly areas were of a massive doleritic type, occurring in small discrete randomly oriented blocks. No traces of disseminated copper were found within the rocks themselves. The relatively high stream sediment copper content must be attributed to a number of adjacent scattered small veintype sources. The Young Cobalt Mine was not examined.

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The Oratunga anomaly of Metals Exploration, 1966, is deepseated and was not pursued by Noranda, 1968. The Alpana anomaly of Metals Exploration, 1966, was examined more closely in an attempt to explain the cause of the widespread I.P. effects. Twelve auger holes were carried out to determine what rock type occurred under the alluvium, and whether any copper was present. The bedrock was found to be siltstone and sandstone with no significant level of copper indicated. No firm conclusion can be drawn as to the cause of the I.P. anomaly but an alternative explanation is suggested (Noranda, 1968). The I.P. anomaly may be caused by an extensive stratum of coarse hematite within the gravels near the surface of the Alpana locality.

The diamond drill hole proposed was not drilled - this was to test a possible northern extension of the lode at the Blinman Copper Mine.

The anomalies located by soil sampling were investigated. No new deposits of significance were found. The method was considered to be unreliable due to the fixing of copper released from dolomites close to the source, thereby limiting dispersion. Slightly mineralised breccia which weathers easily releases copper and clouds any anomalous results.

Gold Copper Exploration Pty. Ltd., 1970 re-interpretated existing information of previous work carried out on the Blinman Dome. (by P. Haslett, Minoil Services).

Robertson Research, 1971, for Gold Copper Exploration Pty. Ltd. sampled drainage outside the diapir area to the south. A sample density of 10 samples per stream (mile) was considered a minimum requirement.

Their conclusions were :-

The geochemical data suggests that mineralisation in the lease area beyond the diapiric core zone is poor.

Copper values indicate two anomalous zones which occur on the margin of the diapir and in the Brachina Formation.

No zinc or lead anomalies occur.

Two significant silver values are located in the Tapley Hill Formation. (6 and 15 ppm).

Barium anomalies relate to the eastern and southern margins of the diapiric core.

There are no significant iron anomalies and a single manganese anomaly coincides with a weak iron/barium anomaly on the eastern contact of the diapiric core.

In general, the contact zone of the Blinman Diapir, and in particular the eastern margin, appears to possess most potential.

The results of the Noranda - Binks geochemical stream sediment survey indicated that :

Five anomalous copper zones exist (100-170 ppm), which are not related to known prospects. A further five zones have low grade anomalies of between 50 and 100 ppm. Further work is required to ascertain the source of these anomalies in the rim rocks of the Blinman diapir, the locations of which are on Figs.13.3 to 13.9 of Envelope 1394-II, 28/7/1971.

Assay results obtained :

Prospect 1 (Young Cobalt Mine).

Sample Number	Type	Width mm	Cu %	Zn ppm	Co ppm	Pb ppm	Ag ppm	Ni ppm	Au g/t
80095	dolerite (dump)	-	0.02	21	40	10	1	55	<0.5
80096	vein (dump)	-	1.70	390	400	100	9	195	<0.5
80097	vein	130	1.70	150	860	70	11	135	<0.5
80098	wallrock dolerite	-	0.30	41	75	160	1	95	1.0

analyses by atomic absorption.

The values indicate that the dolerite does not contain encouraging copper mineralisation and although the vein contains significant copper, the vein is somewhat narrow.

Prospect 2 (Wheal Friendship Mine)

Sample Number	Type	Cu %	Zn ppm	Co ppm	Pb ppm	Ag ppm	Ni ppm	Au g/t
80099	malachitic shale (dump)	0.85	390	20	80	4	55	<0.5

The copper mineralisation is of very low grade, and associated metal values are low.

Prospect 3 (Cobalt Mine)

Sample Number	Type	Width mm	Cu %	Zn ppm	Co ppm	Pb ppm	Ag ppm	Ni ppm	Au g/t
80100	siltstone	900	1.5	45	15	180	2	65	<0.5
80101	siltstone	900	0.91	43	10	30	1	70	<0.5
80102	siltstone	1.2m	0.93	27	20	30	2	50	<0.5

The mineralisation of 1.0% copper over a 3 feet width is encouraging especially as malachite occurs alongs the bedding of the siltstones, in addition to occurring in fractures and fine veins. The extensions of this deposit requires investigation.

Prospect 4

Sample Number	Type	Width mm	Cu %	Zn ppm	Co ppm	Pb ppm	Ag ppm	Ni ppm	Au g/t
80103	veined dolerite	610	3.6	32	480	30	3	110	<0.5
80104	veined dolerite	610	0.46	82	600	50	1	205	<0.5

The average copper grade of the two samples is 2% over a 0.6 m width of veined dolerite. Further work is necessary to ascertain the extent of the mineralisation.

Prospect 5

Sample Number	Type	Cu %	Zn ppm	Co ppm	Pb ppm	Ag ppm	Ni ppm	Au g/t
80105	malachitic siltstone (dump)	0.98	32	20	40	1	40	<0.75

The small area of mineralisation and the low grade of copper and associated mineralisation in the siltstone bedrock does not warrant further work at the present time.

Prospect 6.

Sample Number	Type	Width m	Cu %	Zn ppm	Co ppm	Pb ppm	Ag ppm	Ni ppm	Au g/t
80106	limestone	3.3	0.41	28	40	100	1	130	<0.5

Although the mineralised breccia zone in the limestone is 3.3 m wide, the copper content is very low, and the prospect does not warrant further work at the present time.

Prospect 8.

Sample Number	Type	Width mm	Cu %	Zn ppm	Co ppm	Pb ppm	Ag ppm	Ni ppm	Au g/t
80107	veined dolerite	610	0.14	18	40	50	1	90	<0.5

This mineralisation is of very low grade, and the prospect does not warrant further work at the present time.

Prospect 9

Sample Number	Type	Width mm	Cu %	Zn ppm	Co ppm	Pb ppm	Ag ppm	Ni ppm	Au g/t
80108	dolerite	305	0.01	23	15	30	3	60	<0.5

No significant mineralisation is present, and the prospect does not warrant further work at the present time.

Prospect 10 (Doctor Mine)

Sample Number	Type	Width mm	Cu %	Zn ppm	Co ppm	Pb ppm	Ag ppm	Ni ppm	Au g/t
80109	dolerite (dump)	-	0.96	34	60	50	2	120	<0.5
80110	hematite vein	25	0.21	58	60	80	2	80	<0.5
80111	dolerite	1.8m	0.08	43	50	30	1	85	<0.5

The mineralisation is sporadic and of low grade and the width of the mineralised zones are not encouraging. No further work should be done on this prospect at the present time.

The analytical data from the nine prospects indicates that the copper mineralisation is encouraging in two prospects, (3(Cobalt Mine) & 4) while no work is recommended on the other seven prospects at the present time. No significant metal association was found.

It was concluded by Robertson Research, 1971 :

The area has been divided into the Blinman diapiric core zone, and the area of rim rocks surrounding it. The former zone has been comprehensively examined by several authors and a detailed geochemical stream sediment survey has been previously conducted. Consequently the present geochemical study has been restricted to the area outside the diapiric core rocks.

The regional geochemical stream sediment programme has resulted in three anomalous copper zones. A moderately high anomaly is associated with the eastern margin of the diapir, while low anomalous values in the Etina and Brachina Formations may reflect local lithological control of copper mineralisation.

Only two weak zinc and four weak lead anomalies were detected and are not regarded as significant.

Three anomalous silver values were located, two of which occur in the Tapley Hill Formation and one in the vicinity of a fault.

Three anomalous barium values occur, two on the margin of the Blinman diapir while the Nucaleena dolomite Formation has an overall enhanced barium content, again revealing a limestone-barium correlation.

Iron is moderately anomalous in the marginal zone of the diapir, while low widespread anomalous values reflect the Brachina, Enorama and Etina Formations of siltstone-shale lithology.

Manganese anomalies occur on the margin of the diapir and indicate local iron-barium-manganese mineralisation. Shale formations in the area give rise to above average manganese values due to the general higher manganese content of these rocks.

Within the Blinman Diapir, the results of previous surveys indicated that 10 anomalous copper zones required further investigation. (Robertson Research, 1971). It was concluded that -

> Copper mineralisation in the diapiric core is associated with dolomites, melaphyres and dolerites.
>
> No further work has been carried out on the various copper prospects but analytical data has been appraised.
>
> Only two of the prospects show sufficiently encouraging grades and extent of copper mineralisation to warrant further immediate work.

North Flinders Mines Ltd., 1971, surveyed two prospective occurrences. However, no plans are with the report to aid in location of occurrences D & L. Of occurrence D. grades of 1% or better copper were reported in the mineralised zone of 2 m width with observable strike of 100 m. It was recommended to drill to look for extensions or to use I.P.

Occurrence L consists of a dolomite plug in the diapir surrounded by metamorphosed and pyritized breccia. Copper occurs in the margin of the breccia and in the zone of metamorphism. Grades of 1% copper were obtained. No further work was recommended.

North Flinders Mines Ltd., 1971 also looked at the Wepowie lead, silver Mine which occurs along a strong NS fault zone near the Oratunga Diapir. Galena and polysphaerite were present.

At the request of Mr. M. Cole of North Flinders Mines Ltd., McPhar Geophysics Pty. Ltd. reviewed geophysical data and drilling results over the Blinman Dome Project, S.A.

An induced polarization and resistivity survey of the Blinman Dome was carried out by McPhar Geophysics Pty. Ltd. on behalf of Metals Exploration N.L. in 1965 and 1966. The results of this survey were summarized in a report by Dr. P.G. Hallof and Dr. R.A. Bell of McPhar, dated March 15, 1966. Subsequently the area was held by Noranda Australia Limited and the results of the geophysical work and subsequent drilling were received by the Noranda staff and summarized.

Various recommendations included in the Noranda reports were not followed and the purpose of this current review is to further assess the conclusions reached and make recommendations on possible further work. (McPhar, 1966).

Until recent years it was common practice to conduct I.P. surveys on broadly spaced lines with the aim of detecting possible major zones of mineralisation. It was realized, of course, that many smaller zones of mineralisation, which could nevertheless prove economic, might easily be missed by a survey of this type. This approach was common in Australia and was used in the 1965-1966 survey at Blinman; lines were surveyed 1530 m apart using 153 m and 350 m electrode intervals. (McPhar, 1966).

Recently it has been more usual to follow up these reconnaissance surveys in greater detail on closely spaced lines. Other techniques (geochemistry, geology, etc.) are also used to define areas of interest for more intensive geophysical work and this approach has contributed to a number of important discoveries now under development as mining ventures (e.g. Nepean, Scotia, Attutra Mine etc.)

The vast amount of detailed field data (induced polarization and resistivity) accumulated during recent years of the McPhar modelling program (currently in progress in Toronto) have contributed to the understanding by McPhar of I.P. interpretation. It is often possible to reappraise the results of old surveys (assuming the data is valid) and offer an alternative and hopefully better interpretation. In particular, as drilling results and additional geological data become available, it is often useful to try to decide whether the source of I.P. anomalies has been identified and, if not, whether further work is justified.

DISCUSSION OF BLINMAN I.P. RESULTS. (McPhar, 1966).

The initial reconnaissance I.P. survey of the Blinman Dome was carried out using 153 m, 229 m and 305 m electrode intervals on lines 1530 m apart. Three significant anomalies were detected, designated the Oratunga, Central and Alpana anomalies. Additional detailed measurements were made on adjacent lines to confirm the Oratunga and Alpana anomalies and the Central anomaly was checked with low frequency measurements. The three anomalous areas are discussed separately.

(a) ORATUNGA ANOMALY.

The Oratunga anomaly was initially detected on line 150E by measurements with 153 m electrode intervals. Subsequent measurements with 229 m electrode intervals on line 139E, line 145E, line 150E and line 155E confirmed the anomaly and outlined a broad zone of anomalous response.

The I.P. anomalies comprising the Oratunga anomaly have been detected with broad electrode intervals and although the source is described as "relatively narrow and at depth" (McPhar report dated March 15, 1966), this refers to width relative to the electrode interval. The source may still be 200 m wide.

The depth to the source appears to be approximately 153 m on line 150E but this is not clearly defined, a better estimate may be possible if the line is resurveyed with 93 m electrode intervals.

The magnitude of the I.P. response suggests a zone of relatively disseminated metallic mineralisation, although it is not possible to give reliable estimates of the percent sulphides, which might cause such an anomaly, it could be quite low and is possibly in the range 1% to 5%.

The last paragraph on page 32 of Noranda report No. 107 suggests that the location of DDH-BLI may not have tested the "centre of anomaly". With the poor resolution inherent in measurement with large electrode intervals it is quite possible that a narrow source may not be accurately positioned. It is misleading to attempt to position the source of an anomaly by scaling off the maximum reading or a pseudo section. The pseudo section is merely a convenient system of displaying data and should not be considered a geological section.

It seems likely that the drillhole DDH-BLI is sited correctly to test the source of the anomaly but there is always some uncertainty regarding the position of the source. Traces of pyrite and chalcopyrite were noted in the core and one 0.6 m section averaged 0.21 per cent copper. No graphite was positively identified but it is described as a possible source of the anomaly. The combination of graphite and sulphides may be the source of the anomaly. If the core is still available, laboratory tests could establish whether significant I.P. effects can be produced by the metallic sulphides and graphite present. Additional I.P. measurements with shorter electrode intervals (e.g. 93 m) should also improve anomaly definition, it would then be possible to say with more certainty whether or not the drillhole DDH-BLI was correctly sited.

(b) CENTRAL ANOMALY.

The "central anomaly" was partly defined on line 225E with 350 m electrode intervals using normal operating frequencies (2.5 and 0.3 cps). The line was repeated using 350 m electrode intervals and low frequencies (1.25 cps and D.C.) and the anomaly was confirmed but down-graded in importance. No further work on this line or an adjacent lines was attempted.

Although the central anomaly has not been completely defined it does suggest a broad zone of disseminated metallic mineralisation at depth. The anomaly is defined by a marked increase in frequency effect with no significant decrease in resistivity. This response is typical of very low grade mineralisation however, it could still prove to be of economic significance.

It would be desirable to resurvey this line with 350 m electrode intervals in order to completely cover the anomaly before attempting further interpretation. Additional measurements with shorter electrode intervals, low frequencies or on adjacent lines may be desirable if the complete anomaly pattern is encouraging.

(c) ALPANA ANOMALY.

The Alpana anomaly was detected on line 400E by measurements with 153 m electrode intervals at normal operating frequencies (2.5 and 0.3 cps). The anomaly was checked and confirmed by measurements with 153 m electrode intervals and low frequency (1.25 cps and DC) and measurements with 93 m electrode intervals. Additional measurements with 93 m electrode intervals on line 395E and line 405E confirmed the anomaly and outlined a broad zone of anomalous response.

On all lines surveyed the anomaly appears broad and shallow, therefore the apparent effects measured (resistivity, frequency effect and metal factor) should approach the true values of these parameters in the source rocks. The anomalous zone is defined by a broad zone of uniformly low resistivities [generally in the range 10-20 (ohm ft/2)] with a slight associated increase in frequency effect. No definite metallic source is necessary to explain this anomaly. The source appears shallow on all lines surveyed (i.e. less than 93 m) and it could be associated with a deep alluvial cover.

Drilling by Metals Exploration and Noranda and geological mapping by Noranda have established that the Alpana anomaly coincides with "a basin of the alluvium which is the only one of its kind in the Blinman area and therefore provides a unique setting for the accumulation of alluvium". (Noranda report No. 116) The suggestion that the anomaly may be due to the soils and gravels accumulated in this basin is not unreasonable and it is not necessary to postulate the presence of coarse hematite in the gravels in order to explain the observed anomalies.

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The uniformity of the measured apparent resistivities with both 93 m and 153 m electrode intervals implies that the low resistivity material continues to a depth of at least 200 m. Although the depths of the Noranda auger holes are not recorded they are almost certainly quite shallow. Metals Exploration Drill Hole No. 2 at 11755N, 40020E "drilled vertically to 118 m through a sandstone-siltstone-shale sequence containing very common heavy mineral bands" (Noranda report No. 107) however it is suggested that this intersection may not be representative of the area occupied by the anomaly.

It appears likely therefore, that the source of the broad anomalous zone is an area of low resistivity bedrock. The decrease in resistivity may be due to the presence of disseminated mineralisation or to an increase in porosity (possibly due to fracturing). If the bedrock is more porous, it would be expected to erode more easily than the surrounding rocks and this may be the reason for the formation of the basin of alluvium.

Measurements with 61 m and 30.5 m electrode intervals were recommended in original McPhar report. These measurements would define the boundaries of the anomalous zone more precisely and also help in estimating the depth to the top of the source. If discrete zones of mineralisation occur, they would be better defined by these additional measurements.

CONCLUSIONS AND RECOMMENDATIONS BY McPHAR, 1971.

(a) ORATUNGA ANOMALY.

A definite metallic source is indicated and the depth may not be as great as estimated in earlier reports. Drilling has intersected sulphides (pyrite and chalcopyrite) and graphite but the concentration has not been considered sufficient to explain the observed anomalies. No quantitative estimates of total sulphide or graphite content are given.

Relatively low concentrations of sulphide and graphite may be sufficient to explain the observed anomaly and laboratory tests on selected core samples are recommended to ascertain the I.P. response. It is of course realized that this core may no longer be available.

Additional I.P. measurements with shorter electrode intervals should help to establish whether the main I.P. anomaly was tested by DDH-BLI and whether I.P. effects measured in the core are consistent with the apparent I.P. effects measured at the surface. A suggested I.P. program is listed below.

Line	Electrode Interval	Extent of work
145E	153 m	one double set up at 265N
150E	153 m	" " " " " 275N
150E	93 m	" " " " " 275N
155E	153 m	" " " " " 270N

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(b) CENTRAL ANOMALY.

The Central Anomaly was not completely defined by the measurements on line 225E. A disseminated metallic source is suggested by the observed I.P. results but no follow-up work has been attempted. Measurements over the anomaly should be completed as a first step, later it may be desirable to survey additional adjacent lines but the I.P. response obtained so far is not pronounced and the anomaly is unlikely to prove significant.

Line	Electrode Interval	Extent of Work
225E	350 m	one double set up at 160N

(c) ALPANA ANOMALY.

The Alpana Anomaly outlines a broad area of low resistivity coinciding with a basin of alluvium. The source appears shallow (less than 93 m) but with a depth extent of several hundred feet. No definite metallic source is indicated. Measurements with shorter electrode intervals are recommended to better define the depth of the source and possibly define discrete zones within the broad anomaly.

Line	Electrode Interval	Extent of Work
400E	61 m	first separation cover 100N to 140N
400E	30.5 m	first separation cover 100N to 140N

BRIEF DESCRIPTIONS OF SITES OF COPPER MINERALISATION ON THE BLINMAN DOME (MODIFIED FROM NORANDA, 1967 AND OTHERS).

BLINMAN MINE

Location: 0.8 km northwest of Blinman P.O., Co. Taunton, Hd. Carr, M.C. 1806.

References

J.B. Austin, 1863, The Mines of S.Aust.; Parl. Pap. 65, 1872; Record of Mines 4th Ed., 1908; Mining Review 19, 1914; Mining Review 22, 1915; Mining Review 76; 1942; Bull. geol. Surv. S.Aust., 21, 1944; Mining Review 88, 1949.

The Blinman Mine has been investigated in some detail by Dickinson (1944). The following description is essentially a summary of his report.

History

The Blinman Mine was discovered in 1862 when rich hand picked oxidised ore was mined at the surface. Shortly after its discovery, the mine was purchased by the Yudnamutana Copper Mining Co., which worked it till 1874. This company produced 30,000 t of ore averaging 10-15% copper during this period. By 1874 the workings had reached a depth of 108 m. Low grade sulphide ore (presumably primary), assaying 5-7% copper was reported in the deepest level at this time. The property

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was subsequently purchased by the South Australian Consolidated Copper Mining Co. which carried out limited operations until 1881, when it was acquired by the Corporation of South Australian Copper Mines Ltd. This company worked the mine from 1882 until 1884 during which time 4% ore was extracted. In 1885 the mine was taken over by the South Australian Mining and Smelting Co., which carried out mining operations from 1888 until 1891. In 1888, H.Y.L. Brown inspected the mine and reported that run of mine ore assaying 8% copper was being extracted together with rich ore assaying 30 - 40%. The Tasmanian Copper Co. acquired the mine in 1897 and worked it from 1903 until 1907, when a decrease in the grade of the sulphide ore and a decline in the copper price caused mining operations to cease. During this period drilling failed to prove the lode below the 165 m level. Since 1908, mining operations have been carried on sporadically by small parties of gougers.

The Blinman Copper Mine was the most productive copper mine in the Flinders Ranges, with a total production of 10,000 t of copper from 200,000 t of ore mined. It is situated in a geological environment of considerable interest located in an eroded dome, the core of which is occupied by a mass of brecciated sediments.

The copper deposit occurs in a band of dolomite which strikes north and has a near vertical dip in the upper levels of the mine. The dolomite is one unit in a series of silty sediments up to 76 m thick, which forms a block within the diapir some 335 m in length.

There are three distinct ore shoots in the mine : the main ore shoot is known as the Southern Orebody and has produced most of the ore. It is 110 m long, is up to 15.5 m wide and extends from the surface down to the lowest levels stoped. The southern limit is marked by a fault. Copper mineralisation in and along the fault suggests that some mineralisation at least post-dated the fault. Sampling by Noranda, 1967 of the 10 m of dolomite exposed in the adit walls gave an average grade of 1.5% of copper. In the surface plan the dolomite is shown to extend up to 10 m either side of the edges of the stopes.

The Northern Orebody is narrower. The Caunter Orebody is 2 m wide, parallel with the Northern Orebody on the western side of the mine with the dolomite of the orebodies separated by a narrow band of dolomitic siltstone.

In the oxidized zone the copper minerals consist mainly of cuprite and malachite. The bulk of the high grade mineralisation appears to have been associated with veins ranging from 25 to 50 mm to 0.5 m in width. Most of these veins were transgressive of the dolomite, extending beyond the limits of higher grade mineralisation into the eastern wall. Some longitudinal veins also occurred. The mineralisation is present as veins occupying tension fractures transverse to the orebody, open cavity fillings and lining of vughs and disseminated mineralisation in the massive dolomite.

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The grade as sampled by Noranda varied between 1.5% and 2.24% copper.

The Southern Orebody constitutes 650 t per vertical 0.3 m including a 5 m strip of low grade ore either side (Noranda, 1967).

The Northern and Caunter Orebodies contributed a further 120 t per vertical 0.3 m. Total potential was therefore 770 t per vertical 0.3 m.

The prospects for re-opening the mine would depend on showing that another major ore shoot is present between the north end of the workings and the northern end of the dolomite where only a meagre showing is present at surface and from drilling deep in the hope of a major change in the extent of mineralisation.

If it could be shown that perhaps a third, or, better still, a half of the ore zone had been neglected at the north end - this would raise the overall tonnage potential and perhaps warrant consideration of drilling at greater depth. (Noranda, 1967).

Localities are indicated on Fig. 3 (Noranda, 1967).

(1) White's Mine

A pit, 24.5 by 12.3 m and about 3.1 m deep, has been sunk on copper mineralisation in a dolomitic siltstone block.

The main copper mineral malachite is seen uniformly distributed in walls of the pit along joints and bedding planes. Some chalcocite is observable in more massive dolomite amongst the dump material.

The deposit is located close to the southern margin of a 91.5 m wide basic dyke. Copper minerals - malachite and chalcopyrite - occur in narrow veins and amygdules in a narrow offshoot of the dyke. The carbonate mineralisation including chalcocite may have been formed by leaching of copper from minute veins in the dyke and its reprecipitation in the dolomitic siltstone nearby - a purely surface phenomenon. Alternatively, the siltstone may have been mineralised under hydrothermal conditions.

The mapping revealed unmineralised shales in a creek to the west, and diapiric breccia to the east and south. Thus the deposit has no appreciable extent and is not of economic significance.

(2) A small pit, 6.1 m long and 1.2 m deep, has been sunk in a small shear zone in a block of amphibolite. The copper mineralisation is very minor in the form of malachite painted along joints in the amphibolite. The malachite is restricted to joints, and a few fine veins; it does not disseminate out into the amphibolite.

No extensions of the copper mineralisation have been observed in the vicinity of the pit. As a result this copper showing is not thought to be significant.

(3) Cobalt Mine

A series of workings are located on a steeply dipping block of dolomite and dolomitic siltstone about 153 m long.

Chalcopyrite, malachite and azurite are observed as blebs or veinlets, parallel to joints and bedding planes.

The lode has been worked to a depth of about 18.3 m in a narrow vertical stope 1.2 m wide and 12.2 m long, near the southern end of a bed of dolomite 6 m to 9.2 m wide. There is a shallow shaft and a very small stope in the same dolomite 46 m further north. Although the stopes are very narrow, copper carbonates and oxides are present outside the lines worked. The southern section averaged 1.2 per cent copper over 3 m width, the northern section 0.85 per cent copper over 7.6 m width. The southern result was a little disappointing, limiting the length of mineralisation so that no further work was done.

The deposit is bounded by two creeks which cross the line of lode at north and south, both contain outcrops of diapiric breccia, indicating the strike limits of the dolomite as being not greater than 153 m.

The dolomite at this mine is long enough and wide enough to be of interest as a small target, but the grade of mineralisation indicated at the surface is very low.

(4) Wheal Friendship Mine

Two shafts and a series of shallower workings have been sunk on a small block of "mine type dolomite". The block appears to be contorted.

The main copper minerals, as observed in dump material, are chalcopyrite, chalcocite, and malachite, with a little azurite. The chalcopyrite-chalcocite takes the form of small veinlets and blebs, while the malachite and azurite line small cavities and joints.

A series of grab samples were taken from dump material to give an indication of the grade of material rejected, which was 0.61 per cent copper.

Soil samples were taken by post hole digger at 8.5 m intervals in traverses north and south of the mine. The traverses turned up several high soil values, apparently in a zone east of the mine shaft, but when further sections were sampled in between no continuity of mineralisation could be established. The area seems characterised by small blocks in the diapir, one of which is mineralised with copper. Because of the depth of colluvial material overlying most of the outcrop areas, it has not been possible to get a very clear idea of the structure of this deposit. The presence of a number of small dolomitic blocks, with some haphazardly distributed high soil values, prompted the additional soil samples.

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(5) Brown's Prospect

An inclined shaft of 9 m extent, and a circular pit about 15.3 m across and 3 m deep, and a series of smaller pits have been sunk on a large block (about 195 m long). The block is made up of dark grey shales and siltstones and brecciated dolomitic siltstones striking 030° dipping to the northwest. It is in the dolomitic siltstones that copper mineralisation is located, where it takes the form of a fairly uniform dissemination of malachite in small blebs and veinlets, associated with calcite and a green micaceous material. It has an outcrop of 76 m in length and varying widths from 0.6 m to 9 m.

Further mapping on Brown's Prospect has limited the length of the possible mineralised zone to about 155 m. Two rock units carry the mineralisation, one being the siltstone and the other is overlying brecciated siltstone, grit or possibly even diapiric breccia. It is uncertain whether the mineralised brecciated rock was part of the dolomitic-siltstone block or part of the diapiric breccia. Faults were seen in the pit offsetting the mineralised horizon.

To the northwest the prospect is cut off by a northeast trending dolerite dyke with vertical contact. Two soil samples sections indicate some sort of mineralisation persists to the dolerite (values up to 1300 oom).

No copper was seen in this dyke.

Chip sampled sections across the exposed ore zone gave sections as follows: 7.5 m 0.9 per cent, 15.5 m 0.5 per cent, 13.5 m 0.2 per cent and 15.2 m 0.6 per cent. Dip of horizon is 40° North, so true widths are about 66 per cent.

To the south-east soil sample results indicate that the mineralisation passes under cover of soil.

Brown's Prospect appears to have a maximum size potential of about 61 m long by (allowing for 40° dip) 4.5 to 6 m - which could be doubled in length if mineralisation persisted either way. The grade of the surface showing is very low. The presence of trace copper over great width suggests the possibility of some dispersal of the copper from the dolomitic siltstone into the overlying brecciated siltstone and grit.

Extension along strike is prevented by the dolerite to the northwest and diapiric breccia to the southeast.

It is the best of the outside showings seen, but does not warrant testing at this stage.

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YOUNG COBALT MINE.

Location: 3 kms south of Blinman P.O., Co. Taunton, Hd, Carr, M.S. 17713.

References: Record of Mines, 4th Ed., 1908.

Record of Mines, 1908, p. 354, describes the outcrops of the lode at Young Cobalt Mine as showing copper intermixed with iron and quartz with nodules of cobalt (erythrite). The mine is associated with a dolerite on which the main shaft was sunk. There is no record of production from this mine.

The following assays are also quoted in the 1908 Record of Mines :-

	I.	II.	III.	IV.
Copper	6.5%	28%	14.5%	7.5%
Cobalt	11.72%	1.46%	1.15%	4.89%
Silver	89 gms.		110 gms	
Nickel		6%		

Two shafts (12.4 and 7.5 m) have been sunk on a small plug of dolerite.

A series of small pits have been sunk around the dolerite in the diapiric breccia.

The mineralisation is in small veins (less than 0.3 m thick) containing mainly siderite, calcite and hematite, as well as small amounts of chalcopyrite, chalcocite, malachite and azurite. The main copper mineralisation is concentrated in veins in the dolerite and is not disseminated from these veins throughout the dolerite to any degree.

Sporadic copper and iron staining with dolomitisation is observed in a few of the surrounding pits giving the appearance of a weak halo.

As the copper mineralisation is restricted to this small plug of dolerite, it appears to warrant no further attention.

(7)
(8)
(9) These three copper occurrences will be grouped together as they are very similar and of insignificant size.

They are small pits or blast holes sunk on the margin of small amphibolite blocks. The copper mineralisation is very weak and sporadic, having an extent of only a few inches.

The main copper mineral is malachite seen in joints, vesicles or in small calcite siderite veins. The bulk of the amphibolite is unmineralised, but constantly carries large grains of micaceous hematite in small veins, along joints or as a dissemination.

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The occurrences have not been found to be associated with any widespread or worthwhile mineralisation and, as a result, have been accorded no further attention.

(10) Here, three copper occurrences have again been grouped together for description, also represented by small pits and blast holes sunk on amphibolite.

The copper mineralisation is in small veins (less than one foot thick) carrying calcite-siderite and hematite. The main copper minerals are chalcopyrite and malachite. The mineralised veins contain angular amphibolite fragments, giving the impression that they are fracture fillings. What is apparently some form of wall rock alteration causes the amphibolite to weather more rapidly adjacent to the mineralised veins, and gives rise to white powdery material. As these veins are narrow, have a short strike length and are of isolated occurrence, they have been accorded no further attention.

(11) Three occurrences here have been grouped together, represented by small pits and blast holes sunk at the contact of an amphibolite block and diapiric breccia.

Very minor amounts of malachite are observed in joints in association with micaceous hematite. The copper mineralisation has an extent of only a few inches. They represent mineralisation of the same type as Nos. 7, 8 and 9. Thus, having such small extent and low grade, they have been accorded no further attention.

(12) A shallow pit (0.6 m deep) has been sunk on a small block of "mine type dolomite". The block is brecciated along its West margin; in this area there are sparse veins of malachite. In the unbrecciated portions of the block copper mineralisation is very weak, appearing as isolated blebs of chalcopyrite (up to 7 mm in size) in the massive dolomite. The copper mineralisation is restricted to the dolomite block. A copper occurrence similar in type and extent is to be seen 110 m northwest of Young's Cobalt Mine.

As dolomite blocks in which the copper mineralisation occurs are of such small size (as shown on Coats' (1964) map) these occurrences have been afforded no further attention.

(13) Several shallow pits have been sunk on a small block of "mine type dolomite". The copper mineralisation is very weak and sporadic, in form of blebs of chalcopyrite and malachite. Soil samples were taken by post hole digger in three traverses to test the extent of the copper mineralisation under the soil cover, but indicated values of less than 100 ppm.

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(14) Four occurrences of copper mineralisation have been grouped for description as they are of similar type and apparently insignificant extent.

The copper mineralisation is exposed in shallow pits (less than 0.6 m) except for No. 14A, where a pit 2.5 m deep has been sunk. In this deeper pit a mineralised vein (1.2 m thick) runs along the breccia-amphibolite contact; it is not possible to trace it on surface outcrop.

The copper minerals are malachite and chalcopyrite which are confined to the immediate vicinity of the amphibolite, being associated with hematite. None of the occurrences have any significant width or strike length, thus precluding them from warranting further investigation.

(15) Four occurrences of copper mineralisation have again been grouped together for description, broadly parallel to No. 14 in type and extent. Little further can be added except that the copper mineralisation tends to be in calcite-siderite-hematite veins in the amphibolite, rather than in joints and veinlets at the amphibolite-breccia contact. The limited length of the veins and lack of dissemination precludes them from further attention

(16) A shaft (5 m deep) has been sunk on the Eastern margin of a block of dolomitic grit (39.6 x 9.2 m).

The copper minerals are chalcopyrite and malachite occurring in small blebs (up to 9 mm). The mineralisation in the block as a whole is very sporadic. Two shallow trenches have been sunk to test strike length extensions to block and have revealed only unmineralised diapiric breccia. The small size of the dolomitic block limits any future interest.

(17) A shallow pit has been sunk on a small block of "mine type dolomite" (90 m x 12 m).

Copper mineralisation is found in small blebs and veinlets as malachite and chalcopyrite. Mineralisation through the block is not at all uniform. It appears to be concentrated on the north end of the block and does not extend into the diapiric breccia. As a result of weakness and irregularity of the copper mineralisation it has been accorded no further attention.

(18) Five copper occurrences have been grouped together for description. They are seen in small pits in and around the margins of several amphibolite blocks. The main copper minerals are chalcopyrite and malachite occurring in joints and small calcite-siderite-hematite veins (less than 0.3 m thick). The distribution of only several mineralised veins in each amphibolite block and no dissemination of the copper mineralisation into the amphibolite from the veins precludes them from further interest.

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(19) A small pit and a blast hole have been sunk on a small block of "mine type dolomite". The occurrence is of the same type and extent as No. 12 and, as a result, is regarded as being of little significance.

(20) Two small pits have been sunk on a block of amphibolite exposing small hematite-calcite veins carrying a little malachite. The extent and importance of these occurrences parallels No. 18.

(21) Several shallow pits have been sunk on an amphibolite block and its contact with the diapiric breccia. The copper mineralisation is typical of other amphibolite occurrences.

The only interest was some positive evidence of mineralisation of the diapiric breccia, with disseminated malachite and azurite. This mineralised breccia only had an extent of a few inches and is of little significance.

(22) The Doctor Mine

Two shallow shafts and a series of shallower workings have been sunk on a small dolerite plug. The copper mineralisation is in small quartz-calcite-siderite-hematite veins in the form of chalcopyrite and malachite. There is minor mineralisation along joints adjacent to these mineralised veins, but there is no general penetration of the dolerite copper mineralisation. The dolerite has been strongly brecciated and altered.

Mineralisation does not extend into the diapiric breccia and, as the mineralised block is of very small size (45.6 m across), it is thought unlikely that a significant orebody exists at the Doctor Mine.

(23) Two shallow pits have been sunk on this block of steeply dipping dolomite and dolomitic siltstone (152 m long). The copper mineralisation appears to be restricted to a thin dolomite band (4.5 m thick). The copper mineralisation is in form of small blebs and veinlets of malachite sporadically placed through the dolomite. This block of dolomite and dolomitic siltstones bears a very strong resemblance to the north end of the block containing the Blinman Mine. If significant mineralisation is discovered in this part of the Blinman Mine block, a closer investigation may be warranted at this site.

(24) Breakneck Gorge Mineralisation

Three shallow pits have been sunk on a block of dolomite and dolomitic siltstone 265 m long. The strongest mineralisation is in the thin band of dolomite on the southwest side of the block. The copper minerals are chalcopyrite and malachite in blebs, small veinlets, joints and along bedding planes. Some malachite is disseminated through the dolomitic siltstones adjacent to the mineralised dolomite (3 to 5 m thick).

This block was used in orientation of the soil and stream silt sampling programme. Soil samples taken by post hole digger at the rock-soil interface reflect the mineralisation (see sketch). Some soil values tend to suggest that the copper mineralisation may not be restricted to to dolomitic siltstone-dolomite block.

(25) A small pit has been sunk on a small block of amphibolite where weak copper mineralisation (malachite) is exposed. The occurrence is of similar type, extent and importance to Nos. 7, 8 and 9.

(26) A shallow pit has been sunk on a dolomite block, copper mineralisation is seen in a vein carrying calcite and hematite and takes the form of small blebs and veinlets of malachite. No extensions of this mineralisation have been observed, or appear likely, and it has not been investigated further.

(27) A small exposure of "mine type dolomite" has been observed, carrying very weak copper mineralisation in the form of veinlets of malachite. The smallness of the block restricts any further interest in this occurrence.

(28) Two small pits have been sunk on a large siltstone block, copper mineralisation is exposed in a narrow vein carrying quartz and calcite in the form of malachite veinlets and blebs.

As these mineralised veins are discordant and very narrow, having little strike length, they have been accorded no further attention.

(29) Three small pits have been sunk on a small block of "mine type dolomite" (45.6 m long, 9.2 m wide). Weak copper mineralisation extends over about 24.5 m in the form of small blebs and veinlets of malachite.

The smallness of the block precludes further attention.

(30) Two occurrences have been grouped for description, they represent small copper showings in dolomite exposed in two shallow pits. No copper mineralisation can be seen except in the shallow pits and, as the dolomite is not very extensive, they have received no further attention.

(31) A large pit, 15.3 m x 13.8 m, and 4.5 m deep has been sunk at contact of a quartzite block and diapiric breccia. No copper mineralisation can be observed in the walls of the pit or in dump material.

(32) (33) (34) A series of shallow pits have been sunk on these three occurrences which reveal weak localised copper mineralisation about the margins of amphibolite blocks.

They represent occurrences similar in type and extent to Nos. 7, 8 and 9, and therefore have been accorded no further attention.

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(35) This showing consists of three small pits, 3 m deep, dug on a narrow north striking vein running through diapiric breccia. The immediate area is soil covered. Mineralisation consists of malachite and some chalcocite over a width of about half an inch. Adjacent to the vein there are several boulders of dolomite in the breccia of two to three inches diameter, which are quite strongly fractured and mineralised. The bulk of the gangue rock is the normal calcitic breccia with slabby shale fragments. The length of the workings is about 15.2 m and there are signs of diggings in a creek 30.5 m to the south.

Although the prospect is far too small to be of economic interest, it raised the possibility that the diapiric breccia was mineralised in this area.

Three rows of auger holes were put down to bedrock to obtain soil samples across the strike of the vein at 30.5 m intervals. Generally the soil copper content was low, with 150 ppm the highest value obtained close to the central pit, with a mantle of about 40 to 50 ppm extending south towards the creek. Values of 10 ppm to east and west indicated there is no general mineralisation in the diapir in this locality.

(36) Two small prospects occur in amphibolite. One is on the steep southeast side of a hill of amphibolite and comprises malachite stains in calcite-siderite veins in a shallow pit.

The other prospect lies at the head of a creek further north, but again is associated with a small plug of amphibolite. Neither prospect is of economic interest.

53/133 Survey of Brown & Farghers Iron Ore Prospect. M.C. 3335.
Blinman. 1961. R.P. Coats.

This prospect is 7 kms NW of Blinman.

Hematite was originally mined as a flux for use in the copper smelters at the Blinman Mine. The ore body occurs within the diapiric zone which occupies the core of the Blinman Dome.

The ore body occurs as a pear-shaped mass with its long axis N-S. It is completely enveloped by diapiric breccia. The contacts of the ore body with the breccia dip outwards on all sides so that the ore body expands its depth. It is surrounded by a narrow halo of carbonate, consisting of coarsely crystalline siderite and finegrained calcite or dolomite. Micaceous hematite occurs with the carbonate.

reserves 35,000 t
68% iron ore

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RECOMMENDATIONS

The geology within the diapir core is extremely complex. A purely geological approach to exploration is not likely to be successful. Surface mapping is unlikely to reveal any new mineralisation of significant economical importance.

A diamond drill hole (of about 150 m) to test for the northern extension of the lode at depth is warranted. (Blinman Mine).

Earlier detailed soil and stream sediment surveys have shown that such geochemical techniques are not suited to the particular geological environment of the area. Geochemistry would therefore seem to be an unreliable exploration tool for further work. Certain elements have not been extensively sampled, such as gold and cobalt.

Induced polarization is the only geophysical method used thus far to produce any reasonable anomalies, during a broad scale survey. However drilling of the anomalies has been negative in both cases. The explanation that graphite in shears caused the Oratunga anomaly seems feasible. However neither explanation for the negative drilling results over the Alpana anomaly seems particularly satisfactory. After completing a 115 m hole, Metals Exploration N.L. explained the anomaly by heavy mineral layering in sandstones. However such sandstones are found in surface outcrop over wide areas of the diapir (see Coats' Map 1964) and these did not register on the I.P. survey. Noranda subsequently drilled 12 Auger holes of average depth 7 m over the anomaly area. This merely enabled geochemical sampling at the top of apparently flat-lying bedrock. The anomaly was explained by the possibility that a stratum of coarse hematite boulders may be present in the overburden because 5 of the 12 holes recorded hematite present. This explanation does not seem particularly convincing.

Reinterpretation of the I.P. anomaly at the Alpana Anomaly is warranted as it may not have been satisfactorily tested. Geophysical reassessment of the Central Anomaly detected by I.P. by Metals Exploration N.L., but never drilled is recommended.

Magnetic anomalies have been differentiated by the S.A.D.M.E. about 1.5 km east of Doctors Copper Mine and across the Alpana area. This work carried out recently is additional to the work of Mumme. Gridding is proceeding on the former anomaly which is in rugged terrain on 24 lines 100 m apart, i.e. 2.4 kms with stations every 50 m. This work has differentiated a drill target - possibly more of stratigraphic than of economic importance.

There is possible potential for evaporite minerals.

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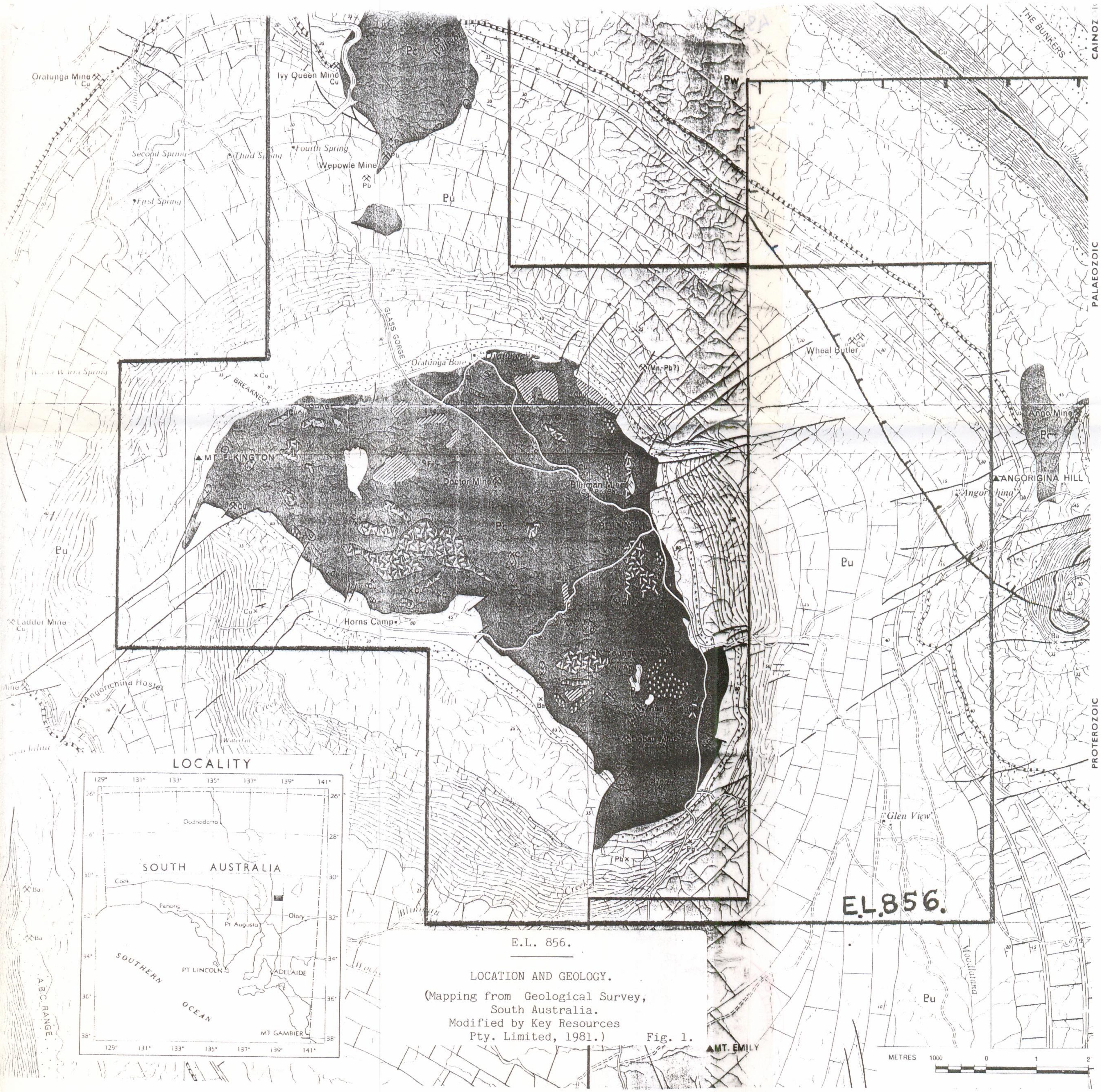


E.L. 856.

LOCATION AND GEOLOGY.

(Mapping from Geological Survey, South Australia. Modified by Key Resources Pty. Limited, 1981.) Fig. 1.

CAINOZOIC — QUATERNARY — PLEISTOCENE

Qp — Dissected gravels and conglomerates, older scree deposits. Locally carbonate cemented.

TERTIARY

T — Duricrusted sandstone.

?PERMIAN

P — Torrentially-bedded sandy conglomerates; far travelle[d] boulders with glacial faceting and striations in grey sand[y] clays.

PALAEOZOIC — CAMBRIAN — MIDDLE CAMBRIAN — LAKE FROME GROUP (€f)

GRINDSTONE RANGE SANDSTONE: Resistant, whit[e] sandstones passing upwards into softer, pink and whit[e] felspathic sandstone with well-rounded, white quart[z] pebbles.

PANTAPINNA SANDSTONE: Medium-grained, pink an[d] red felspathic sandstone with prominent cross-beddin[g]. Minor shales and dark mineral laminae.

BALCORACANA FORMATION: Red-brown micaceou[s] shales and felspathic sandstones with repeated thin, gr[ey] dolomitic limestones.

MOODLATANA FORMATION: Red-brown, micaceou[s] cross-bedded sandstone and arkose. Rare thin dolomite near the base.

WIRREALPA LIMESTONE: Grey, mottled and rubbly lime stones with green, shaley matrix. Trilobite fragments an[d] brachiopods.

BILLY CREEK FORMATION: Red and green micaceou[s] shales with minor thin, calcareous, tuffaceous beds passin[g] up to red-brown micaceous shales and sandstones wi[th] halite pseudomorphs. Rare trilobites. Edeowie Limesto[ne] Member at base.

LOWER CAMBRIAN — HAWKER GROUP (€h)

NARINA GREYWACKE: Grey-green calcareous silston[e] and chloritic sandstones north of the Wirrealpa Diap[ir].

ORAPARINNA SHALE: Green to black, very thinly bedd[ed] siltstone with trilobites and brachiopods.

BUNKERS SANDSTONE: White, medium-grained sandston[e] cross-stratified and with calcareous interbeds.

PARARA LIMESTONE: Dark, flaggy and silty limestone wi[th] shale interbeds. Unnamed shale unit at base.

WILKAWILLINA LIMESTONE: Massive, clean limestones [in] part with blue-grey mottling. Dolomitic and sandy near th[e] base with oolitic and algal beds. Archaeocyatha a[nd] brachiopods abundant in the upper part. Pebble beds ne[ar] Wirrealpa Diapir.

PARACHILNA FORMATION: Soft-weathering argillaceo[us] sandstone with abundant vertical burrows. Oolitic a[nd] shaley lenses.

PROTEROZOIC — ADELAIDE SYSTEM — MARINOAN — WILPENA GROUP (Pw)

POUND QUARTZITE:

Upper member: Resistant, white ortho-quartzite with min[or] red shale bands.

Lower member: Red, micaceous and felspathic sandsto[ne] with medium scale cross-bedding.

WONOKA FORMATION: Grey and pink calcareous shale a[nd] flaggy limestones.

BUNYEROO FORMATION: Grey-green and red, very thi[n] bedded shales, in part dolomitic; including cuprifero[us] Wearing Dolomite Member.

A.B.C. RANGE QUARTZITE: Medium-bedded felspat[hic] sandstone, ripple marked and cross-bedded.

BRACHINA FORMATION: Brown and greenish, thin-bedd[ed] siltstones. Common slump structures and interferen[ce] ripple marks.

UMBERATANA GROUP (Pu) — MARINOAN / STURTIAN

NUCCALEENA FORMATION: Cream to pink, well bedd[ed] dolomite.

ELATINA FORMATION: Pink to red fine-grained sandsto[ne] or felspathic greywacke, local tillitic lenses.

TREZONA FORMATION: Grey calcareous shale and int[er]beds of red, oolitic, flake breccia limestone.

ENORAMA SHALE: Purple-weathering, grey-green, ve[ry] thinly bedded silty shale, slightly dolomitic.

ETINA FORMATION: Blue and grey-green dolomitic sha[le] with interbeds of oolitic and sandy limestone and felspat[hic] greywacke.

WOCKERAWIRRA DOLOMITE: Fine-grained, buff dolom[ite] and dolomitic siltstone.

TAPLEY HILL FORMATION: Very thinly bedded, green a[nd] grey laminated shales.

MOUNT CAERNARVON GREYWACKE MEMBER: Fine to mediu[m] grained, buff-weathering felspathic greywacke and sa[nd]stone with minor shale bands.

TINDELPINA SHALE MEMBER: Finely laminated dark sha[le] slightly dolomitic and pyritic.

Bc — Diapiric breccia with calcareous matrix.

WILLOURAN — CALLANNA BEDS

Grey and red dolomitic siltstones with halite pseudomor[phs].

Purple and buff-coloured silty shales, thin sandsto[nes] and dolomites.

Interbedded dark grey siltstones and dolomites. (Mine [...] dolomites.)

Quartzites and heavy mineral laminated sandstones.

Melaphyres, amygdaloidal in part, associated siltstones, t[...]

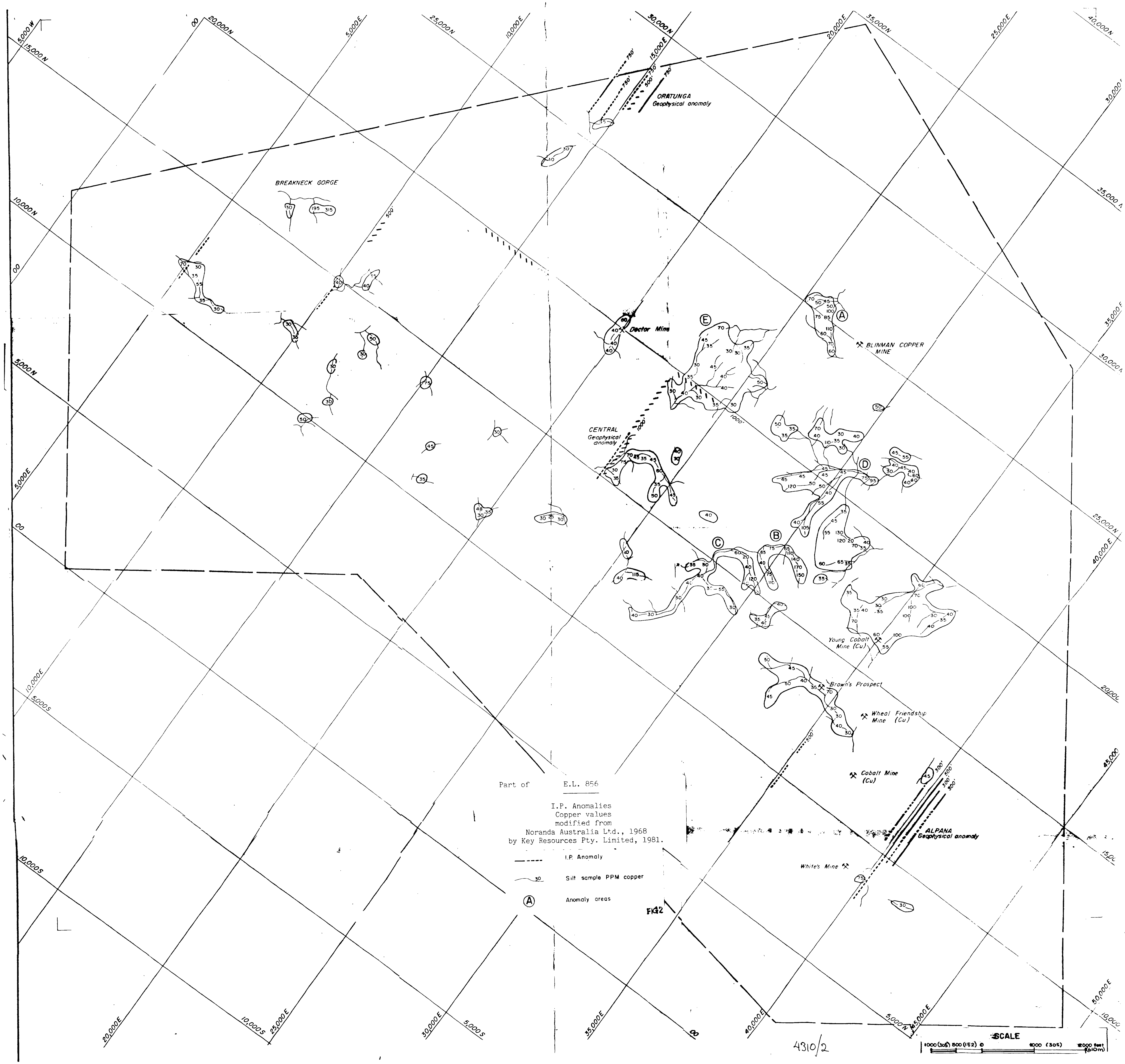
PRE-ADELAIDE SYSTEM.

Granodiorite, Rapakivi granite, etc., incorporated in dia[piric] breccia.

IGNEOUS ROCKS

Dolerites intruding the core of the Blinman Diapir.

4310/1


Part of E.L. 856
I.P. Anomalies
Copper values
modified from
Noranda Australia Ltd., 1968
by Key Resources Pty. Limited, 1981.
I.P. Anomaly
Silt sample PPM copper
Anomaly areas
FIG2
ORATUNGA
Geophysical anomaly
BREAKNECK GORGE
Doctor Mine
CENTRAL
Geophysical anomaly
BLINMAN COPPER MINE
Young Cobalt Mine (Cu)
Brown's Prospect
Wheal Friendship Mine (Cu)
Cobalt Mine (Cu)
ALPANA
Geophysical anomaly
White's Mine
SCALE
4310/2

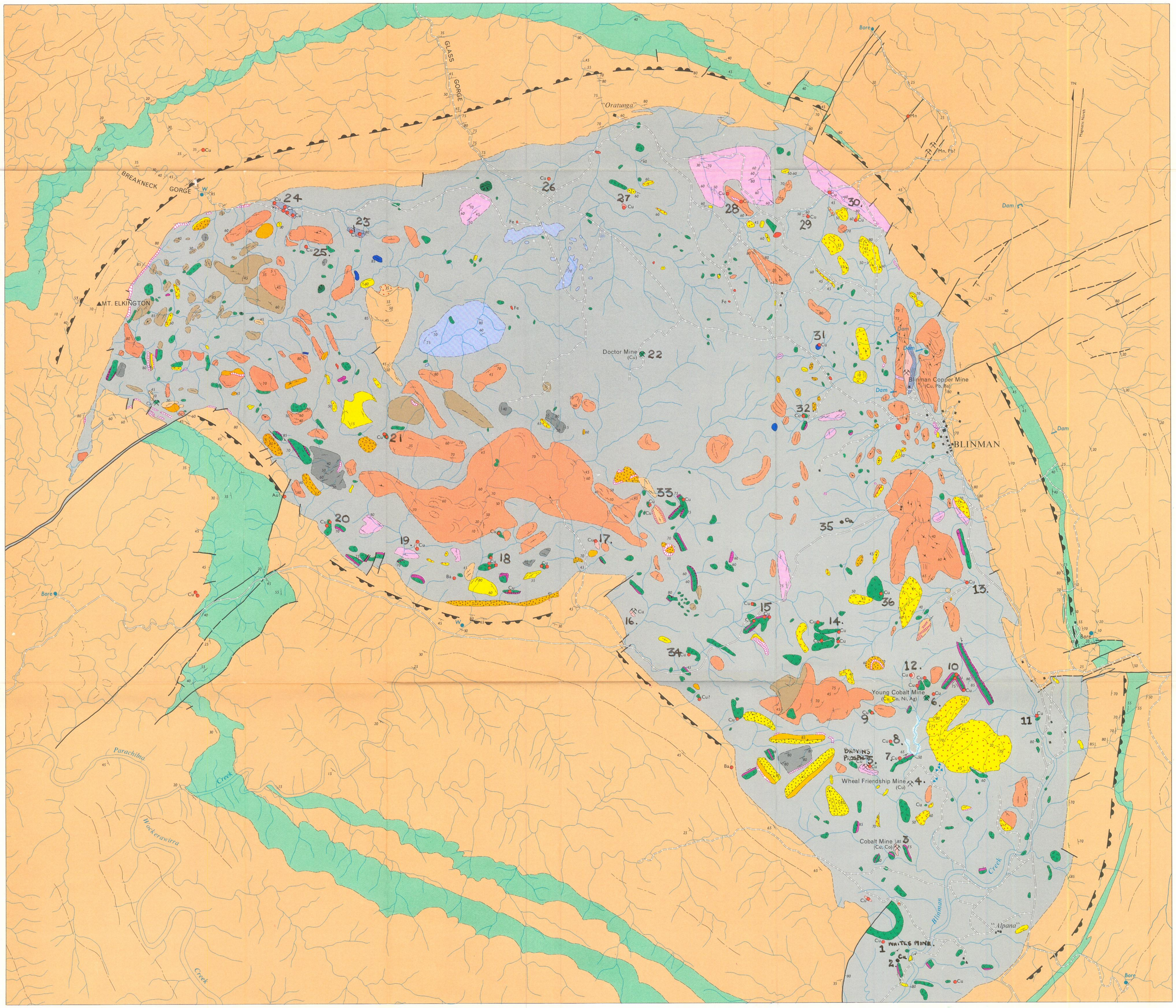
THE GEOLOGY OF

THE BLINMAN DOME DIAPIR

GEOLOGICAL SURVEY OF SOUTH AUSTRALIA
DEPARTMENT OF MINES, ADELAIDE

Published 1963

GEOLOGICAL ATLAS SPECIAL SERIES



REFERENCE

?PERMIAN

- Grey sandy boulder clays, sandstones and grits.
- Scattered faceted and striated boulders on bedrock surface.

STURTIAN

RIM ROCKS

- Laminated silty shales, calcareous in part; gritty grey limestones, greywackes; local sedimentary breccias, thinly bedded dolomites and rare erratics near base.
- Well bedded dolomites and dolomitic shales.

CORE COMPLEX

- Laminated silty shales, quartzites, chert breccias and dolomites.
- Massive boulder tillite.

PROBABLE WILLOURAN EQUIVALENTS

- Grey siltstones with halite pseudomorphs, dolomitic in part, interbedded heavy mineral laminated quartzites.
- Red micaceous siltstones, dolomitic in part.
- Massive greywackes and siltstones.
- Laminated ferruginous and siliceous ribbon slates and siltstones, dolomitic in part.
- Green laminated ferruginous phyllites.
- Blue slates and siltstones, thin interbedded sandstones.
- Purple shales, siltstones and slates, interbedded buff silty shales, thin sandstones and dolomites.
- Well bedded dark grey siltstones and slates, interbedded fine grained siliceous dolomite, dolomitic siltstones. (Mine type dolomite.)
- Dolomites undifferentiated.
- Dolomitic siltstones and dolomites.
- Calc-silicate metasediments.
- Quartzites and sandstones undifferentiated.
- Well bedded, heavy mineral laminated, pitted quartzites and sandstones, occasional ripple marks and halite pseudomorphs.
- Heavy mineral laminated quartzites, interbedded purple slates and conglomerates.
- Melaphyres, amygdaloidal in part; associated blue slates with halite pseudomorphs, dark siltstones, greywackes, arkosic grits, cherts and tuffs.

AGE UNCERTAIN

- Dolerites.
- Stressed gabbros, basic gneisses.
- Breccia, dolomitic in part.
- Rapakivi granite, granite porphyry, quartz felspar porphyry, granodiorite, granite gneiss. (Equivalent to older granite suite of Mt. Painter.)

GEOLOGICAL BOUNDARIES
- OBSERVED
- INFERRED

FAULTS
- OBSERVED
- INFERRED

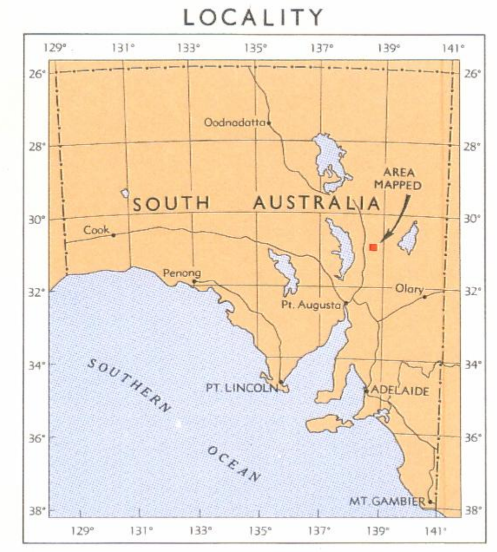
BEDDING
- STRIKE AND DIP
- VERTICAL
- TREND OF BEDDING
- TOP OF BED, CROSS BEDDING

AXIS OF UPTURNING

MINERAL OCCURRENCE

COPPER	Cu	COBALT	Co
GOLD	Au	NICKEL	Ni
SILVER	Ag	LEAD	Pb
MANGANESE	Mn	BARITE	Ba
IRON	Fe		

LOCALITY



SCALE

FEET 2000 0 2000 4000 6000 8000 10000 12000 14000 16000 FEET

METRES 1000 0 1 2 3 4 KILOMETRES

- MAIN ROAD
- ROAD
- TRACK
- EPHEMERAL STREAM
- MINE
- BORE
- WELL
- BUILDING
- TRIANGULATION STATION

Geology by R. P. COATS, B.Sc.

Map preparation by Cartographic Section, Department of Mines, S.A.

Compiled under the direction of
L. W. Parkin, M.Sc., Deputy Government Geologist,
T. A. Barnes, M.Sc., Government Geologist,
Director of Mines.

Issued under the authority of the Honourable
Sir A. Lyell McEwin, M.L.C., Minister of Mines

H. J. WALL, GOVERNMENT PHOTOLITHOGRAPHER, ADELAIDE

BLINMAN DOME

1 COPPER OCCURRENCES. (AFTER NORANDA) FIG. 3.