8 FIELD TRIALS OF THE PROTOTYPE SAM RECEIVER

8.1 Introduction

The final requirement of the project was to conduct a series of SAM case studies over known mineralisation, using the SAMCard-enhanced TM-4 as a prototype receiver. Apart from permitting further evaluation of the mapping capabilities of the SAM technique, the studies were to provide a means of assessing the field practicality and functionality of the SAMCard. It was also anticipated that the transmitter-receiver synchronisation and constant sample interval provided by the SAMCard would enable the first effective examination of Total Field Magnetometric Induced Polarisation (TFMMIP) parameters.

This chapter describes the results of three case studies which were surveyed with the prototype SAM receiver. The case studies were selected for inclusion in this thesis on the basis of their significant contribution to our understanding of the SAM method. These include:

(i). **The Taronga Tin Deposit, Emmaville, NSW.** The Taronga site is an excellent IP target. The case study also proved invaluable due to the extreme topography which enabled a preliminary examination of the effect of terrain on the Primary field correction.

(ii). **The HYC Zinc Deposit, McArthur River, NT.** The SAM survey conducted over the HYC deposit was the first opportunity to assess the technique's ability to

define a shallow dipping conductor. In addition, the HYC deposit had been previously surveyed with MIP, enabling a direct comparison of the results of that survey with the results of the SAM survey.

(iii). **A Homogeneous Half-Space, McArthur River, NT.** This survey was considered extremely valuable as it provided the first opportunity to verify the accuracy of the corrections for the Normal and Primary fields.

For all case studies, the same general field procedures were used as were described for the feasibility studies. The main difference was the use of the SAMCard-enhanced TM-4 as the SAM receiver and the SAM-XMT transmitter controller for the Zonge transmitter. Any other variation from that field procedure is described for each of the sites. An evaluation of the SAMCard is included in Section 8.5.

8.2 SAM Case Study #1 - Taronga Tin Deposit, Emmaville, NSW

8.2.1 Location

The Taronga Tin Project site is located in the New England region of northern New South Wales and is centred on the Grampian Range, 10 km north-west of the village of Emmaville (Figure 8-1). The presence of tin in the Grampian Range has been recognised since about 1890. Small alluvial tin operations and sapphire mining have long been a feature of the region. The area has been assessed at different times by various mining companies. The Broken Hill Proprietary Company Ltd (BHP) initially investigated the Taronga Deposit in the 1930s with little success. Operations resumed in the 1950s only to be abandoned again about 10 years later. Following BHP's involvement, several other companies were active in the area, including Australian Geophysical Pty Ltd, Minerals Recovery (Australasia) NL (now known as Pelsart Resources NL) and Endeavour Resources Limited. However, their interest was mainly in the mining of tin-bearing elluvial scree and alluvial tin.

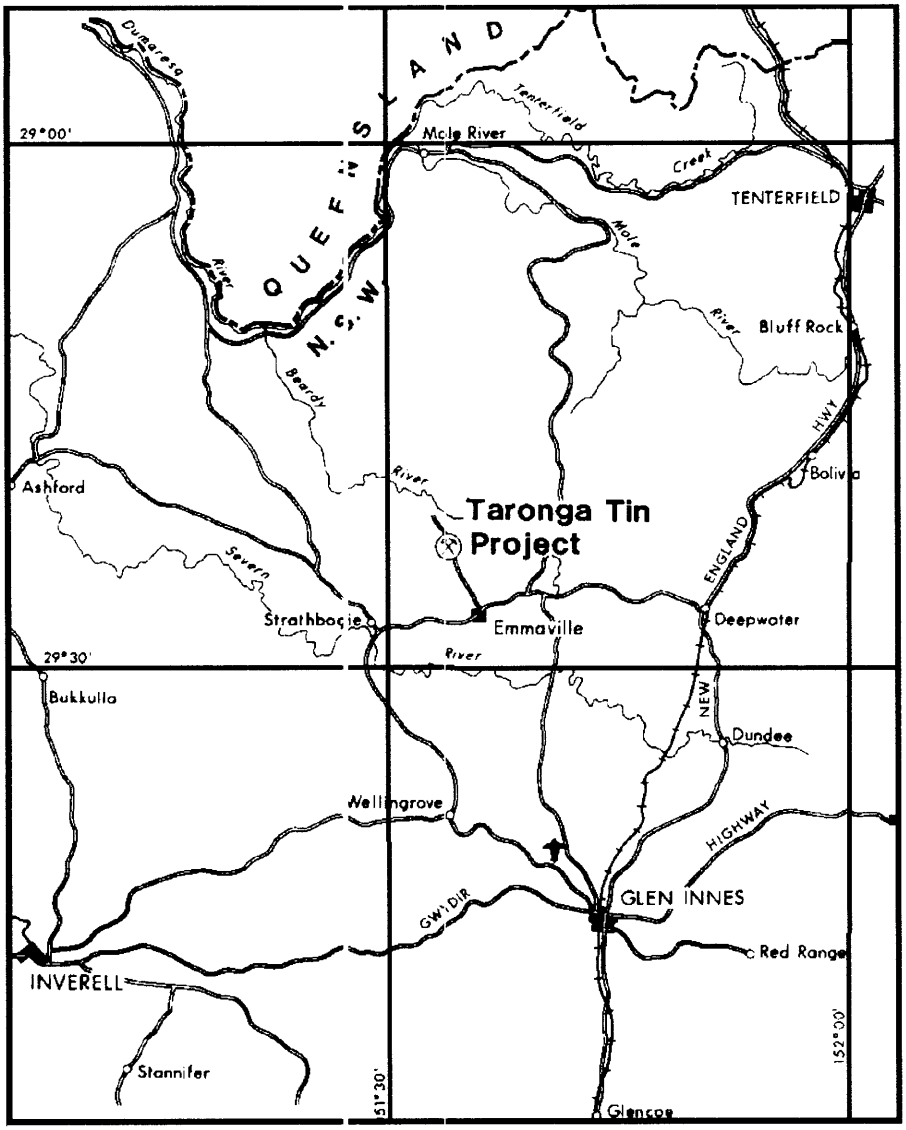

Figure 8-1. Taronga District Map (After Newmont Holdings Pty Ltd, 1982).

In 1978, a Joint Venture Agreement was negotiated between Newmont Holdings, ICI, Pelsart and Endeavour to assess the hard rock tin potential of the combined tenements previously held by Pelsart and Endeavour. Evaluation of the Taronga Deposit, including its geological interpretation and manual reserve estimation was completed in 1981. The total mineable reserves were estimated at approximately 31 million tonnes averaging 0.165% Sn. However, depressed tin prices since that time yielded the deposit uneconomic and mining of the resource has, consequently, been deferred indefinitely.

A SAM survey was conducted over the Taronga Deposit in February, 1995. Grid north was oriented at 41° from magnetic north. The magnetic inclination was -60.2°.

8.2.2 Geological Setting

The regional and local geology of the tin deposits at Taronga is described comprehensively by Newmont Holdings Pty Ltd (1982) and summarised by Cattach (1985). They occur within a sequence of Permian sediments, volcanics and intrusives. The site's regional setting is depicted in Figure 8-2. The region's basement is the Grampian Formation which consists of an Early Permian deep marine flysch sequence of interbedded siltstones, sandstones and greywackes. The flysch sequence contains the tin mineralisation and is locally termed the Taronga siltstone.

Several major lenses of slump conglomerates interfinger with the siltstone toward its upper limits. The conglomerates appear to have been formed as a result of tectonic uplift which was also responsible for a minor phase of basic volcanism, culminating in several small lava flows which are generally confined to the conglomerate horizons.

A shallow marine massive mudstone comprises the uppermost unit of the Grampian Formation. This formation is conformably overlain by the Emmaville Volcanics, a thick sequence of predominantly terrestrial acid volcanics.

A second sequence of volcanics unconformably overlie the Grampian Formation and the Emmaville Volcanics. Three distinct units are apparent in the period.

(i). An unnamed basal unit, identical in lithology to the Emmaville Volcanics, restricted to an area south of the Mole Granite.

(ii). An overlying andesite unit called the Tent Hill Porphyrite.

(iii). An ash fall or ash flow tuff called the Dundee Rhyodacite Porphyrite, outcropping over an area of 600 square kilometres.

This period was marked by igneous intrusion and mineralisation, the oldest of which is the Taylor's Adamellite which outcrops in a series of stocks and dykes. The Mole Granite, a coarse-grained leucocratic granite, is the largest and most recent intrusive and is the source of all tin-tungsten-molybdenum mineralisation in the Taronga region.

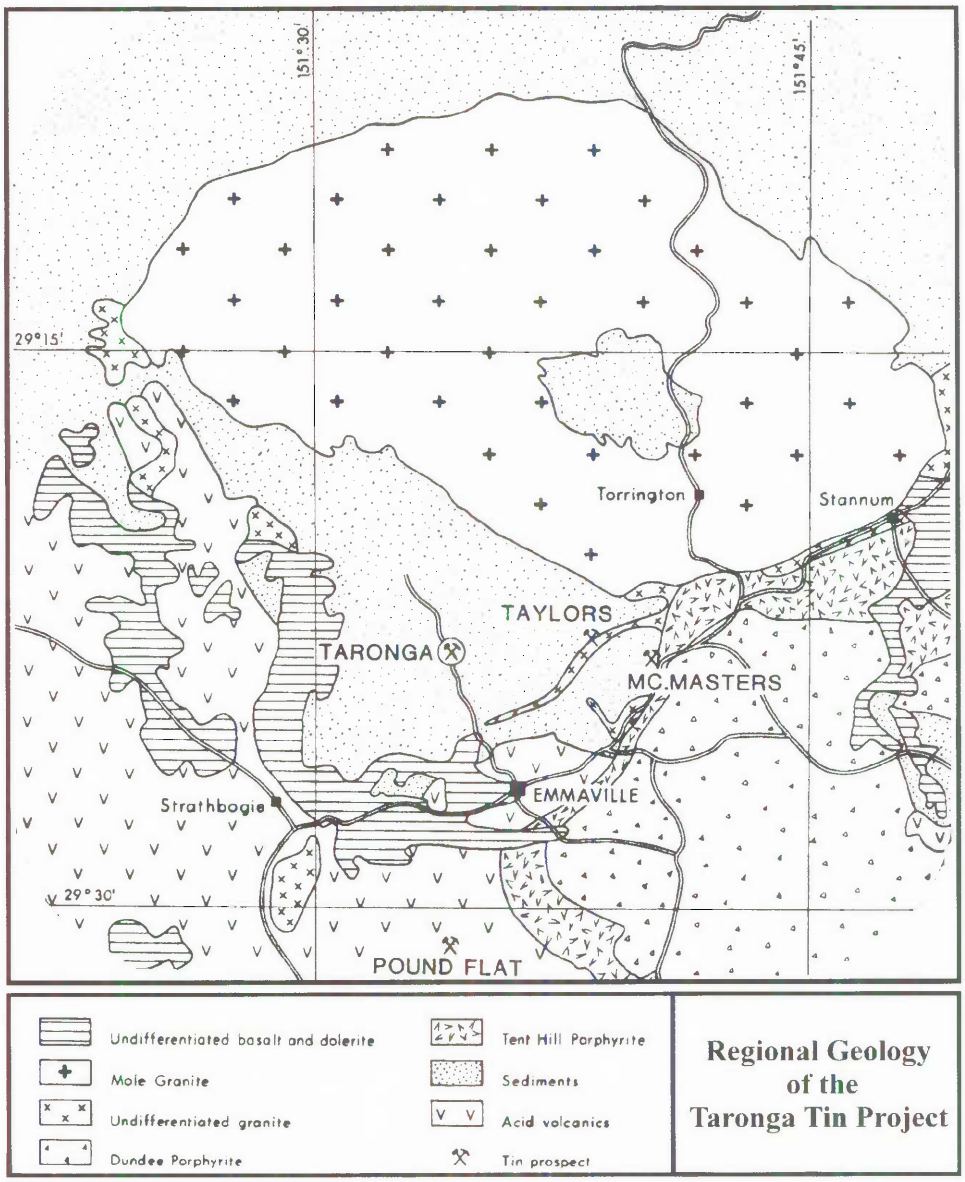

Figure 8-2. Taronga Tin Project Regional Geology (After Newmont Holdings Pty Ltd, 1982).

Since the intrusion of the Mole Granite, the region has undergone continuous erosion except for the Tertiary Period when much of the area was covered by basaltic flows. The region had suffered only minor deformation prior to the intrusion of the Mole Granite, creating long wavelength, low amplitude folds in the Early Permian units. However, the emplacement of the granite has had a major structural impact on the overlying sediments which host the Taronga mineralisation.

Subsequently, mineralisation fluids which emanated from the crystallising granite, concentrated in areas of sheeted veining, particularly overlying granite cusp areas. Post-dating the tin mineralisation, a second intrusive phase of the Mole Granite produced a joint-controlled stockwork containing tungsten-molybdenum-bismuth mineralisation with associated strong phyllic alteration. The Taronga district geology is depicted in Figure 8-3.

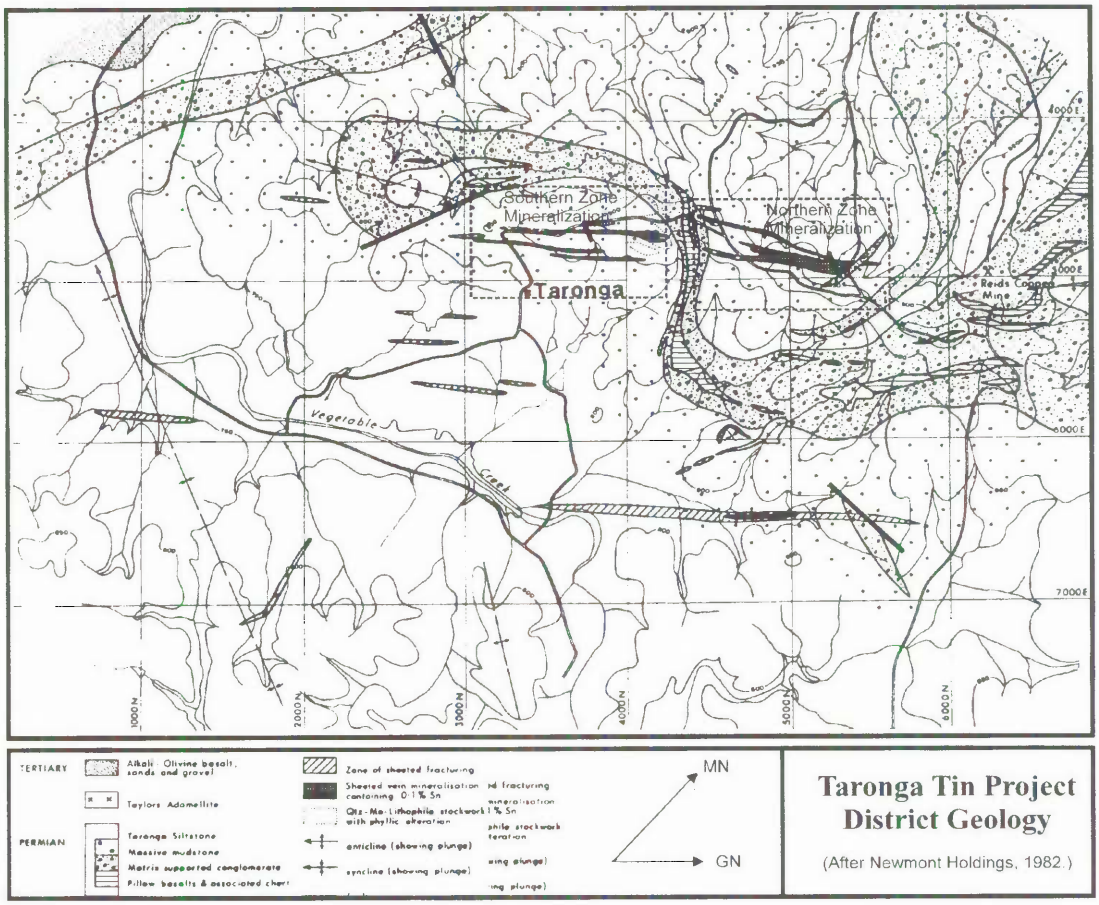

Figure 8-3. Taronga Tin Project District Geology (After Newmont Holdings Pty Ltd, 1982).

8.2.2.1 Form of the Mineralisation

Two main mineralised zones, the Northern and Southern zones, comprise the Taronga tin deposit (see Figure 8-3). These are separated by 500 m of a complexly folded and faulted conglomeratic mudstone-metabasalt-chert unit. The Southern Zone is comprised of four main vein swarms, whereas the Northern Zone is a complex series of subjacent vein swarms arranged in a right lateral en-echelon pattern.

> *"The sheeted veins are composed of columnar intergrowths zonally arranged, commonly with a muscovite selvedge, mantled in turn by quartz, topaz, arsenopyrite, and fluorite, with cassiterite and chalcopyrite providing the inner core. The tin mineral, cassiterite, forms coarse, unevenly distributed crystals which tend to cluster on vein surfaces. However, approximately 10% of the total tin occurs as fine intergrowths along vein selvedges"* (Newmont Holdings Pty Ltd, 1982, 2-1).

Of the total mineral assemblage, sulphides, of which arsenopyrite is dominant, represent 5 to 8% by weight. Also present are minor to trace amounts of pyrite, chalcocite, covellite, chalcopyrite, galena and sphalerite.

The SAM trial was conducted over the Southern Zone Mineralisation. A geological cross-section across the mineralisation on Line 3525 mN is included as Figure 8-5. which is shown in plan form in Figure 8-4. The location of the cross section is shown with respect to the mineralisation in Figure 8-4 by Line A-A'.

Figure 8-4. Taronga Southern Zone Mineralisation (Drawn From Newmont Holdings Pty Ltd, 1982).

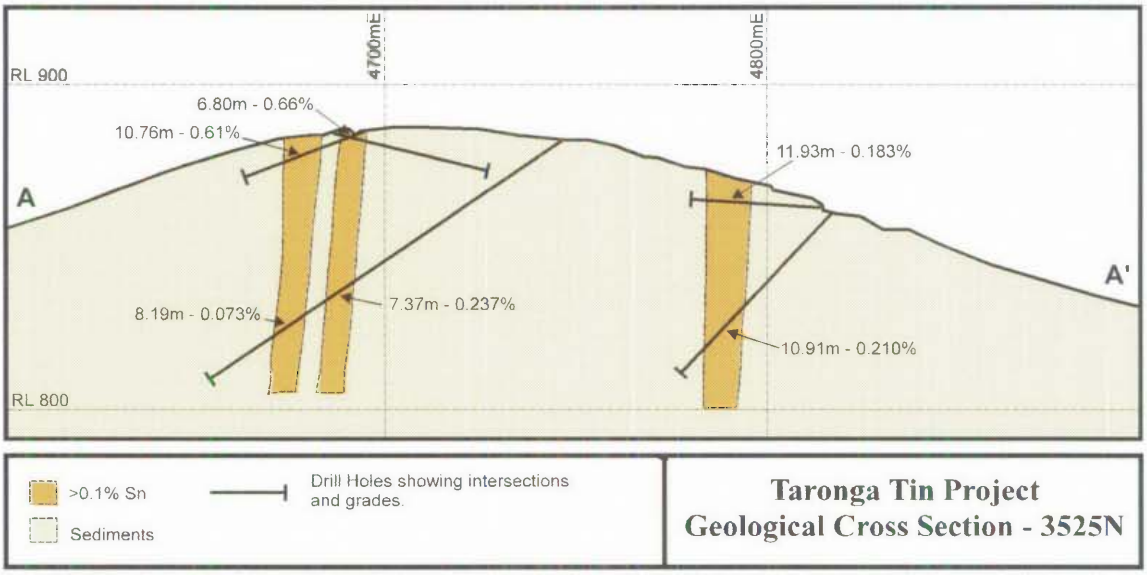

Figure 8-5. Geological Cross Section - Line 3525 mN (Drawn From Newmont Holdings Pty Ltd, 1982).

8.2.3 Prior Geophysics

In 1980, the Taronga Deposit was mapped with dipole-dipole array induced polarisation surveys. The technique proved to be ideal for defining the general zone of the mineralisation with both chargeability and resistivity parameters showing significant contrasts. The dipole-dipole pseudosections from Line 3525 mN shown in Figure 8-6 were typical of the data recorded over the mineralisation. As can be seen from the figure, the chargeability anomaly is a typical inverted "V" shape centred on 4790 mE with a more intense western flank due to the influence of the mineralisation at about 4680 mE. The apparent resistivities varied from 250 ohm-m in the mineralised zone to in excess of 3000 ohm-m in the host rock. The metal factor (MF) pseudosection shown in the figure is derived by dividing the chargeability data by the apparent resistivity data and, consequently, emphasises zones of high chargeability and low resistivity.

In its standard configuration, the IP technique failed to resolve the individual veins. However, high definition dipole-dipole IP surveys conducted by Cattach (1985) demonstrated that IP/resistivity was capable of resolving the main mineralised zones but was impractically slow and expensive for routine application.

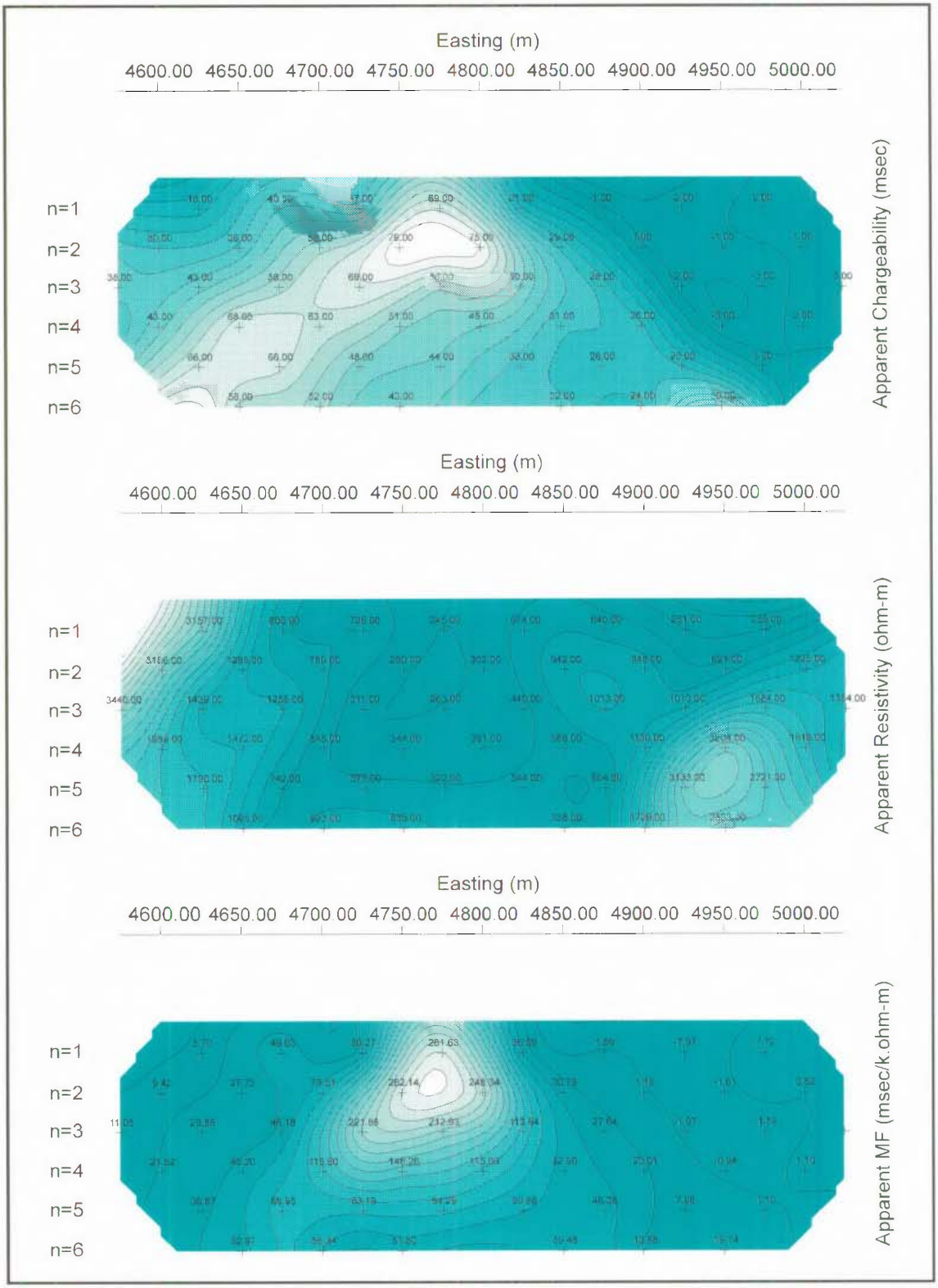

Figure 8-6. Taronga - dipole-dipole array IP pseudosection from Line 3525N (Drawn From Cattach, 1985).

8.2.4 SAM Field Procedure

A single 500 m x 500 m grid was surveyed at the Taronga site. The boundaries of the survey area were defined in local coordinates as shown in Figure 8-7. Electrodes were emplaced at 4807 mE; 4202 mN (C1) and 4790 mE; 3275 mN (C2). Because of the high resistance of the country rock, the transmitted current was maximised by establishing three electrodes at each end of the grid. Each of the electrodes was approximately 1.5 m^2 in area and separated from each other by about 2 m. However, in spite of the effort put into electrode preparation, the maximum current which could be maintained was 2.5 A.

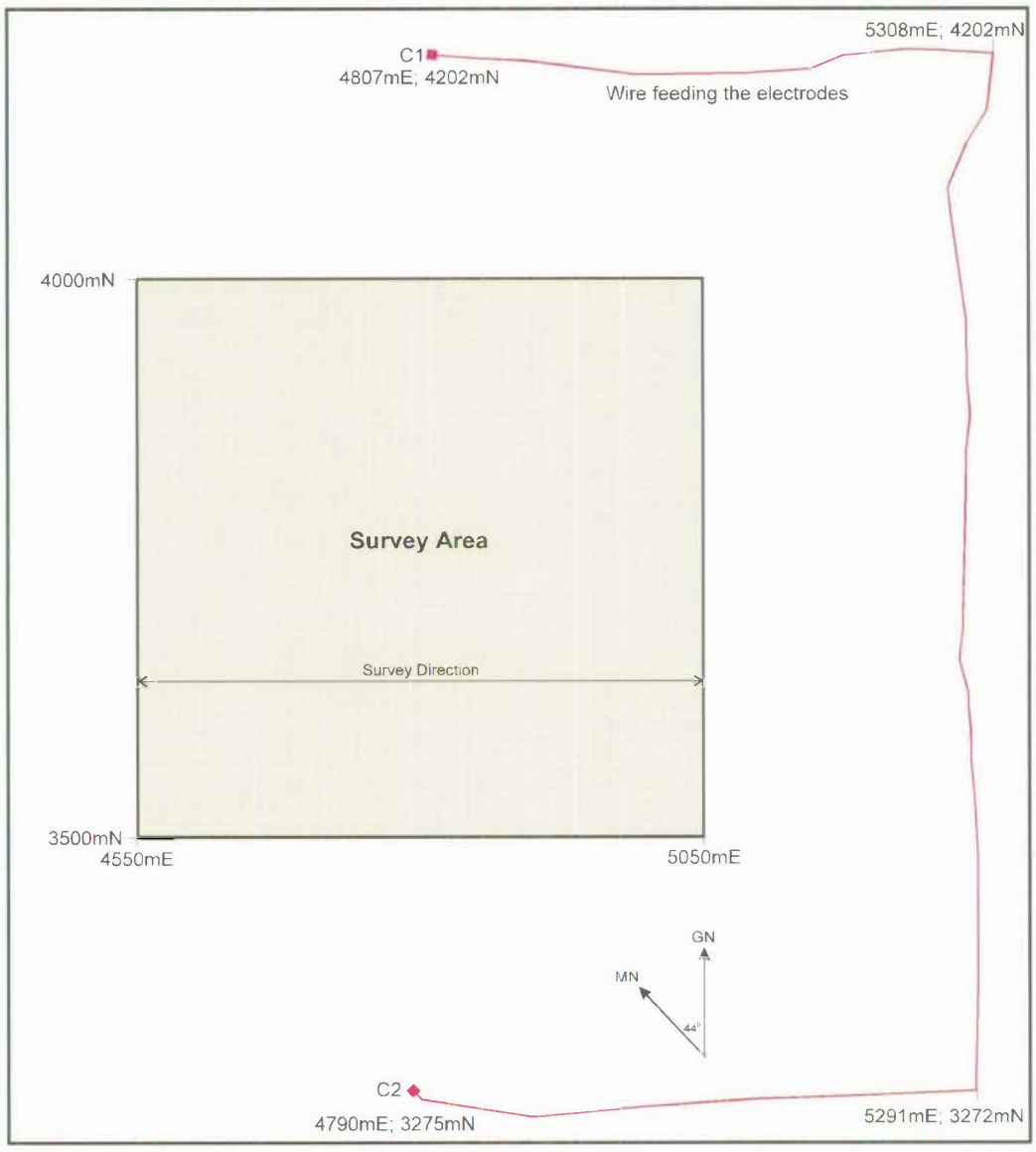

Figure 8-7. Schematic showing the layout of the electrodes and their feeding wires with respect to the survey area.

It was intended that the wire feeding the electrodes be laid out in a "U" shape to the east of the survey area. However, the site was quite steep and heavily wooded in places and the location of the wire was dictated largely by accessibility. The position of the wire was mapped after completion of the survey and is shown in plan form in Figure 8-7. The locations of the survey area and the wire are shown with respect to the topography in Figure 8-8.

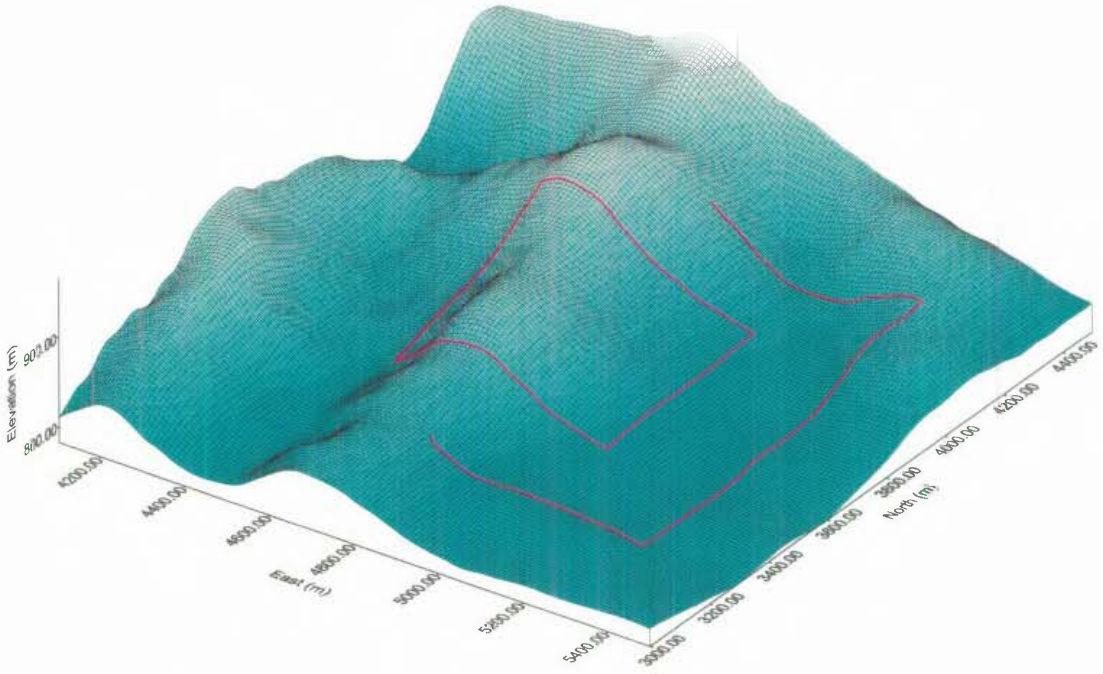

Figure 8-8. The location of the survey area and current-carrying wire with respect to topography.

The transmitter was governed by the SAM-XMT controller, configured to produce an 8 Hz, 100% duty cycle square wave. The SAM signal was sampled at the rate of 1024 samples per second. However, the waveforms were averaged to a single 128 point waveform per second prior to recording, thus resulting in an 8 times reduction in data volume. Data were recorded along lines orientated grid east-west and spaced 10 m apart. High definition magnetic data were recorded at 0.5 m sample intervals.

The site was particularly difficult to traverse as a result of the topography and the effects of prior mining and exploration activities in the area. The requirement to negotiate felled trees and scree slopes as well as steep cliff faces restricted the average survey speed to about 1 km per hour.

8.2.5 Results

8.2.5.1 Total Magnetic Intensity (TMI)

The total magnetic intensity data were corrected for diurnal variation and upward continued to an elevation of 2 m to reduce the effect of the near-surface contamination. An image of the data is shown in Figure 8-9. The data were severely affected by cultural contamination, particularly by the presence of collared drill holes and assorted scrap metal. Short north-south trending linears are due to road cuttings leading to drill pads. The mineralisation itself is not magnetic and, consequently, does not manifest in the image. However, a longer wavelength anomaly is apparent in the data.

In order to investigate this feature further, the data were upward continued to an elevation of 25 m. The result of the procedure is shown in Figure 8-10. The image shows a distinct "low" with a curvilinear boundary on the east at about 4900 mE. The magnetic low is interpreted as being due to an extension of the Mole Granite which is believed to be the source of the tin mineralisation in the Taronga Region.

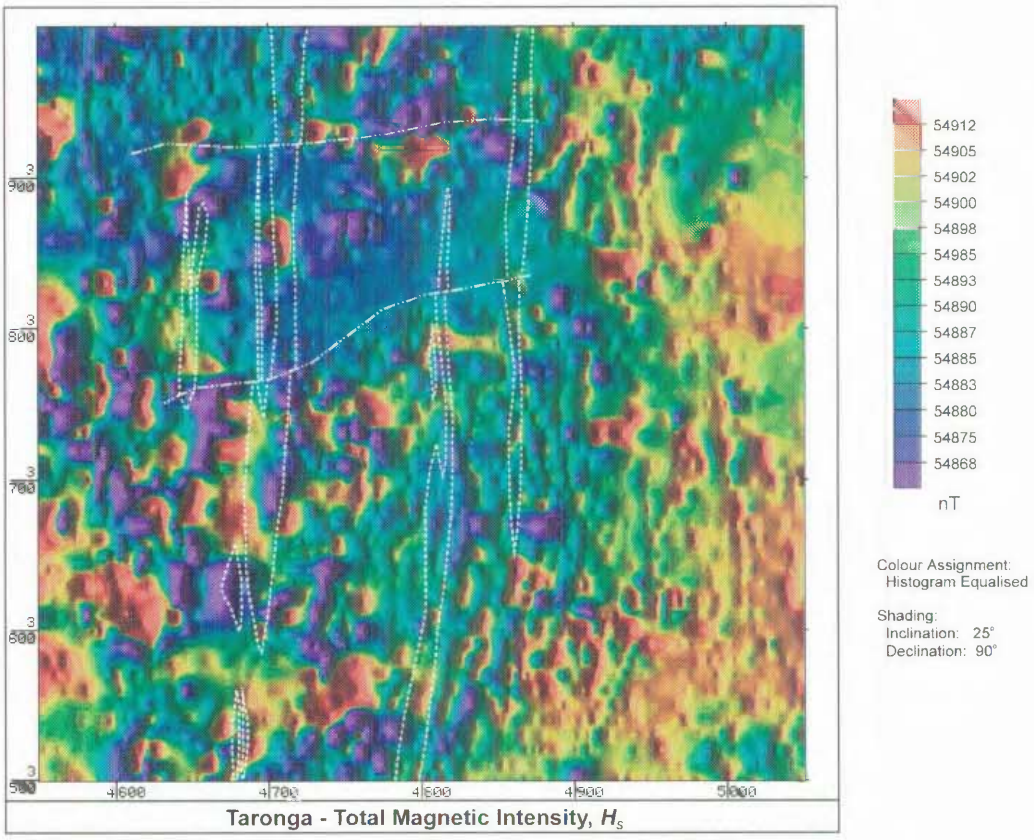

Figure 8-9. Taronga - Total Magnetic Intensity, H_S.

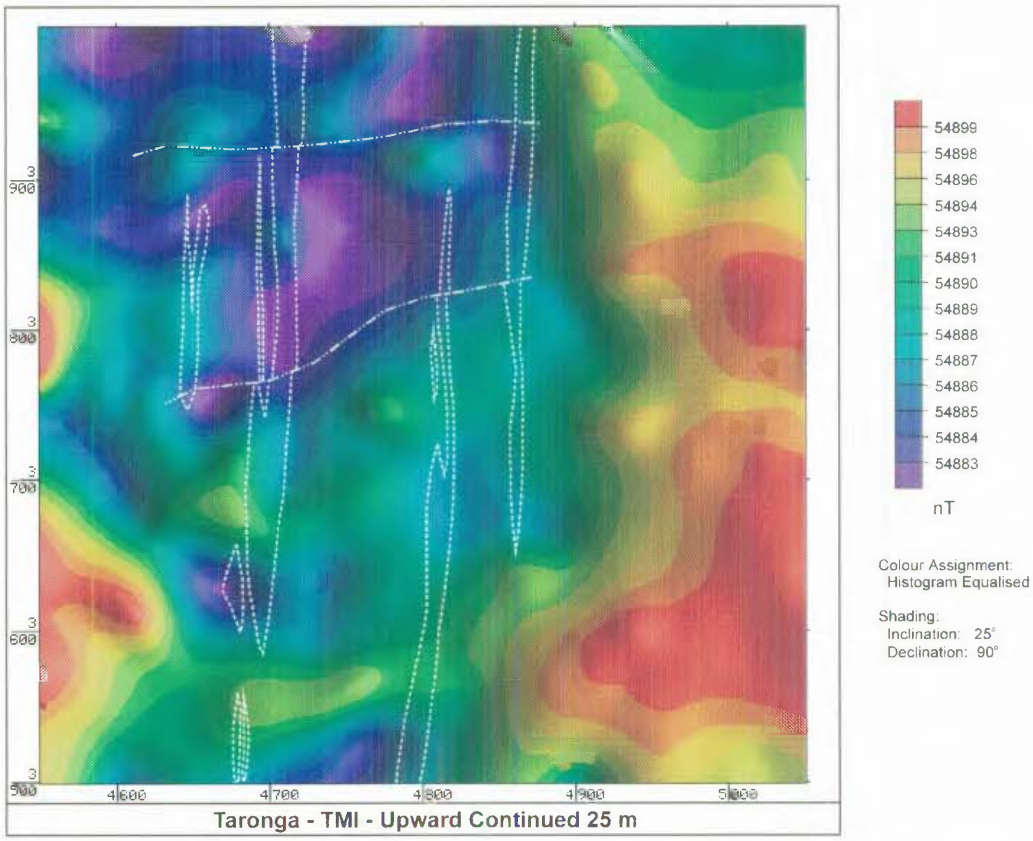

Figure 8-10. Taronga - TMI - Upward continued to 25 m.

8.2.5.2 Total Field Magnetometric Resistivity (TFMMR)

The SAM waveforms were slope corrected and the amplitude of the signal, H_{Mod}, was determined by calculating the amplitude of the fundamental frequency and correcting for its relationship to the square wave, as per the feasibility studies. The polarity of the signal was determined by calculation of the phase with respect to the transmitted current. H_{Mod} was corrected for the Primary field, $H_{Primary}$, and normalised by subtraction of the Normal field, H_{Normal}. An image of the normalised TFMMR, H_N, is shown in Figure 8-11. H_N reduced to the pole is shown in Figure 8-12. An overlay of the outline of the geology from Figure 8-4 is included on all images.

As can be seen from the image in Figure 8-11, the H_N parameter has detected a broad conductive zone and three well-defined north-south trending linear anomalies. The western boundaries of the linears correlate with the known locations of the three main vein swarms. Reduction to the pole was found to have the effect of aligning the anomalies over the mineralised zones.

Another more subtle, sub-parallel feature was detected at about 4950 mE. This anomaly does not correspond with known mineralisation and its cause is unknown. It possibly correlates with the boundary of the magnetic "low" discussed in Section 8.2.5.1. A linear feature coincident with the location of a known fault at about 3800 mN is also visible in the image. However, it was suspected that its detection may have been largely due to the fact that it coincides with a major topographic feature.

Colour images have the effect of suppressing detail in order to accommodate dynamic range. An attempt at enhancing the detail in the image was made by calculating the first vertical derivative of the data shown in Figure 8-12 and is illustrated in Figure 8-13. The result of the process was to highlight the linears. No other significant features were detected.