Time domain spectral IP measurements from the Rosebery mine

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The Rosebery mine is a volcanogenic massive sulphide deposit located on the west coast of Tasmania. Before mining, the deposit contained in excess of 15 Mt of ore with grades averaging 18% zinc, 5.5% lead, 0.5% copper, 187 g/t silver and 3.8 g/t gold. The mine lies in a sedimentary sequence within the Cambrian Mt Read Volcanics and the sulphides occur in association with (pyrite-bearing) 'Black Shales', within altered and pyritized 'Host Rocks'. The 'Footwall Schists' are siliceous and also contain disseminated pyrite. The hanging wall 'Massive Pyroclastics' are unaltered (Fig. 1).

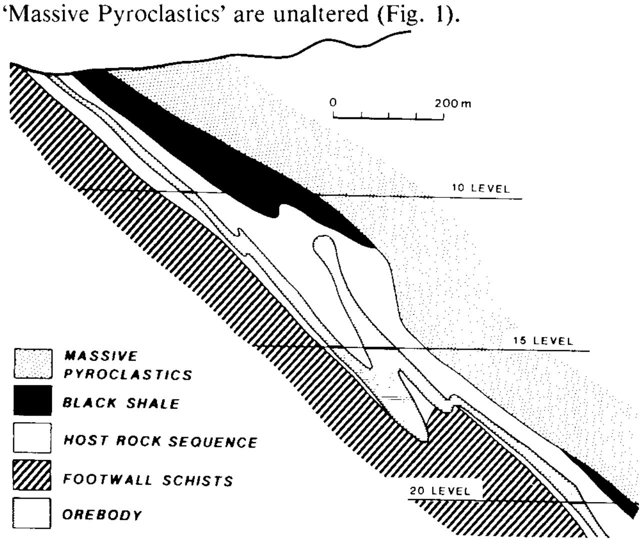

Fig 1 Typical cross-section of the Rosebery deposit (after Burton 1975).

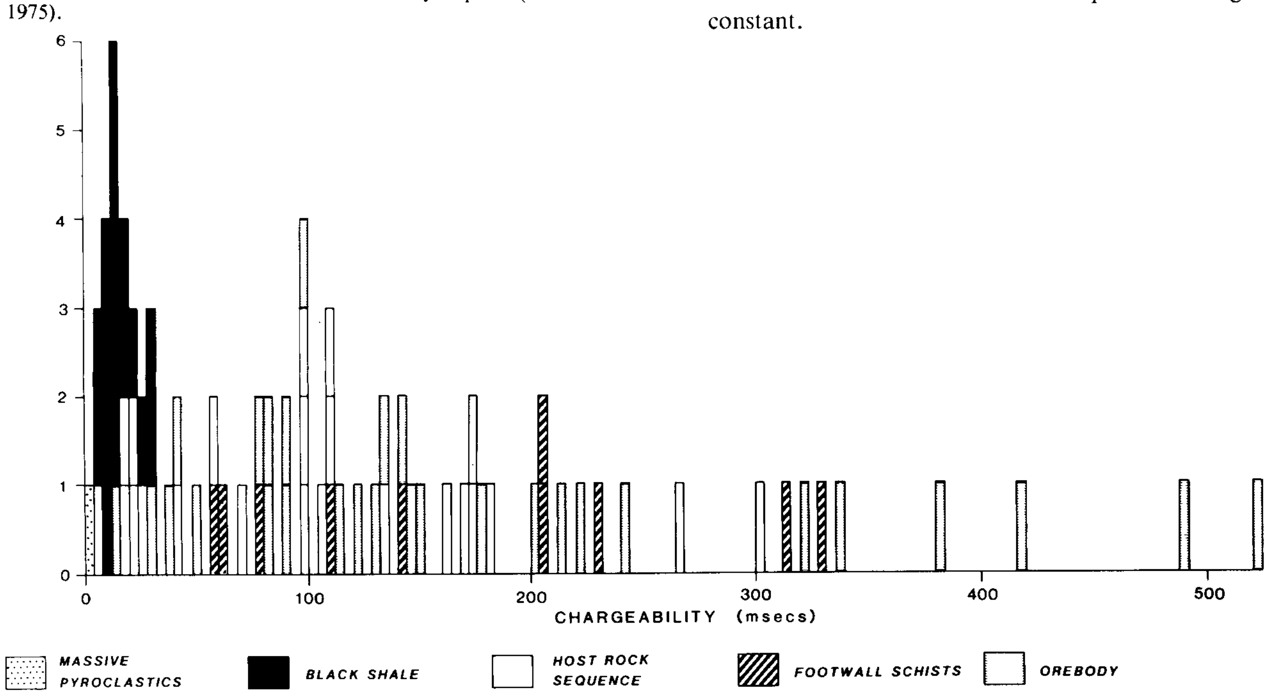

Fig 2 Histogram of measured chargeabilities. Although the black shales have low values, so do some ores.

A series of underground IP measurements were carried out to determine the spectral parameters of each of these rock types. (The black shales could not be entered from the workings and were measured on the surface, in a bulldozed pit.) In particular, it was hoped that the technique would be able to distinguish the ore from the black shales—this not being possible from the measured chargeabilities (Fig. 2).

Dipole-dipole arrays of 1 m length were used with separations of 1 m and 2 m, to ensure that only the one rock type was being sampled. A battery powered 'Lo-Po' transmitter was used with a Huntec Mark Four receiver to record the data. Normal field procedures were employed and no particular effort was made to collect accurate (i.e. very repeatable) data.

The data was first analysed by fitting an exponential to the late-time values (after Tyne 1981). Although excellent fits were obtained, there was no separation of rock types (Fig. 3). Next, the data was inverted to the Cole-Cole dispersion:

$$\rho(\omega) = R_o\,(1 - m(1 - \frac{1}{1 + (i\omega\tau)^c}))$$

Where $\rho(\omega)$ is the complex resistivity of the ground at frequency ω, R_o is the DC resistivity, c the frequency dependence, τ the time constant and m is commonly called chargeability. No corrections were made for electromagnetic coupling and the data was fitted to only one Cole-Cole model. Good fits were obtained to the data. Using this model, the rock types were separated, especially the black shales. The best discrimination was obtained in a plot of m against time constant.

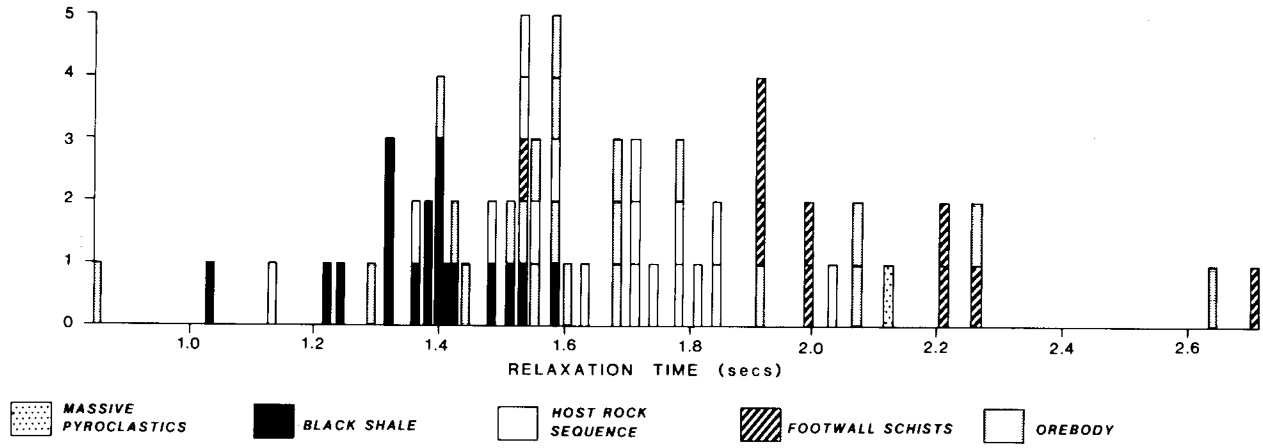

Fig 3 Histogram of relaxation times. (Exponentials were fitted to the late-time data: $Ae^{-t/\tau}$, where τ is relaxation time.)

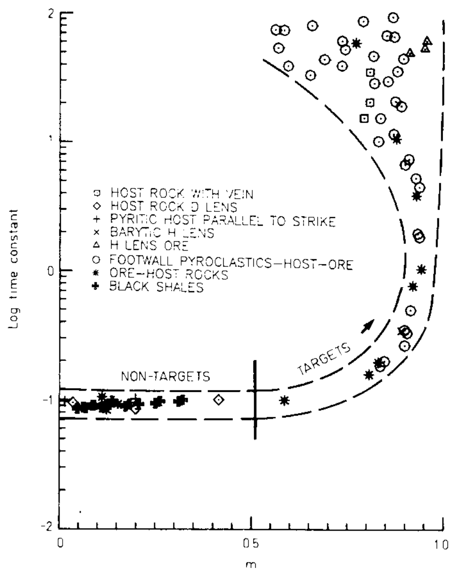

Fig 4 Plot of data in time constant–m space.

This is indicated in Fig. 4 which shows a remarkable trend of values in τ–m space.

Although the black shales here had generally low chargeabilities, so did some of the ores. A much better separation was obtained from the spectral parameters. This work now needs to be extended to see if similar results can be obtained from other areas.

References

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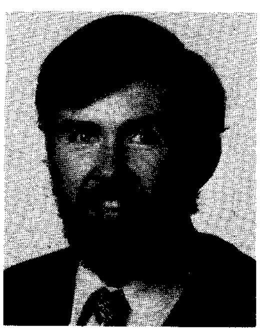

John Bishop received a BSc from the University of Sydney in 1967 and a PhD from Macquarie University in 1979. He had several years government and industry experience before going to Macquarie University where he taught geophysics and investigated physical properties of rocks. In 1980, he formed Mitre Geophysics Pty Ltd, a Tasmanian based consulting company specialising in mineral exploration. He is a member of ASEG, SEG, EAEG, and AIG.

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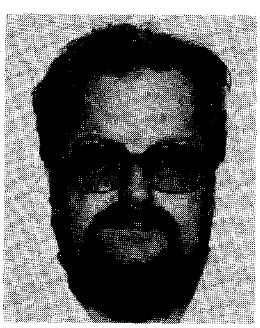

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