The Geophysics of the Trough Tank Gold-Copper Prospect, Australia

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Summary

The Trough Tank gold-copper prospect lies approximately 250 kilometres south-east of Mt Isa in Queensland, Australia. The prospect was initially located by airborne magnetics. Reconnaissance drilling located quartz-magnetite rock with anomalous gold beneath 30–40 metres of Mesozoic cover. There is no bedrock or anomalous geochemistry associated with the anomaly and so it represents a true 'blind' target.

Ground magnetics, induced polarisation, fixed and moving loop time domain EM and drilling have all been employed to detail the anomaly. Drill core laboratory measurements to determine physical properties revealed minimal remanence but strong demagnetisation. The structural complexity of the prospect plus the demagnetising effects made initial drill siting difficult with high magnetite content producing extremely high magnetic amplitudes. Important modifications to published algorithms and modelling programs were found necessary to calculate theoretical anomalies which correspond to measured anomalies.

Dipole-dipole IP over the area defined a broadly anomalous chargeable zone coincident with the postulated sources determined by the ground magnetics. Fixed and moving loop EM using Zonge and SIROTEM equipment permitted greater resolution of the main conductive lithologies and a reasonable structural interpretation was developed. Drilling on EM and magnetic targets to date has intersected up to 41 metres of highly conductive, pyrite-chalcopyrite bearing, quartz-magnetite rocks.

Introduction

The location of the Trough Tank gold-copper prospect is shown in Fig. 1. The regional geology indicated in Fig. 2 shows the area of the prospect to be covered by a sequence of Mesozoic sediments up to 50 metres thick and lying unconformably above Proterozoic rocks of the Kuridala and Staveley Formations. Where these rocks outcrop to the north they comprise schists, amphibolites, carbonaceous shales and meta-quartzites which are intruded by granites and dolerite dykes and sills of various ages.

Also to the north are known gold-copper occurrences such as Starra, a deposit contained in quartz-hematite-magnetite ironstones within the Upper Proterozoic Staveley Formation. To date, geologic reserves for this deposit are 6 million tonnes of 5 g/tonne gold and 2 per cent copper (Collins, 1987).

Exploration at Trough Tank

A reconnaissance aeromagnetic survey by Newmont was flown in the region in 1974 in search of volcanogenic massive sulphide targets. This defined a major magnetic anomaly in an area covered by about 30 metres of Mesozoic sandstones and thus lacking any surface indications or geochemical response. Ground magnetometer follow-up work sited a few percussion drillholes on the main magnetically anomalous features. Massive quartz-magnetitic iron formations without any fresh sulphides or gossanous material were intersected and so the prospect was downgraded. Later discovery of the Starra deposit renewed prospectivity in the area and a more detailed aeromagnetic survey was undertaken in 1986.

A ground magnetometer survey along northeast-southwest grid lines 70 metres apart with a 10 metre reading interval

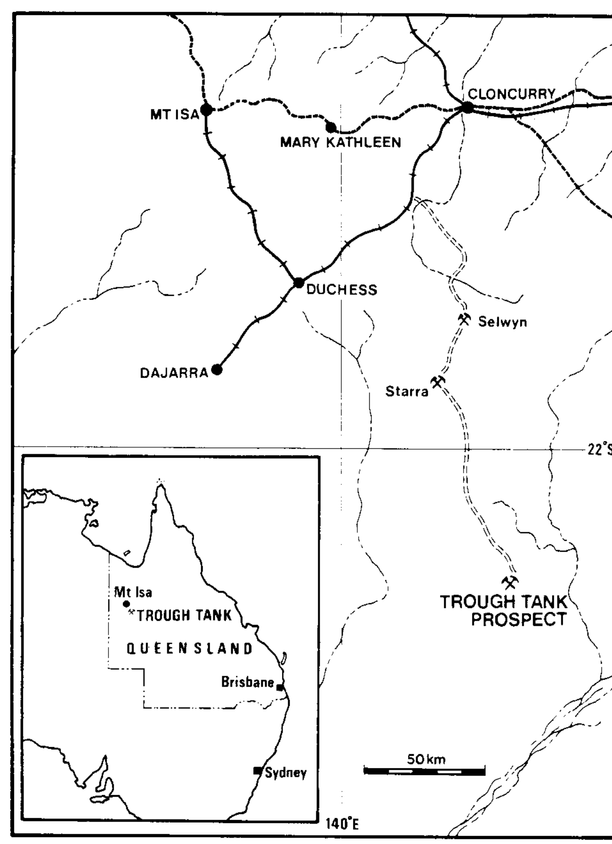

FIGURE 1
Locality map of Trough Tank prospect.

was undertaken. Results are shown in Fig. 3 and reveal a highly distorted magnetic signature indicative of a structurally complex sequence of strongly magnetic lithologies. All measured profiles were exceptionally 'clean' with little or no high frequency magnetic noise being derived from the 30–40 metres of Mesozoic overburden. Based on the observed profiles some drill sites were proposed using conventional 2 ½ dimensional computer modelling.

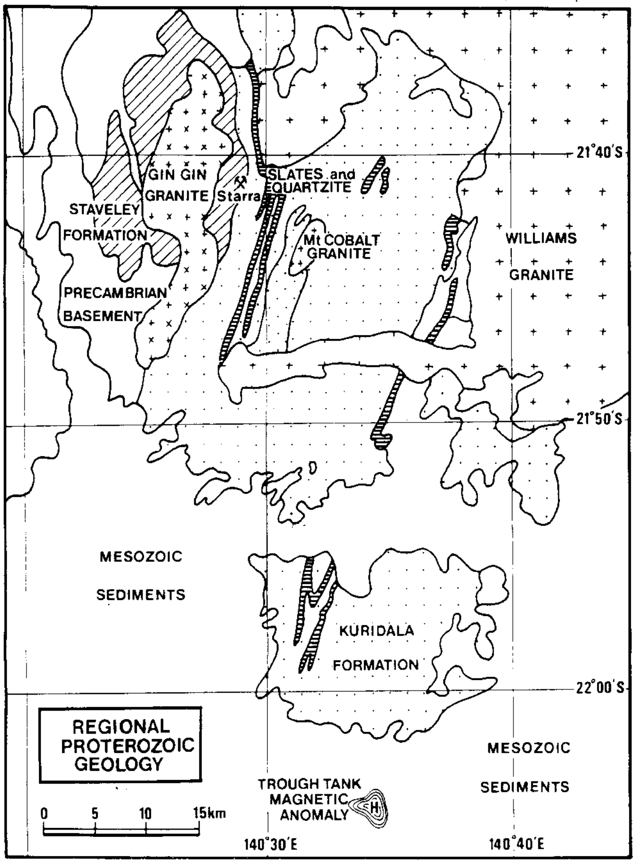

FIGURE 2
Regional geology of Trough Tank area.

The first two diamond drillholes were unsuccessful in intersecting the magnetically modelled source. It was not until the third and fourth holes that it was realised strong demagnetising effects were associated with the high amplitudes of the observed anomaly. A number of laboratory measurements on drill cores containing high magnetite content revealed minimal remanence properties. It was therefore inferred that remanent magnetisation was not the cause of the incorrectly sited initial holes. These same cores however had magnetic susceptibilities as high as 0.5 cgs (6.3 SI) units.

Published modelling programs calculate a 'total field' anomaly as the projection of the anomalous field vector into the regional geomagnetic field direction. For small anomalies, this value closely approximates the scalar intensity anomaly which is actually measured, but the approximation breaks down for strong anomalies. It was therefore necessary to modify the modelling programs to calculate theoretical responses which correspond to measured anomalies (Clark, 1987); Emerson *et al.*, 1985). Successive magnetic modelling (Clark *et al.*, 1987) have enabled more accurate drill positioning despite the demagnetisation problems and structural complexity of the prospect.

Electrical and EM work

An extensive dipole-dipole IP survey over the area defined a broadly anomalous chargeable zone coincident with the modelled sources determined by the ground magnetics. The

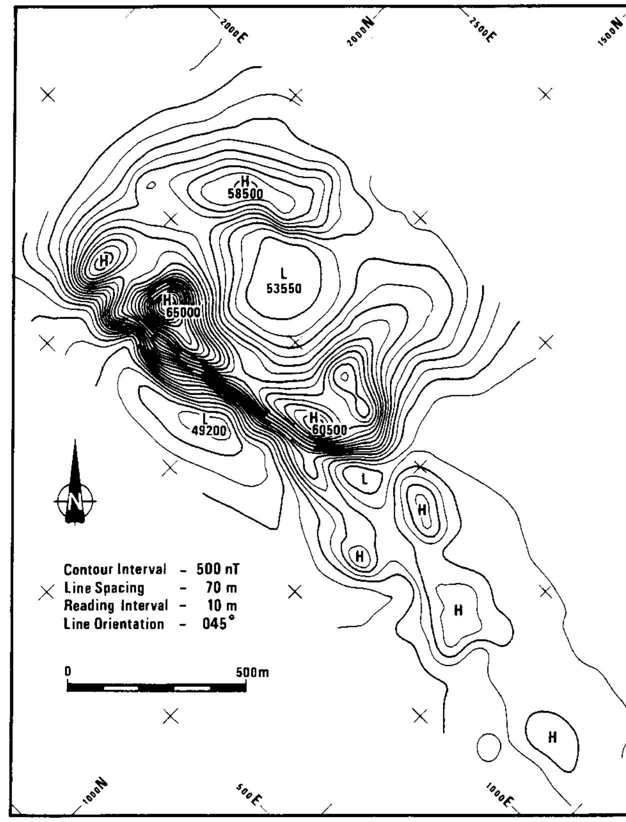

FIGURE 3
Total field magnetic contours from ground survey, Trough Tank.

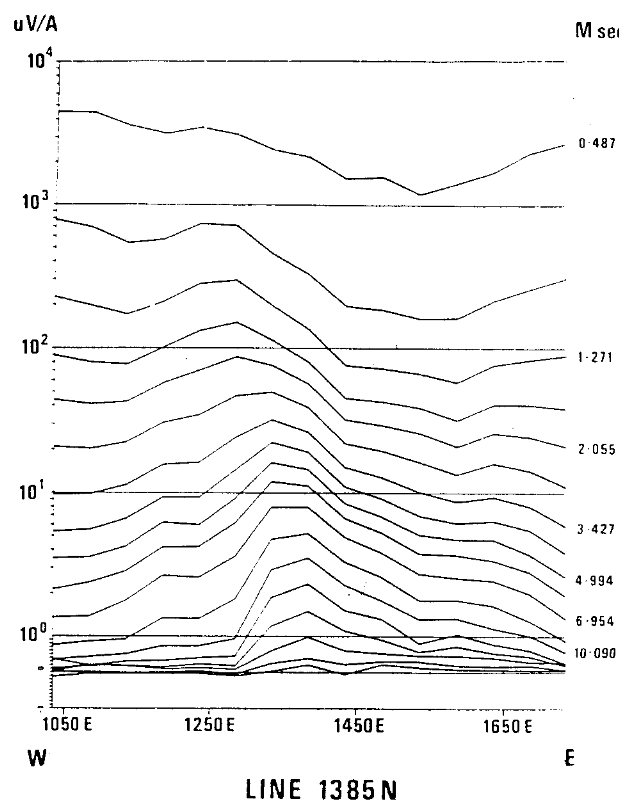

FIGURE 4
SIROTEM profiles using 70 m displaced loops, 50 m moves, Line 1385N, Trough Tank.

survey using 100 metre current and potential electrodes was well suited to detecting chargeable lithologies beneath the 30–50 ohm.metre Mesozoic overburden. Only moderate correlation between resistivities and chargeable zones were observed suggesting the polarizable horizons were not good galvanic conductors.

A survey of fixed loop-roving receiver, time domain EM was undertaken over the anomaly to isolate any conductors indicative of increased chalcopyrite content within the quartz-magnetite rocks, as observed at Starra. The transmitter loops were 300 × 600 metres using Zonge equipment with horizontal and vertical component readings being measured along all lines at 50 metre intervals.

The EM survey results indicated a moderately strong conductor trending south and southeast with good correlation to the magnetic and IP chargeable zones. On some lines a decay constant between 2.9 and 3.5 ms was calculated and this compares well with that observed at Starra (Collins, 1987). The conductor has a strike length of over 800 metres with a structurally complex fold/fault zone in the southeast as is also indicated by the magnetics (see Fig. 3). At Starra, the most structurally complex zones with tightly folded ironstones typically host the greatest gold/copper content. Consequently a series of more detailed moving loop SIROTEM surveys were employed over this area to verify the position of the conductor and assist in defining its structure. A typical response along line 1385N is shown in Fig. 4.

Results

Based on the magnetics and EM conductor positions a number of drillholes were proposed.

To date, up to 41 metres of deformed pyrite-chalcopyrite-bearing quartz-magnetite rocks have been intersected. Mineralisation includes bornite, chalcocite and cuprite with the sulphides associated with the magnetite and/or hematite. Pyrite and chalcopyrite contents vary from trace to over 20 percent plus isolated massive bands. Minor chalcopyrite rimming coarse grained magnetite combine to form a highly conductive series of lithologies with strong structural complexity. Additional drilling is continuing to further investigate this interesting prospect.

Acknowlegements

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Alternative Stacking Techniques for Deep Crustal Data

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Summary

Two of the distinct characteristics of the deep seismic reflection profiles from the Precambrian Arunta Block, Central Australia include the high frequency content (up to 60 Hz) of the reflections at two-way travel times of 6–10 s and the arrival of reflected energy to at least 14 s two-way time with the absence of a 'non-reflective' upper crustal zone.

The data quality is generally good, though individual reflections are short in horizontal extent. Typically reflector segments are continuous over 10–30 traces which makes correlation difficult. Different stacking techniques have been used to try to increase the distance range over which correlations can be made, but with limited success over a CMP stack.

The relatively high level of reflected energy from considerable depth suggested the development of an energy stack. The method is similar to 'reflection strength displays', but instead of modulating a stack with the envelope of the energy density, the energy within a specified time gate is displayed. The energy stack should be applied after equalizing the effective size of each shot to reduce contamination by near surface effects. This approach has a number of advantages:

(a) the interpreter can start to look at packets of energy rather than the normal amplitude display, and the display is not affected by signal polarity.

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