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Inversion of Time Domain Spectral IP Data

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Summary

A part of the Tasmanian Mines Department's Mount Read Volcanics Project involved the collection of IP data from a variety of materials to define the expected signatures of massive sulphides, barren sulphides, alteration zones and relatively unaltered host rocks. In all data were collected from some 70 sites using time domain equipment. These data provide a unique uniform collection of in situ property measurements for western Tasmania.

The possibilities of mineral discrimination by fitting Cole-Cole models to the in situ data appear excellent. The economic massive sulphides are characterised by a distinct field of m-tau values bounded on the lower m side by a class of black shales and on the low tau side by other sulphide mineralization.

Discussion

In terms of polarizable targets, the West Coast of Tasmania contains a variety of ecomomic and barren sulphide deposits, together with black shales. These form a number of world-class mines including the Renison Bell tin mine, the Mt Lyell

copper-gold ore bodies, the Rosebery base-metal mine and the recently discovered Hellyer deposit together with a large assortment of polarizable but uninteresting formations. The Tasmanian Mines Department recently initiated the 'Mount Read Volcanics' project involving projects in geology, geophysics and geochemistry, aimed at enhancing the understanding of the mineral deposits of western Tasmania and encouraging further exploration.

One of the experimental aspects of the geophysical part of the project involved the collection of time domain IP data from a wide range of materials using *in situ* measurements with small electrode spacings of 1–2m. In all some 70 sites were studied including traverses through ore in mines at Mt. Lyell, Rosebery and Que river, a barren pyrite deposit at Chester, a selection of black shales and alteration zones.

The purpose of these measurements was threefold. Firstly, to obtain a uniform systematic set of basic rock properties for geophysical modelling and the interpretation of field data, secondly to secure data to add to the information on the geophysical 'signatures' of known deposits, and thirdly to experiment with the possibility that spectral IP parameters might be of use in target discrimination. Some preliminary studies by Bishop & Lewis (1984) and Mather (1985) had indicated that discrimination might be feasible.

The data was obtained with a standard Huntec Mark IV receiver and included both full and partial waveform recordings. A uniform set of observations using a 50ms delay followed by 10 windows of 150ms was obtained together with some data using other windows. At this time only partial waveforms have been analysed using essentially the method outlined in Lewis (1985). There is thus the possibility of improving parameter resolution using selected other data from the rest of the waveform. Interpretation involves the iterative non-linear least squares fitting of parameters to data using an anologue of the well known Marquardt algorithm. While previous work has examined in detail the quality of fit between model and data, here the process was regarded as a simple production tool and all results have been used without selection.

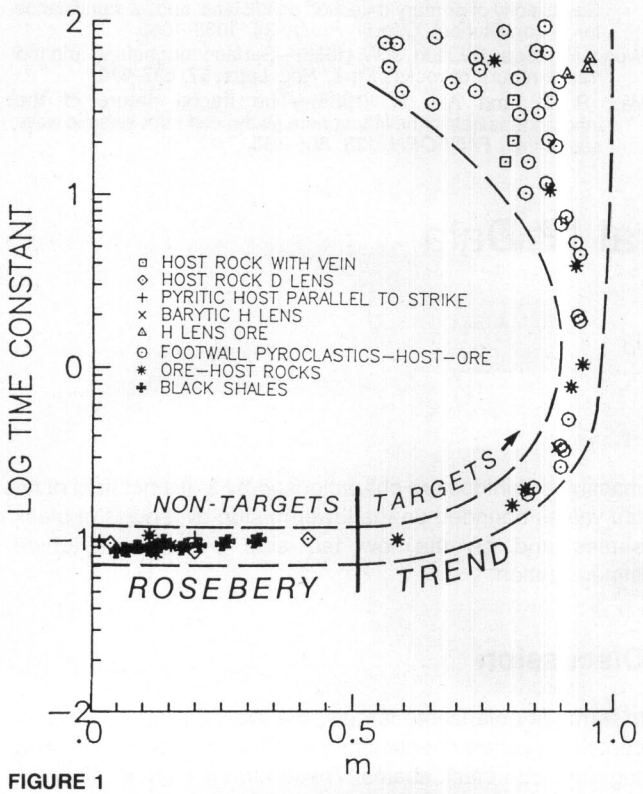

FIGURE 1
m-tau plots for the Rosebery Mine IP data.

The results may be conveniently examined in diagrams where various combinations of the 4 Cole-Cole parameters are plotted against one another. For discrimination purposes it seems that tau-m and c-m plots are the most useful. Preliminary work at Rosebery and Hellyer suggested that a pattern, the 'Rosebery Trend' characterised these deposits (Fig. 1.). In contrast, results from the Chester Mine, a massive barren pyrite deposit (Fig. 2) show that the Chester mineralization falls within the uninteresting target field of the older data. A further example of the central volcanic belt sulphide mineralization from Howard's Anomaly on the Anthony Road, is also quite distinct from the other economic mineralizations (Fig. 3).

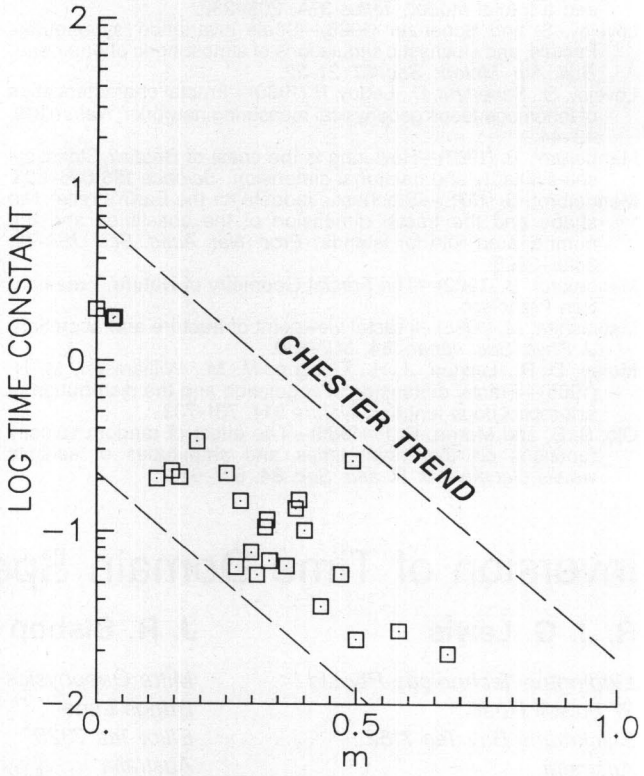

FIGURE 2
Special IP data for the barren pyrite deposit at Chester.

Alteration zones near mineralization can show appreciable frequency dependence but high resistivities and modest time constants, higher than some of the black shales, as shown in data from the Hercules Mine area (Fig. 4 and 5).

In summary the material of western Tasmania show a wide range of Cole-Cole properties which may be synthesised as shown in Fig. 6. The economic targets are characterised by high values of m and tau and on such a criterion are quite distinctive.

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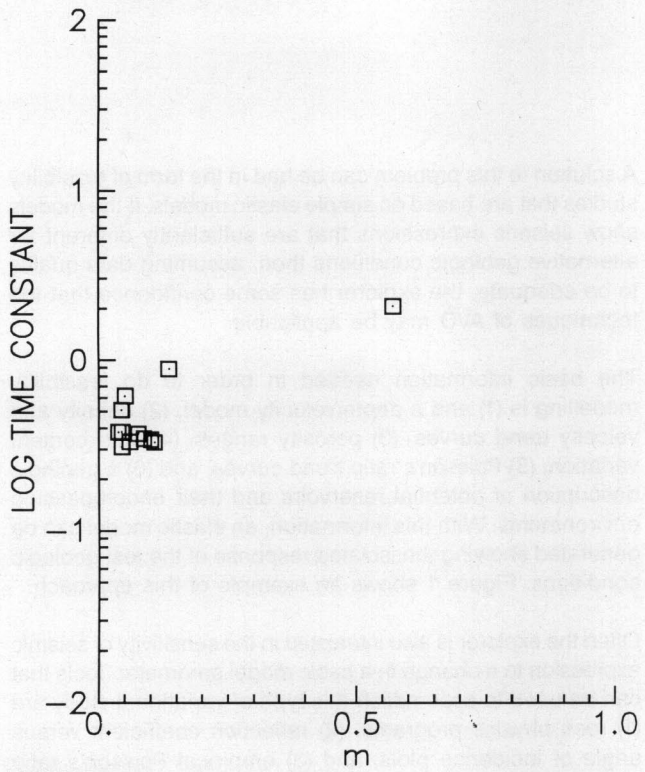

FIGURE 3
The Howards Anomaly mineralisation appears uneconomic.

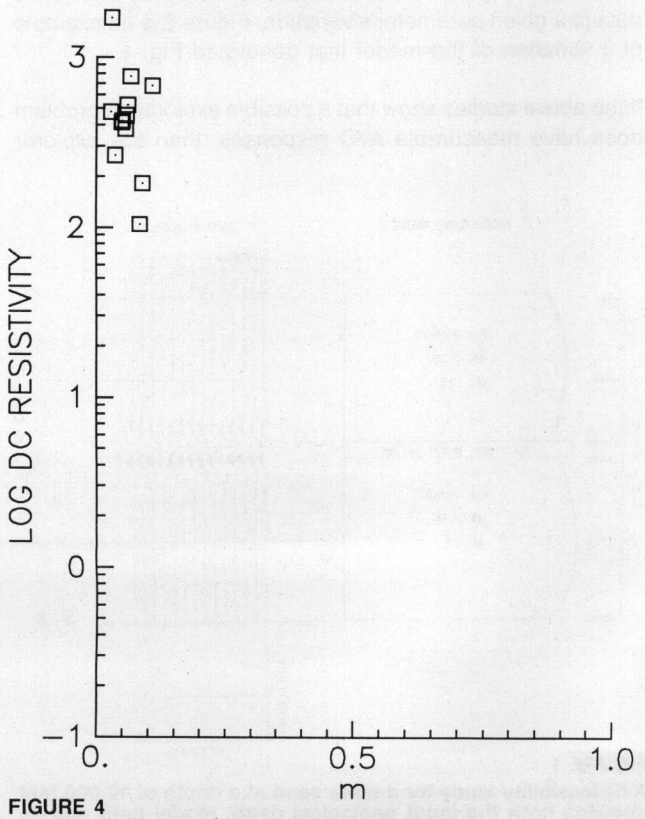

FIGURE 4
Alteration at Hercules has very low m values.

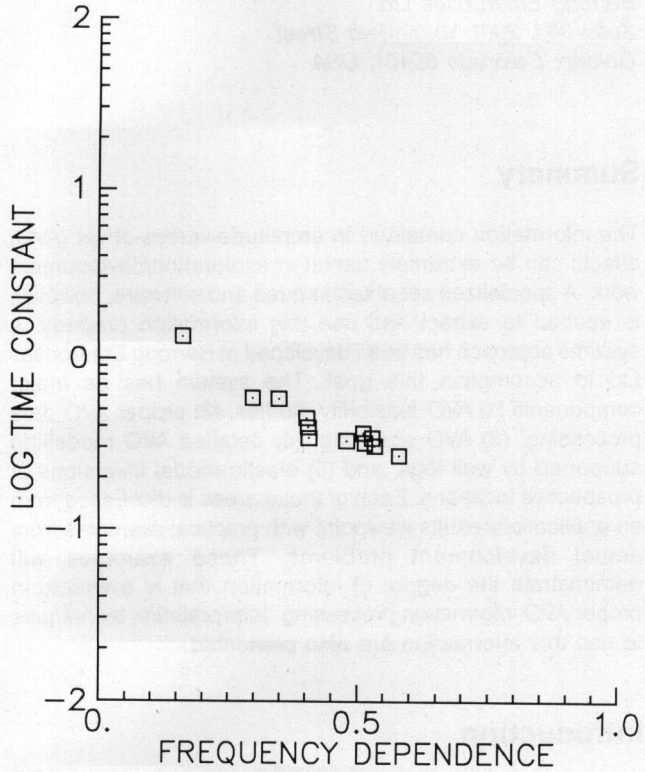

FIGURE 5
Hercules alteration shows a range of c values.

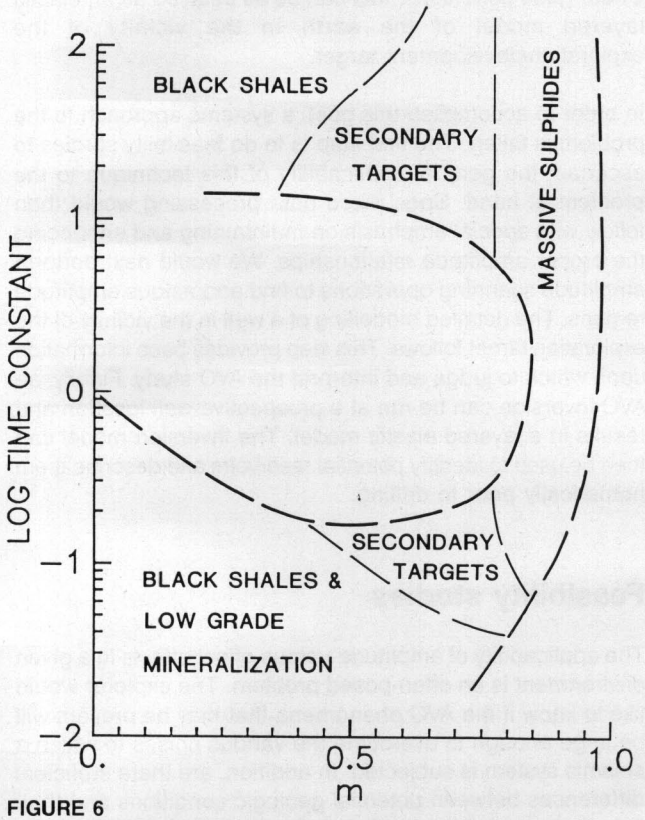

FIGURE 6
A synthesis of the spectral IP data for western Tasmania.