ERL 94 REDBANK NT

9th ANNUAL REPORT

AUGUST 1998

Author: G. Greenhill
Date: August 1998
**General Details**

<table>
<thead>
<tr>
<th>Description</th>
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<tr>
<td>Rental</td>
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<tr>
<td>Area</td>
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</tr>
<tr>
<td>First Granted</td>
<td>10 August 1989</td>
</tr>
<tr>
<td>Expiry Date</td>
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Summary

Alameda Pty Ltd have done no active exploration work on the ERL for the Reporting period. Alameda have maintained the tenement rents.

A letter advising that if by the end of July 1998 a JV partner had not materialised for our latest enquiry that Alameda would seek to reduce but hold the necessary area of ERL 94 to cover the mining leases held by Alameda (Redbank Copper Pty Ltd).

The area retained is needed for the camp, airstrip and road infrastructure linking the companies leases to enable future proposed mining activities on MN631/636, ML 1108 contained within the retained ground.
Expenditure
(Estimates)

Fulltime Caretaker Costs 20,000
On Costs 1,500
Camp Costs 12,000
Environmental Monitoring 2,500
Site visits by Directors 6,000
Administration 6,000
Geological Review 5,000

Total: $53,000

During the course of the reporting period the caretaker’s primary responsibility has been for the security and maintenance of the camp and environmental monitoring with the ERL. Only a proportion of his wages have been estimated against the ERL cost. Some of the wages are related to ore crushing activities associated with MN631/636 within ERL 94.
REDBANK COPPER PTY. LTD.

REDBANK AREA, N.T.

ERL 94, MLNs 631-636, 1108

SUMMARY OF GEOLOGY, PAST EXPLORATION AND RESERVES

Compiled by Andy Giles
September 1997
CONTENTS

1.0 INTRODUCTION
2.0 LOCATION & PHYSIOGRAPHY
3.0 TENEMENT STATUS
4.0 PROSPECT SUMMARY
5.0 HISTORY & EXPLORATION SUMMARY
6.0 GEOLOGY
   6.1 REGIONAL GEOLOGY
   6.2 MINERALISATION
   6.3 ORE GENESIS
7.0 PAST EXPLORATION PROGRAMS
8.0 MINING OPERATIONS
9.0 RESOURCE CALCULATIONS
10.0 EXPLOITATION POTENTIAL
11.0 REFERENCES
1.0 INTRODUCTION

Redbank Copper Pty. Ltd. (RCPL) is seeking expressions of interest from parties looking to acquire mining and exploration tenements covering well defined copper resources and prospects at the historic Redbank copper district near Woollogorang in the Northern Territory.

Redbank offers considerable opportunity for a junior explorer or small miner to acquire ground in the highly prospective McArthur Basin and to initiate production and exploration programs with a short lead time and high likelihood of success.

This paper is designed to provide a general introduction to the geology and history of exploration of the Redbank area as well as to provide a more detailed account of the work conducted in the significant exploration programs from the 60's to the 90's.

Information in this paper has been substantially derived from the works of other authors, adjusted to reflect my own experience as mine geologist at the Sandy Flat copper mine. I have elected for the most part not to individually acknowledge quotes drawn from other papers, but to accredit this material in a more general manner and through the use of a list of references.

Due to the wealth of information available from exploration and mining activities conducted in the Redbank area, it is impossible to cover in detail all data that may be of interest to prospective clients. Further information can be gained from reports, maps and plans held at the RCPL offices at 11 Keogh Way, Kalgoorlie, W.A. 6430.

2.0 LOCATION & PHYSIOGRAPHY

The Redbank copper deposits are located at 137° 46' E, 17° 11' S in the Northern Territory, almost 20kms from the Queensland border and some 60kms south of the Gulf of Carpentaria (Figure 1).

The area is very isolated and only sparsely populated. Topography in the immediate area of the Redbank leases is moderately hilly, with sandstone escarpments rising to 80m facing south and east. Lightly wooded savannah vegetation clothes the hills, becoming quite dense along watercourses and cliffs in the escarpments. The climate is sub-tropical, typically with a humid wet season which lasts from December to March and delivers the majority of the 700mm per annum rainfall. The dry season is quite pleasant with moderate to warm temperatures and generally moderate humidity.

Vehicular access is via a series of well maintained dirt roads from Cloncurry and Mt. Isa in the east and Tennant Creek and Borroloola to the west (Figure 2), however this road access may be restricted or even cut during the wet season and the months that follow. The local airstrip is cleared to more than 1200m, of which approximately 800m is fully maintained and is close to both the established camp facility and the Sandy Flat minesite. Redbank is one of the stops for a weekly mail plane from Tennant Creek.
3.0 TENEMENT STATUS

Redbank Copper Pty. Ltd. holds the following tenements in the Redbank area (Figure 3):

<table>
<thead>
<tr>
<th>Current</th>
<th>Original</th>
<th>Name</th>
<th>Expiry Date</th>
<th>Area</th>
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<tbody>
<tr>
<td>MLN 631</td>
<td>MLC340C</td>
<td>East Prince</td>
<td>31st December 1998</td>
<td>16.18 ha</td>
</tr>
<tr>
<td>MLN 632</td>
<td>MLC341C</td>
<td>West Prince</td>
<td>31st December 1998</td>
<td>16.18 ha</td>
</tr>
<tr>
<td>MLN 633</td>
<td>MLC342C</td>
<td>Sandy Flat</td>
<td>31st December 1998</td>
<td>16.18 ha</td>
</tr>
<tr>
<td>MLN 634</td>
<td>MLC343C</td>
<td>Redbank</td>
<td>31st December 1998</td>
<td>16.18 ha</td>
</tr>
<tr>
<td>MLN 635</td>
<td>MLC344C</td>
<td>Bluff</td>
<td>31st December 1998</td>
<td>16.18 ha</td>
</tr>
<tr>
<td>MLN 636</td>
<td>MLN345C</td>
<td>Sandy Flat West</td>
<td>31st December 1998</td>
<td>16.18 ha</td>
</tr>
<tr>
<td>MLN 1108</td>
<td></td>
<td>Sandy Flat East</td>
<td>1st October 2008</td>
<td>33.07 ha</td>
</tr>
<tr>
<td>ERL 94</td>
<td></td>
<td>Redbank</td>
<td>9th August 1999</td>
<td>39.13 ha</td>
</tr>
</tbody>
</table>

All seven mining leases are entirely contained within, but excluded from, Exploration Retention License 94. ERL 94 covers the most prospective ground in the Redbank area.

4.0 PROSPECT SUMMARY

The names of the different prospects at Redbank are used quite freely throughout this report and other literature. To prevent confusion, the more significant prospects are introduced below and their location is displayed in figure 4.

The Redbank area is named after the original mine on Redbank Creek discovered and operated by William Masterton in the first half of this century. Azurite, immediately east of the Redbank mine, and Prince, some distance to the south-west were also worked by Masterton at this time.

Modern exploration programs dating from the 1960's lead to the discovery of a series of mineralised breccia pipes which were essentially untouched by Masterton. Sandy Flat and Bluff are the primary deposits of this nature; others include Quartzite, Roman Nose, San Manuel, Punchbowl and Camp Valley.

Smaller copper occurrences lying within ERL 94 include Masterton's, Yellow Girl, Black Charlie, Seven Mile, Titley's Flat and Airport Valley. Some of these were originally discovered by Masterton while others were found as a result of intensive exploration conducted in the 1970's.

A number of isolated copper deposits occur outside ERL 94. While these may be of some historic interest, their small size renders them of little economic significance.
5.0 HISTORY & EXPLORATION SUMMARY

The discovery of, and subsequent exploration for copper in the Redbank district has been well documented by various authors. The following summary is reworked from Jensen (1940), Bell (1973), Kusnir & Millin (1983), and Cooke (1990, 1991). More detail is presented in section 7.0.

Chinese workers first discovered copper mineralisation in the Redbank District at China Girl (also known as China Workings) 5 kilometres north-east of Woollogorang Homestead in 1900. Further small copper discoveries (Packaddle and Bauhinia lodes) were made a short distance north-west of the homestead in 1912 by E. Thomas, who subsequently organised an expedition to explore and develop the area. William Masterton participated in this expedition, and remained in the area after the group exhausted their finances. In 1916, Masterton, who was the then owner of Bauhinia, set out prospecting and located the Redbank and Azurite copper deposits in undulating country some 20kms west of Woollogorang. Masterton worked these deposits for more than 40 years, transporting hand-sorted ore grading better than 30% copper to the coast for shipment to smelters at Chillagoe and Port Kembla.

H.I. Jensen, Senior Geologist, lead the first formal exploration party to the Redbank area for the Aerial Geological and Geophysical Survey of Northern Australia in 1940. Jensen mapped the flat lying stratigraphy at Redbank and noted the brecciation evident in many of the mineralised prospects which, he postulated, may have been caused by local spasms of volcanic activity along a fault line in underlying volcanic rocks. Jensen was very upset about the economic potential of the area, and recommended boring and geophysical investigations to gain better knowledge of the lodes at a depth.

Redbank was subject to further sporadic investigation by government geologists, and in the 1950’s several mining companies showed cursory interest in the area. Despite Jensen’s exhortations, it wasn’t until the 1960’s when Carpentaria Exploration conducted the first work of any significance at Redbank with a program of geological mapping and percussion drilling. In 1965 Granville Development acquired control over the area and shipped some 2,000 tonnes of copper ore to Mt Isa to the end of 1966, presumably from existing mines at Redbank, Prince and Azurite.

Placer Prospecting Pty Ltd. acquired an option over the Granville Authority to Prospect and in 1967 conducted a program of reconnaissance exploration over region (geochemistry, geophysics) as well as more detailed work, including drilling and soil sampling at the Redbank, Azurite and Prince. Placer considered these orebodies too small to warrant further work and withdrew from the project.

In 1969 Harbourside Oil N.L. acquired the area and in joint venture with Westmoreland Minerals, conducted a substantive exploration program including diamond and percussion drilling on a number of prospects. Working from some of the geophysical data generated by Placer, the partners drilled an untested anomaly at Sandy Flat and were rewarded with substantial high grade copper mineralisation to a depth of more than 200m Harbourside were also the first to discover primary copper mineralisation at Bluff.

Apparently short of money, Harbourside and Westmoreland brought Newmont Pty. Ltd. into the JV in 1971. Setting an ambitious target of 20 million tonnes at 3% copper, Newmont conducted detailed exploration work on the Bluff and Sandy Flat deposits, further delineating the mineralisation initially discovered by Harbourside. Newmont geologists were the first to postulate the epigenetic or breccia pipe model for mineralisation at Redbank, and the drilling on a number of structures which appeared to fit this model was rewarded with the discovery of mineralisation at Roman Nose, Quartzite, Punchbowl, San Manuel and Camp Valley. The exploration of Harbourside and Newmont at Redbank was very successful in identifying new prospects and defining substantial copper resources at Sandy Flat and Bluff, however Newmont did not consider that these resources satisfied their target requirements and they withdrew from the J.V at the end of 1971.
By 1972, Triako Mines NL had entered into agreement with Harbourside to explore in the Redbank area. Although Harbourside withdrew from the tenements shortly thereafter, Triako continued exploration at Redbank in conjunction with a number of partners including Amex Minerals, Amex Iron Ore Corporation, and Aquitaine Australia Minerals until 1983. Triako’s involvement at Redbank marked a sharp change in exploration focus, with geophysical testwork leading the search for new deposits.

Extensive exploration by Amex on behalf of Triako between 1973 and 1981 included geophysical and geochemical surveys, photo-interpretation and percussion drilling. Although many anomalies were detected and drilled during this program, Triako failed to emulate the success of Newman with the discovery of a new zone of significant mineralisation. Mining leases were established over the better-known deposits at this time.

Amex Iron investigated the Redbank exploration lease and 3 adjacent E.L’s between 1976 and 1977. Their limited work program aimed to assess the potential for stratiform mineralisation and was successful in identifying a 5m thick horizon in the lower part of the Woollongorong Formation with elevated copper values (250 ppm).

In 1982, Triako associate Aquitaine re-interpreted geological data for the area and developed a new genetic model for mineralisation at Redbank (Syngenetic-Diagenetic) which they subsequently tested with geophysical surveys and diamond drilling on the Bluff-Redbank trend. The drilling was unsuccessful and they withdrew from the joint venture.

Via an agreement with Triako, Sanidine NL and Restech Australia Pty. Ltd. were granted the exploration licence in June 1983. Mining leases covering the more prospective ground were transferred from Triako in 1984. Exploration in 1985 and 1986 was conducted by third parties who concentrated on the gold and diamond potential of the leases (with disappointing results) and almost half of the exploration license was relinquished at this time.

In 1988 D.J. Horton and Associates was contracted to manage the exploration program for Restech. Horton conducted a regional geochemical sampling program, again looking for gold but without success. 12 percussion holes were also drilled at Sandy Flat to better define the very high grade supergene copper mineralisation. Based on results from the geochemistry, the exploration licence was reduced to a retention licence (ERL 94) in August 1989 to protect ground around the better prospects.

Colymayne Pty. Ltd. purchased leases MLN 631 to MLN 636 and ERL 94 from Sanidine and partners in 1989. Colymayne has since been renamed Redbank Copper Pty. Ltd.

In 1990 and 1991, RCPL conducted further drilling at Sandy Flat to better define mineralisation for ore reserve calculations. A total of 5 diamond holes and three re-entries were drilled as part of this program, which confirmed the presence of high grade copper mineralisation at Sandy Flat. A single diamond hole and three percussion holes were also drilled at the Redbank prospect.

A revision of the ore reserves for Sandy Flat was conducted by Redbank Copper in 1991. Plant construction and open pit mining at Sandy Flat commenced in 1993. In 1994, Redbank Copper drilled a further 10 percussion holes from the current floor of the existing pit to better define peripheral mineralisation at the proposed base of the open cut, to allow for any necessary design modifications to the open pit to be made. Mining ceased at Sandy Flat in 1996.

In 1994 CRA Exploration Pty. Ltd. entered into agreement with Redbank Copper to conduct exploration on ERL 94. A review of historical exploration data was followed by reverse circulation drilling of 12 selected copper occurrences. Drill core from old holes together with the recent samples underwent multi-element analysis. The lack of significant credit mineralogy in the Redbank ores probably lead to the withdrawal of CRAE from the exploration agreement in 1996.
6.0 GEOLOGY

6.1 REGIONAL GEOLOGY

The Redbank area lies at the south-eastern end of the Macarthur River Basin and is composed of a series of volcano-sedimentary rocks of Carpentarian age. The Gold Creek Volcanics and the underlying Woollogorang Formation, which host mineralisation at Redbank, form part of the upper Tawallah Group, the oldest group of the basin. This succession of rocks is exposed on the eastern platform (Wearay Shelf) of the basin and dips at a very low angle to the north-northwest off the Murphy Tectonic Ridge to the south (Figure 4).

The sediments of the shelf area comprise both shallow water marine and continental deposits with intercalated volcanic units that are reported to wedge out to the north-west. Some twenty kilometres north east of Redbank, the formations of the Tawallah Group are intruded by the Packsaddle Microgranite. Rb-Sr dating of this granite gives an age of 1,575 +/- 120 m.y. (G. Knutson et al, 1979). Units of the Macarthur Group overlay rocks of the Tawallah Group to the south west.

Strata in the Redbank area display a variety of dip directions that are interpreted locally as reflecting the presence of a number of shallow domes and troughs and the presence of block-faulting (Figure 5). Steeper dips have been observed in drill cores from mineralised zones however these almost always reflect the effect of slumping within pipe-like mineralised structures. The local stratigraphy at Redbank and some of these interpreted structural features are presented on an idealised cross-section after Kusnir and Millin (1983) (Figure 6).

Regional reconnaissance and the interpretation of air-photo and aeromagnetic data have lead to the identification of a series of lineaments relating to zones of shearing and faulting. Numerous authors have commented on the apparent correlation between the distribution of mineralisation at Redbank and these lineaments.

6.2 MINERALISATION

Copper is the only metal currently identified at Redbank which forms mineral occurrences of economic significance. Theories of ore genesis are more completely discussed later, but in brief, copper mineralisation at Redbank is noted in three different settings.

- Cross-cutting structural features (breccia pipes; faults) of probable epigenetic origin
- Stratabound epigenetic mineralisation in close proximity to the structures above where copper mineralisation has "bled" into more permeable horizons within the host rock (vesicular flow-tops; agglomerates)
- Syngenetic stratiform copper mineralisation (most commonly in the Woollogorang Formation)

Most of the major deposits in the Redbank area fall within this first category. Host rocks are often strongly brecciated and copper mineralisation usually occurs as fracture fillings and disseminations. Alteration is pronounced, and in addition to the pervasive K-metasomatism observed throughout the field, host rocks may have undergone further alteration including carbonation, haematization and argillic alteration. Hausen (1971) has identified a consistent alteration pattern throughout many of the major deposits. An inner core of argillic alteration (chlorite, illite and clay minerals including
tectonic elements
N.E. Northern Territory
Redbank project
kaolinite) is progressively surrounded by envelopes of dolomitic then sideritic alteration. Copper mineralisation progressively decreases in tenor with increasing siderite and Hausen suggests that mapping alteration trends may be useful as a guide to detecting undiscovered pockets of ore within the larger, more complex pipe structures (Sandy Flat, Bluff).

In the primary sulphide zone, mineralisation is composed primarily of chalcopyrite and pyrite with rare bornite and sphalerite. Sulphide minerals may occur as fine disseminations within the host rock, as fracture fills and veinlets or even as small crystals or massive filling within vesicles in the host. Chlorite and dolomite are common gangue minerals with minor quartz and celadonite. At Sandy Flat in particular, a shiny black carbon mineral with a conchoidal fracture, locally termed pyrobitumen, is almost always associated with copper mineralisation. Rutile commonly occurs as fine disseminations within the sulphide minerals.

In the oxide zone, malachite, azurite and chrysocolla are the most common copper minerals, though a number of less common minerals, especially brochantite, may be mistaken for malachite and can even be locally dominant. Towards the base of the oxide zone, cuprite (in the capillary form chalcotrichite) and native copper form minor components of the ore. Iron oxides, pyrobitumen and clays with various carbonates comprise the gangue mineralogy. The oxide ore at Sandy Flat is relatively unique in the Redbank field, having undergone substantial supergene enrichment. This has lead to the formation of a cap of oxide copper minerals (grading 20% copper on average) composed of massive, dense crusts of malachite and cuprite and coarse spherical agglomerates of radiating acicular azurite crystals which have replaced highly altered host rocks in the core of the ore body.

Chalcocite is the dominant sulphide mineral in the transitional zone, and again at Sandy Flat there has been considerable supergene enrichment in this area. Covellite and diginite are the more common accessory minerals. Veinlets, fracture fills and disseminations are most common and with increasing depth chalcocite often forms as a dark patina on the surface of chalcopyrite.

At Sandy Flat, several stratabound zones of mineralisation have been identified outside the boundary of the pipe. The most prominent of these zones forms as a flat, annulus like ring around the pipe, much like the rings around Saturn. This mineralisation is confined to more permeable horizons, particularly the vesicular tops of trachyte flows and extends beyond the boundaries of the pit, though an impression is gained that mineralisation is strongest near the pipe. Small crystals of copper sulphides and pyrobitumen are common within vesicles, and occasionally local breccia zones with sulphides in veinlets and fractures are seen.

In the lithic sandstone units within the Gold Creek Volcanics, movement associated with the formation and subsequent slumping of the breccia pipes has lead to the fracturing of these more competent rocks. Fractures are commonly open and lined with drussy quartz and pyrobitumen and may also contain small crystals of chalcopyrite, though usually not in quantities to be of economic significance.

Limited drilling of any significant depth outside of pipe boundaries means that there is good potential for similar zones to be found at other prospects, though it is difficult to give an estimate as to the possible size and economic potential of these zones.

Within some of the pipe like structures drilled by Newmont (esp. Sandy Flat, Punchbowl, Camp Valley) significant mineralisation has been intersected in the upper part of the Woologorong formation. A number of authors have implied that this mineralisation may be stratiform in nature. Even Newmont, it appears, believed that some of the copper mineralisation in the Woologorong Formation at the Bluff was located outside of the breccia pipe (Mason, 1971). Given that these holes have been drilled very close to a major mineralised structure (the breccia pipe), I find it difficult to accept that the only evidence for stratiform mineralisation (essentially the fact that the mineralisation
occurs at a consistent stratigraphic level) outweighs the likelihood that the mineralisation is related to the event which formed the breccia pipe. Hence, I lean towards the suggestion initially postulated by Westmoreland that such mineralisation may be the localised epigenetic metasomatic replacement of carbonate rocks in the Woologorong Formation.

Regional exploration by Amax Iron Corp did identify genuine stratiform mineralisation in the Woologorong formation with a particular horizon (an algal dolomite in the lower part of the formation) containing consistently elevated copper levels (250 ppm). Low grade mineralisation from the upper part of the Woologorong formation (10m @ 0.46% Cu) was intersected in drill hole BSF-5 (Triako) 250m east of Sandy Flat, however this is the only intersection of note which is clearly derived from some distance outside a breccia pipe.

### 6.3 ORE GENESIS

Over the years there has been considerable debate regarding the nature of mineralisation at Redbank and geologists who worked in the area have proposed a number of different genetic models. In their 1983 summary, Kusmir and Milin noted some of the important features identified at Redbank that any genetic model needs to explain, including:

- Location of most known orebodies along lineaments.
- Steep to vertical disposition of most orebodies.
- Apparent cylindrical shape of a number of orebodies (e.g. Sandy Flat) with relatively small diameters.
- Mineralisation extending outside the boundaries of these cylindrical "pipes".
- Intense fracturing and brecciation of the host rocks.
- Extensive alteration of the host rocks including regional K-metasomatism of the Gold Creek Volcanics
- The net-vein fracture system that characterises much of the mineralisation.
- An identified increase in thickness of more than 100m in the Gold Creek Volcanic unit within the boundaries of these pipe like structures.
- The wide spread of isotope ratios (magmatic, marine and mixed) for carbon and oxygen from carbonates in the veinlets.
- Most sulfur isotope ratios indicating a non-magmatic source for the pyrite and chalcopyrite.
- The existence of mineralisation along the Woologorong/Gold Creek interface.

To which I would add:

- The presence of a local sandstone boulder conglomerate which caps some of the pipes (Quartzite, San Manuel, Roman Nose, Camp Valley).
Breccia Pipe Model

- Carbonated, K rich trachytic magma rose to a shallow depth below surface, producing a vapour phase capable of carbonate and potash metasomatism.
- Moderately impervious roof rocks resulted in pressure increases, leading to explosive pressure release and hydraulic fracturing of the roof rocks.
- Sudden decrease in pressure leads to an implosive event and the formation of cylindrical zones of brecciation occurring at the intersection of linear zones of weakness.
- Sulphides and carbonates precipitated from the vapour phase in open cavities. Re-dissolution and re-precipitation of sulphides derived from the both the pipes and surrounding rocks by heated coneate fluids.

Syn-Diagenetic Model

- Rapid basin subsidence and contemporaneous infill from trachytic lavas vented from within the basin.
- Incipient development of local depressions within the basin controlled by existing basement lineaments.
- Accumulation of sulphate brine within the depressions, these brines being derived both from the Woollogorang Formation and hydrothermal magmatic solutions.
- Precipitation of copper minerals close to the Gold Creek/Woollogorang interface
- Waning volcanism and subsequent deposition of more clastic sediments.
- A repeat of this cycle to explain mineralisation in the upper parts of the Gold Creek Volcanics (e.g Sandy Flat)

Revised Genetic Model

- Narrow zones of rapid subsidence controlled by pre-existing basin lineaments in a sub-aqueous environment.
- Simultaneous infilling of volcanics and sediments along these active faults which acted as conduits for mineralising fluids.

Essentially the three models each try to explain different features of mineralisation at Redbank. As none of these models were postulated before RCPL commenced mining operations at Sandy Flat, all are based on the limited exposure to the ore bodies provided by drill core, and information from geological mapping.

Many features of the morphology of the Sandy Flat orebody can only be explained with reference to the breccia pipe model proposed by Newmont geologists. Indeed, the Newmont exploration program, which based on this model, was the most successful program in discovering new occurrences of mineralisation in the Redbank copper field.

The Syn-Diagenetic model is unable to account for any of the gross morphological features of the breccia pipe at Sandy Flat. However, this model may be used to explain the weakly mineralised stratiform horizons which occur within the Woollogorang Formation. As Westmoreland Minerals pointed out, the thick zones of well mineralised carbonates and limey sandstones at the top of the
Woolgorang Formation have only been discovered in the vicinity of the mineralised pipe and are most likely to have formed due to the effect of mineralising fluids within the pipe rather than by syngenic means. Currently, the limited deep drilling near the identified pipes at Redbank is inadequately positioned to definitively test either theory and further work may not only decide the question but may also lead to the discovery of further mineralisation.

The Revised Genetic model appears to attempt to combine some of the features of each of the other models. It is possible that mineralised block-faulted structures south of Sandy Flat (the Masterton - Yellow Girl - Black Charlie trend) may have formed in this manner, but again this model fails to explain the morphology of the Sandy Flat pipe.

7.0 PAST EXPLORATION PROGRAMS

7.1 PLACER PROSPECTING LIMITED

Limited documentation on the Placer exploration program is available. Kusmir and Millin have drawn their data from reports by R. Graylan (1967) and V.L.R. Furlong (1967).

Initial regional reconnaissance was based on geological mapping and the collection of 135 stream sediment samples which were analysed for Cu, Zn & Pb. This was carried out over a wide area (some 970 km²) covered by an early Prospecting Authority.

The exploration of the (more localised) Redbank area included:

1. Geochemical soil sampling on a 400 x 50 ft. grid covering the area from Prince to Azurite. (Several anomalies were evident at and between Prince, Sandy Flat, Seven Mile and Titley's Flat which Placer unwisely judged "unconclusive")

2. Geophysical surveys using E.M. and I.P. methods which yielded several anomalies, the most important being two easterly trending I.P. anomalies in the vicinity of the Redbank Mine. Two diamond holes drilled into these zones did not intersect significant mineralisation and the anomalies were interpreted to have been caused by fine disseminated pyrite. The E.M. survey detected anomalies at Sandy Flat and Seven Mile, however no follow up work was done on these anomalies.

3. Drilling. Apart from the two holes discussed above, one more diamond hole was drilled south of the small Redbank pit and 51 RAB holes were drilled at Bluff, Seven Mile, Prince and Black Charlie. Placer reported that "some interesting intersections were made" in the rotary holes.

It is clear that the amount of work done by Placer was insufficient to substantiate the company statement that the area lacked the potential for the discovery of a major copper deposit. Their regional exploration (135 samples from an area of 370 square miles) was far from exhaustive and their more detailed work (in the area approximately covered by the current ERL 94) failed to follow up on some of the more interesting results generated by the program - as Harbourside Oil was soon to prove.
7.2 HARBOURSIDE OIL - WESTMORELAND

Harbourside Oil NL, in joint venture with Westmoreland Minerals, carried out the following exploration in 1970.

1. Geophysical (I.P.) survey which located several anomalies between Bluff and Prince.

2. Diamond and percussion drilling including the first diamond holes at the Bluff and Sandy Flat, and a number of percussion holes at Redbank, Azurite and Prince.

No report on this work is available, and the few existing records are patchy, however the joint venture partners can be credited with the discovery of the significant primary copper resources at the Bluff and Sandy Flat.

Interestingly, the discovery of mineralisation at Sandy Flat (which has no surface expression) resulted from the drilling of a small I.P. anomaly coincident with a geochemical anomaly detected in the original Placer survey.

7.3 NEWMONT

In 1971, Newmont carried out a substantial regional exploration program over P.A. 2885 including:

1. Photo-interpretation/geological mapping (though much of this data is not available)

2. Stream sediment sampling – no documentation available.

3. Airborne geophysics using E.M., magnetometer and scintillator. Some of the data is available in map form, however many of the details of the survey method are not recorded and it is difficult to assess survey reliability.

Most of Newmont’s effort, however, was directed towards the more detailed exploration of the area containing the known prospects (essentially the area currently covered by ERL 94). This work seems to have been greatly influenced by Newmont’s belief in a “breccia pipe” genetic model. After conducting a review of previous exploration activity in the Redbank area, the following work was carried out by Newmont:

1. Geological mapping of all known prospects

2. Geochemical soil sampling on a 100 x 200 ft. grid spacing over the western extension of the Redbank – Bluff trend and interpreted NE-SW and E-W extensions of Sandy Flat. A weak anomaly extending from Prince to the south of Sandy Flat was the only reported success, but no hard documentation is available.

3. Ground geophysics using E.M., S P., magnetic and I.P. methods including:
   a. E.M. surveys (Turam, self-potential and broadside 600 and 2400 Hz, horizontal loop) at a line spacing of 300 ft. covered all low lying and poor outcrop areas but “no anomaly indicating sulphide mineralisation was recognised”. An orientation survey over Sandy Flat and the Bluff yielded anomalies, however.

   b. Proton magnetometer surveys at the Bluff and Sandy Flat which were unsuccessful.
c. I.P. surveys were conducted over all known pipes and copper showings excluding Camp Valley. Positive but weak responses were obtained at Bluff, Quartzite and Seven Mile only.

4. Drilling: A total of 31,212 feet of diamond and percussion drilling was completed mainly at Sandy Flat (13 holes, 9,717 ft.) and Bluff (11 holes, 4,474 ft.). Other prospects drilled include: Quartzite (5 holes), Roman Nose (4 holes), Camp Valley (2), San Manuel (4), Azurite (2), Redbank (2), Seven Mile (2), Black Charlie (1), Camp Mountain (1) (plus a further 3 holes at Packsaddle outside ERL 94). The core was assayed solely for copper over 5 ft. intervals.

5. Topographic Survey – a contour map at 1:12,000 followed by a triangulation grid enabled the various geochemical and geophysical to be tied in and some drill hole locations to be positioned.

6. Metallurgical testing. Flotation tests gave copper recoveries in the order of 85% to 90%.


Kusnir and Millin question the rationale of the Newmont exploration program, particularly with regard to Newmont’s concentration on known breccia pipes and the lack of follow-up on targets generated from their regional exploration. I would suggest however, that the Newmont program was highly focused and very successful and that perhaps the criticism relates more to differences of opinion on the nature of the mineralisation.

7.4 TRIAKO - AMDIX

The majority of the exploration work carried out by Triako Mines N.L. and associate Amdex Mining was conducted between 1973 and 1977. Like previous workers in the field, Triako commenced with regional studies but later directed most of their exploration dollars on the more prospective areas near known deposits (essentially the ground covered by ERL 94). Unlike previous programs, a substantial quantity of written documentation and reports are available for perusal.

Regional or reconnaissance exploration consisted of the following:

1. Evaluation of all pre-existing documents and data.

2. Photogeology and geological mapping at 1:20,000 scale following the acquisition of colour aerial photographs. Several structures possibly indicating additional collapsed breccia pipes were located, but only one was checked in detail.

3. Airborne magnetic and E.M. surveys (INPUT method) covering the area around the known deposits at a 1/4 mile line spacing and 400 ft. terrain clearance. No massive sulphide prospects were identified, but two small anomalies were recommended for follow-up.

4. Stream sediment sampling for copper covering most of two exploration licences. The Bluff – Redbank and Black Charlie – Masterton trends both returned anomalous results. Two small anomalies were returned from Woollogorang Formation sediments (outside ERL 94). Six soil profiles along topographic slopes located two stratigraphic levels within the Woollogorang with slightly anomalous copper values.

Detailed exploration by Triako concentrated mainly on areas contained within the current ERL 94.
1. Detailed mapping at 1:12,000 and 1:5,000 scale of the various prospects within the Redbank area.

2. Soil/auger geochemical sampling on a 300’ x 100’ grid. Besides anomalies which were detected over the known prospect areas, a strong anomaly at Titley’s Flat was also defined. This anomaly was tested with one drill hole which failed to intersect any significant mineralisation.

3. Geophysical surveys:
   a. Gradient array and dipole-dipole techniques were used in 1973 at Sandy Flat, Quartzite, Seven Mile, Redbank – Azurite and Bluff with I.P. anomalies detected at Sandy Flat, Seven Mile and Azurite.
   c. Successful magnetic and I.P. surveys in 1975 which (in 1979) lead to detailed investigations around Sandy Flat. Several anomalies were detected and later checked by percussion drilling.

4. 302 percussion holes were drilled to check the various geochemical and geophysical anomalies generated by the exploration program. Punchbowl, Sandy Flat, Airport Mountain, NE of Seven Mile and Camp Valley were the major targets and some good results were returned from the first three of these. In particular, Triako were very enthusiastic about the results generated at Punchbowl, describing it as a “prime diamond drill target” and that “the alteration at Punchbowl suggests a pipe like feature at least twice the diameter of Bluff and Sandy Flat pipes” (Triako Mines, 1975). 14 diamond holes were drilled at a variety of prospects including Sandy Flat (3), Airport Valley (3), Airport Mountain (1), Seven Mile (1), Titley’s Flat (1), Roman Nose (1) and Punchbowl (3). Hole AD-1 at Punchbowl intersected good mineralisation, while some low grade copper mineralisation at intersected in BSF 5 Sandy Flat was deemed significant by Triako because of its stratiform nature.

5. Bench scale hydrometallurgical testwork using the “Dextec” process. The Dextec method is a single step metallurgical process operating at ambient pressure and relatively low temperature where ores including mixed oxide-sulphide ores can be converted to pure metal. Twelve large diameter diamond holes (ASF 41 – ASF 50, ASF 52 – ASF 53) were drilled at Sandy Flat to acquire ore samples for testing and the trials were carried out successfully with a reported recovery of 98%.

Triako were surprisingly persistent explorers, and enjoyed a fair degree of technical success with their exploration program, but unlike Harbourside and Newmont, they were not rewarded with a substantial new discovery.

7.5 SANIDINE - RESTECH

Sanidine NL and Restech Australia Pty. Ltd. acquired the exploration license E.L. 4213 and mining leases over the Redbank deposits in 1983. In the following few years Sanidine entered into agreement with a number of companies (Hunter Resources, Stockdale Prospecting) interested in the prospectivity of the Redbank area for gold and diamonds, however exploration results were disappointing.
By 1988, geological consultants D.J. Horton and Associates were managing the exploration program at Redbank on behalf of Restech. The dual thrust of the program seems to have been to further assess the gold potential of the area, while drilling to increase reserves in the high grade oxide-transitional zone of the Sandy Flat orebody.

Regional Exploration

1. Reconnaisance stream sediment sampling. Horton covered a substantial area of the EL at a sample density of a little over 1 sample per 10 km². A variety of metals were assayed for, but Horton was primarily interested in the prospectivity of the area for gold. Generally poor results were returned from the program.

2. Rock chip sampling of known prospects and ore dumps as well as other selected (barren) outcrop and creek float. Again a suite of metals were tested for, but gold was still the focus of interest. Some good copper grades were returned from old ore dumps, but results were otherwise disappointing.

Detailed Exploration

1. Re-sampling of selected core. Horton collected 28 composite chip samples from four cored holes from different prospects (Bluff, San Manuel, Punchbowl, Camp Valley) to test for a suite of metals. Gold was again the focus and results were disappointing.

2. Drilling. 13 reverse circulation drill holes for 740m were drilled by Horton to test reserves in the oxide and transitional supergene zone at Sandy Flat. Difficult ground conditions tested the rig and not all holes achieved their intended depth. High grade copper mineralisation was intersected in all holes but gold results were again low.

3. Resource Calculation

It is difficult to clearly see the rationale behind the dual thrust of Horton’s work. Gold exploration activities were sporadic and seemed to cover some of the ground already covered by Marjoriebanks for Hunter Resources in 1985. In drilling the oxide cap to the Sandy Flat orebody, Horton repeated the mistakes of previous drilling and failed to adequately define the lateral extent of the mineralisation.

7.6 REDBANK COPPER

In 1989, Redbank Copper Pty. Ltd. purchased the Redbank tenements from the Sanidine group in order to exploit mineral reserves at Sandy Flat and Bluff. Exploration activities were naturally focused on providing the additional data necessary at Sandy Flat to enable an informed decision on mining to be made.

Detailed Exploration

1. Drilling. Three separate resource definition and metallurgical drilling programs were conducted over the years 1990, 1991 and 1994.

   a) In 1990, Redbank Copper drilled a single diamond hole (SFD 63) at Sandy Flat to provide core for metallurgical testwork as no record of the Triako metallurgical testwork could be located. Two short percussion holes drilled north and south of the pipe to close off mineralisation in these directions intersected weak copper mineralisation interpreted to have “bled” from the pipe. A further diamond hole and
three percussion holes which were drilled at the Redbank prospect to test for mineralisation originally identified by Harbourside returned modest results.

b) Four new diamond holes and three re-entries were drilled at Sandy Flat in 1991 to firm up ore reserve estimates. Some spectacular copper grades were reported from this phase of drilling and the subsequent ore reserve calculations gave Redbank Copper Pty. Ltd confidence to proceed with capital works for a mine at Sandy Flat.

c) Many of the percussion and diamond holes drilled by Horton and Triako at Sandy Flat failed to reach optimal depth. Ten reverse circulation percussion holes were drilled from the existing floor of the Sandy Flat open cut in 1994 to firm up resource estimates for the section of the orebody between 30m and 85m depth substantially untested by these earlier programs. A recalculation of the Sandy Flat resource was made in 1995 to include information from this latest round of drilling.

2. Surveying. Horton noted some discrepancies between the reported and actual position of drill hole collars at Sandy Flat in 1988. Redbank Copper resurveyed all hole collars at Sandy Flat to give a reasonable basis from which to work reserve calculations.

3. Metallurgical testwork. Good copper recovery at reasonable concentrate grades was achieved for the primary ore at Sandy Flat, however oxide recoveries were substantially lower.

RCPL were clearly not interested in regional exploration, preferring to focus their activity on the work necessary to bring the Sandy Flat mine into operation.

| 7.7 | C.R.A.E. |

At the invitation of RCPL, CRA Exploration entered into agreement to conduct exploration on ERL 94. The program of work was to be conducted over two years. Work completed included the following:

1. Historical data compilation

2. Airborne EM survey flown over the eastern portion of the license area to test the conductivity response of known pipes (Bluff, Quartzite).

3. Percussion drilling of 12 discrete copper occurrences (each with a single hole) for multi-element analysis.

4. Logging of selected old drill core and resampling for multi-element assay.

Though not explicitly stated, the thrust of the program was to identify "credit mineralogy" associated with the known copper mineralisation in the Redbank district. Though some interesting copper results were returned from the sampling program and the airborne EM survey successfully detected low to middle order discrete conductive anomalies over Bluff and Quartzite, CRA Exploration elected for an early withdrawal from its agreement with RCPL. It is believed that the lack of good assay results for credit minerals in the ores at Redbank precipitated this decision. CRAE have furnished RCPL with list of suggested drill targets as a basis for further exploration.
Mining by Redbank Copper at the Sandy Flat deposit has allowed a more detailed observation of this orebody than would be possible from drill core. Some features of this orebody, which have bearing on the discussion regarding genetic models for mineralisation, are listed below.

- The upper contact of the Gold Creek Volcanics has been eroded at Sandy Flat.
- A shallow bowl-like depression over the orebody has been filled with a boulder conglomerate derived from the Masterton Sandstone. This unit reaches a maximum thickness of 10m over the centre of the orebody, but drilling indicates that it lenses out less than a hundred metres from the orebody.
- The Sandy Flat deposit is a sub-vertical, cylindrical structure approximately 80m in diameter.
- The outer edge of the orebody is a prominent annulus up to 5m wide of brecciated trachyte with net-vein mineralisation.
- The core of the orebody is more intensely altered and near surface is composed predominantly of kaolinitic clays and conglomeratic breccia zones with disseminated copper mineralisation suggesting intense reworking of the component rocks.
- The core also contains mega breccia fragments up to 60m in size of poorly or non-mineralised lithic sandstone and red ripple-marked siltstone. These fragments exhibit a variety of dips. The siltstone is postulated to have been derived from a prominent marker horizon at the contact between the Gold Creek Volcanics and the Hobblechaine Rhyolite, i.e. stratigraphically above where it is now located in the Sandy Flat pipe.
- The pipe-like structure displays a sharp contact with the surrounding, essentially flat-lying host rocks.
- Within 10m of the pipe, host rocks to begin dip towards the centre of the pipe and this dip increases with increasing proximity to the pipe (to a maximum of about 50° on the contact).
- Thin lithic sandstone marker horizons within the Gold Creek Volcanics are not reflected in the lithology of adjacent sections of the breccia pipe.
- Outside the boundaries of the pipe, the vesiculated tops of trachyte lava flows may often contain significant amount of copper mineralisation, usually as small crystals of sulphide within the vesicles.
- Apart from one minor, obliquely angled fault with a small displacement, there is no evidence in the walls of the Sandy Flat open cut of any substantial faulting or intersection of faults.

Three different models have been proposed by geologists working in the Redbank field to explain the genesis of copper mineralisation at Redbank.

1. Breccia pipe model whereby the mineralisation would be of hydrothermal, epigenetic origin. (esp. Newmont, Knutson et. al.)
2. Syngenetic-Diagenetic model in which the ores are of sedimentary origin. (esp. Aquitaine)
3. Revised Genetic model which is a pseudo-combination of the above two models. (Kusnir & Millin)
8.0 MINING OPERATIONS

William Masterton first commenced copper mining in the Redbank field in 1916. By 1940, records indicate that he had shipped almost 500 tonnes of hand-sorted ore from the Redbank, Azurite and Prince mines at better than 30% copper, while another company working the Prince had shipped a further 50 tonnes of ore. Masterton continued to work until the 1950's though records of production during this time are not available. In the mid 1960's Granville Development shipped some 2000 tonnes of ore at 15% copper to Mount Isa though the source of this ore is again not documented.

Redbank Copper Pty. Ltd commenced site work and mining operations at Sandy Flat in the second half of 1993. Mining continued through 1994 and in addition to run of mine ore, some 5000 tonnes of high grade ore (+20% Cu) from the supergene oxide zone was shipped directly to Mount Isa. The milling circuit and flotation plant were commissioned mid way through the year. Short mining campaigns in 1995 and 1996 provided extra mill feed as stockpiles became depleted. A drop in the copper price in 1996 and a decision by Mount Isa Mines not to purchase further concentrate eventually lead to the closure of the operation in 1996.

9.0 RESOURCE CALCULATIONS

Newmont Proprietry Limited were the first company to calculate resource figures for a number of the deposits at Redbank. The figures below are taken from Baird (1971).

<table>
<thead>
<tr>
<th>Prospect</th>
<th>Lower Cut</th>
<th>Tonnage</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drill Indicated Resources</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sandy Flat</td>
<td>0.5% Cu</td>
<td>1,653,400 t</td>
<td>2.01% Cu</td>
</tr>
<tr>
<td>Bluff</td>
<td>0.5% Cu</td>
<td>1,975,700 t</td>
<td>1.66% Cu</td>
</tr>
<tr>
<td>Potential Resources</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quartzite</td>
<td>-</td>
<td>100,000 t</td>
<td>1-2% Cu</td>
</tr>
<tr>
<td>Roman Nose</td>
<td>-</td>
<td>300,000 t</td>
<td>1.5% Cu</td>
</tr>
<tr>
<td>Camp Valley</td>
<td>-</td>
<td>300,000 t</td>
<td>-</td>
</tr>
<tr>
<td>San Manuel</td>
<td>-</td>
<td>300,000 t</td>
<td>&lt;2%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4,507,100 t</td>
<td></td>
</tr>
</tbody>
</table>

Newmont considered that it was highly unlikely that cutoff grades less than 2% Cu could be sustained during mining, and the drill indicated resources for Sandy Flat and Bluff at this cutoff grade are summarised below (Mason, 1971).

<table>
<thead>
<tr>
<th>Deposit</th>
<th>Ore Type</th>
<th>Short Tons</th>
<th>Grade (Cu)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bluff</td>
<td>Oxidised</td>
<td>39,900</td>
<td>2.75</td>
</tr>
<tr>
<td></td>
<td>Primary</td>
<td>530,700</td>
<td>3.10</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>570,600</td>
<td>3.07</td>
</tr>
<tr>
<td>Sandy Flat</td>
<td>Oxidised</td>
<td>70,300</td>
<td>5.11</td>
</tr>
<tr>
<td></td>
<td>Transitional</td>
<td>113,575</td>
<td>7.47</td>
</tr>
<tr>
<td></td>
<td>Primary</td>
<td>265,700</td>
<td>3.15</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>449,575</td>
<td>4.55</td>
</tr>
<tr>
<td>Total</td>
<td>Oxidised</td>
<td>110,200</td>
<td>4.25</td>
</tr>
<tr>
<td></td>
<td>Transitional</td>
<td>113,575</td>
<td>7.47</td>
</tr>
<tr>
<td></td>
<td>Primary</td>
<td>796,400</td>
<td>3.22</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>1,020,175</td>
<td>3.73</td>
</tr>
</tbody>
</table>
MacDonald (1989), recalculated the resource at Sandy Flat and Bluff to reflect the additional information gained from drilling subsequent to Newmont, however he limited the extent of his calculations to potential open-pitable reserves.

<table>
<thead>
<tr>
<th>Deposit</th>
<th>Method</th>
<th>Cutoff</th>
<th>Depth to</th>
<th>Tonnage</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sandy Flat</td>
<td>Contoured</td>
<td>0.50%</td>
<td>65m</td>
<td>958,069</td>
<td>2.68%</td>
</tr>
<tr>
<td></td>
<td>Polygonal</td>
<td>0.50%</td>
<td>65m</td>
<td>526,103</td>
<td>3.32%</td>
</tr>
<tr>
<td>Bluff</td>
<td>Polygonal</td>
<td>0.50%</td>
<td>65m</td>
<td>492,461</td>
<td>1.43%</td>
</tr>
<tr>
<td></td>
<td>Polygonal</td>
<td>0.50%</td>
<td>100m</td>
<td>771,335</td>
<td>1.89%</td>
</tr>
</tbody>
</table>

Cooke (1991) calculated mineable resource figures for Sandy Flat based on the latest RCPL drilling. Cooke indicates that no lower cutoff grade has been applied, however that makes little sense and I assume that he has used a cutoff of around 1.0% Cu.

<table>
<thead>
<tr>
<th>Deposit</th>
<th>Pit Depth</th>
<th>Tonnage</th>
<th>Grade</th>
<th>Strip Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sandy Flat</td>
<td>60m</td>
<td>306,000</td>
<td>4.29%</td>
<td>2.65:1</td>
</tr>
<tr>
<td></td>
<td>80m</td>
<td>435,482</td>
<td>4.00%</td>
<td>3.76:1</td>
</tr>
</tbody>
</table>

Giles (1995) has calculated a final set of resource figures for Sandy Flat to include data from the 1994 drilling program by RCPL. A lower cutoff grade of 1% copper was used.

<table>
<thead>
<tr>
<th>Deposit</th>
<th>Type</th>
<th>Depth</th>
<th>Tonnage</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sandy Flat</td>
<td>Indicated Resource</td>
<td>≈110m</td>
<td>453,850</td>
<td>4.00%</td>
</tr>
<tr>
<td></td>
<td>Probable Reserve</td>
<td>86m</td>
<td>386,150</td>
<td>4.33%</td>
</tr>
</tbody>
</table>

It is estimated that RCPL have extracted between 155,000 and 200,000 tonnes of ore from the Sandy Flat pit, and the resource figures must be read with this in mind.
10.0 EXPLOITATION POTENTIAL

RCPL considers that the Redbank area offers great potential to the junior explorer or small miner wishing to gain an exposure to copper. Some of the more attractive features of Redbank are:

- Exposure to ground in the McArthur Basin – Mount Isa Geosyncline area, one of the world's premier base metal provinces. This area is renowned for hosting many of the Australia's largest base metal deposits including Mt. Isa, Hilton, Century and McArthur River and has been the focus for many new discoveries in recent years (Ernest Henry, Century and Eloise).

- Substantial Measured and Indicated copper sulphide resources at Sandy Flat and Bluff.

- Readily exploitable copper oxide deposits at Bluff, Redbank, Azurite and Prince.

- 50,000 tonnes of stockpiled oxide ore from the Sandy Flat open pit. This ore is expected to grade better than 4% copper.

- Established mining leases over a number of the more significant deposits reducing difficulties which may otherwise be encountered with Native Title Legislation.

- A history of extensive exploration which has identified many targets for further work. These range from prospects at an advanced stage of development with identified mineralisation (eg Punchbowl) through to geochemical and geophysical anomalies yet to be tested by drilling.

- Demonstrated potential for undetected stratabound mineralisation associated with existing copper deposits. This may include mineralisation associated with more permeable horizons within the Gold Creek Volcanics as well as the possibility of sizeable metasomatic replacement deposits in the carbonates of the Woollogorang Formation.

- Opportunity to develop and use the latest in extractive technologies including SX-EW and in-situ leaching.

- Existing high quality camp infrastructure, enabling immediate commencement of work programs.
## 11.0 REFERENCES

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<th>Title</th>
</tr>
</thead>
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1971

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