The application of geophysics to the discovery of the Hellyer ore deposit, Tasmania

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Introduction

In August 1983, a drill hole aimed at a deep conductor in Northwestern Tasmania intersected 24 m of high grade base and precious metal mineralization at a depth of 120 m. This intersection proved to be the small, shallow end of the 15 Mt Hellyer deposit (Sise & Jack 1984; Eadie & Silic 1984). The ore body is covered by greater than 100 m of volcanics, making the story of its discovery technically impressive.

History of exploration in the Hellyer–Que River area

Modern exploration in the Hellyer–Que River area for Pb/Zn dates back to the 1960s when the volcanics (Fig. 1) were recognized as being similar to those hosting the Mt Lyell and Rosebery ore bodies.

In 1970, the Aberfoyle group commenced a regional stream sediment geochemical survey followed in 1972 by coverage of a 400 km² block with helicopter-borne electromagnetics (EM). Ground follow-up of one of the few good discrete conductors (which was in the vicinity of anomalous stream geochemistry) resulted in the 1974 discovery of the Que River ore deposit (Webster & Skey 1979).

One of the conclusions drawn from test work on the deposit was that the main ore lens (PQ) was effectively nonconductive due to the large amounts of sphalerite although it responded well to induced polarization (IP). This conclusion was supported in later years by test surveys with moving loop Sirotem and Crone PEM which both responded to the shallow S lens (detected by the original helicopter EM survey) but not to the deeper, base metal rich PQ lens. Because of this, IP became the favoured geophysical tool. In the following 10 years, several IP anomalies, generally supported by high geochemistry, were drilled, showing uneconomic concentrations of sulphides.

In 1979, new light was shed on the exploration problem when UTEM, a fixed transmitter broadband EM system (Lamontagne *et al.* 1978), was tested at Que River. This experiment showed that the PQ lens was in fact more conductive than the S lens, and had been missed by the other EM systems because of its relatively large depth to top and its proximity to the shallow S lens.

When UTEM became readily available in Australia in 1983, the northern two-thirds of the andesite unit was surveyed. The grid was extended far enough north to determine the UTEM response of some disseminated sulphides encountered when drilling an IP/geochemical anomaly in 1982. The most northern line was placed at 10300N (Fig. 2), where an anomaly was detected which was recognized to be as strong as the one over Que River. This was the only moderately strong response on the whole grid of over 100 line km.

The survey was immediately extended another 400 m to the northern extent of the outcropping volcanics. Detailed UTEM work in this area defined a deep, moderately conductive body. Concurrently with the geophysical work, geological mapping of new exposure created by Hydro Electric Commission preparation for a new transmission line, revealed a pod of barite and intense alteration concentrated into the nose of an anticline overlying the conductor, which was in an area that had long been known to have anomalous Pb and Zn in soils. The combination of these factors made this a very high priority target, which management thought merited three drill holes. The first of these holes intersected 24 m of base metal mineralization, the Hellyer ore body.

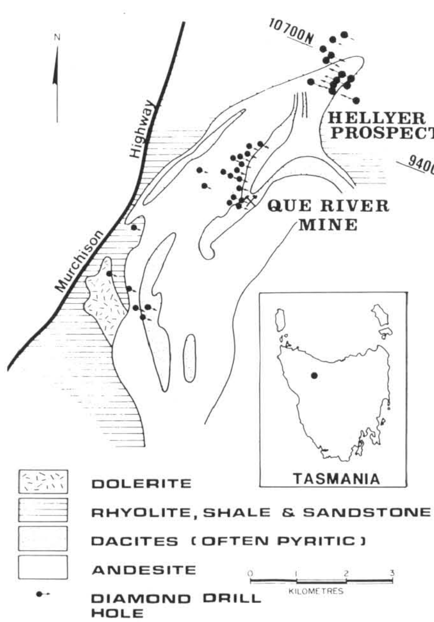

Fig 1 Summary geological plan of Hellyer–Que River area.

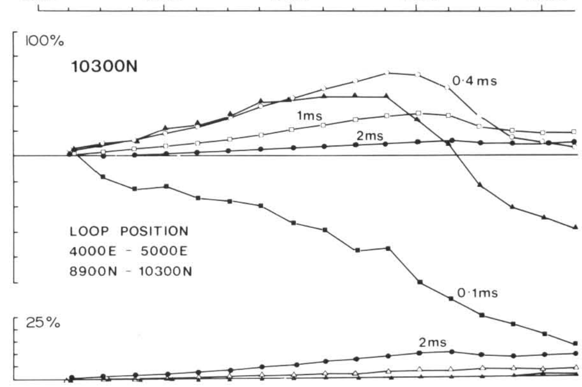

Fig 2 Vertical component UTEM data on line 10300N.

Analysis of the geophysical data

The ability of UTEM to detect the Hellyer deposit where IP, airborne EM (McPhar H400), and Max Min had failed (Eadie & Silic 1984), shows well the power of fixed loop, time domain EM systems. The three most critical lines of UTEM vertical component data are shown in Figs 2, 3 and 4.

The feature that inspired the extension of the grid to the north is seen at station 5675E on 10300N (Fig. 2). This anomaly, which was interpreted to be from a deep, conductive body, is apparent in the data from 0.2 to 2 ms. The fact that the anomaly lasted until 2 ms made this by far the most conductive feature on the grid.

Figures 3 and 4 display the results from Lines 10400N and 10700N, respectively. The amplitude of the response is much lower on these follow up lines than on 10300N because:

(1) the second transmitter loop was located to be maximum coupled with the expected vertical body and ended up being almost totally null-coupled with the actual flat-lying body;

(2) there is less enhancement due to current channelling because the second loop is much closer to the target conductor.

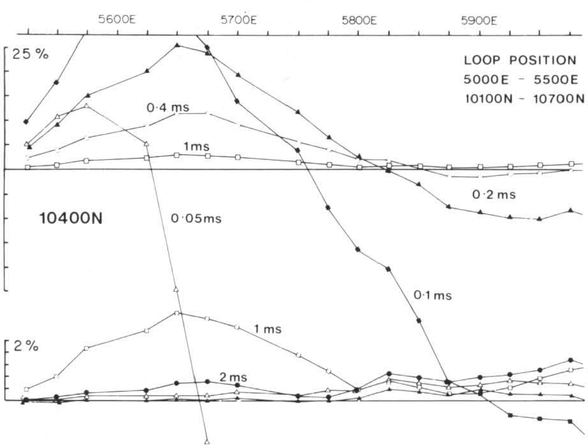

Fig 3 Vertical component UTEM data on line 10400N, the first line drilled.

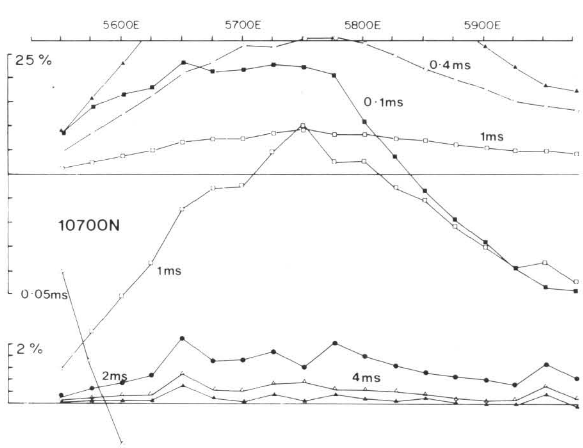

Fig 4 Vertical component UTEM data on line 10700N.

However, the data was good enough to interpret a continuous body from 10300N to 10700N, plunging to the north and open in this direction.

In spite of the fact that the anomaly on 10700N continued to the later time of at least 4 ms, the first drill hole was located on 10400N (Fig. 5), the reasoning being that the target was shallower on 10400N and there was no chance of the data being influenced by the encroaching shales as there was on 10700N (Fig. 6), thus enabling a more precise interpretation. The first hole of the drilling programme, HL 3, successfully intersected the target, as did the third hole, HL 5, on 10700N.

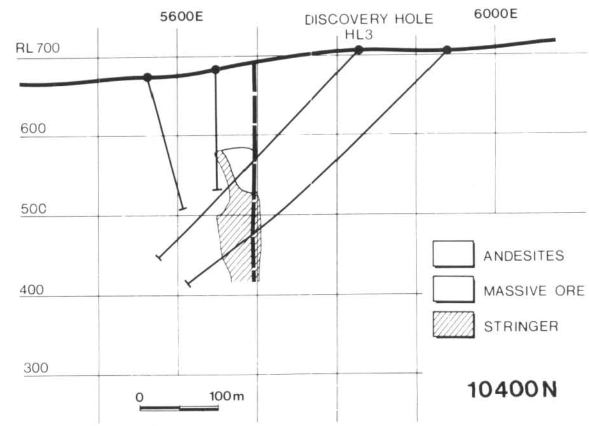

Fig 5 Geological section 10400N.

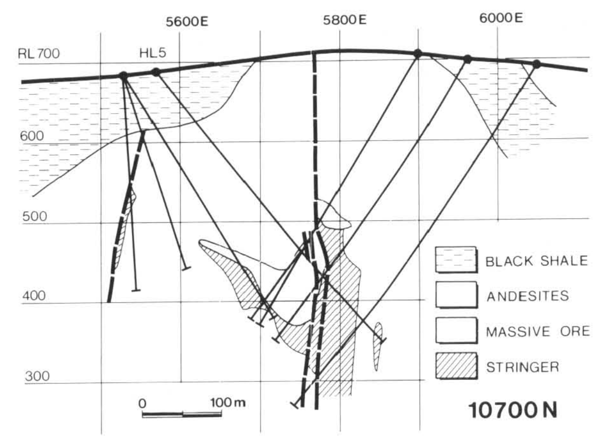

Fig 6 Geological section 10700N.

Acknowledgments

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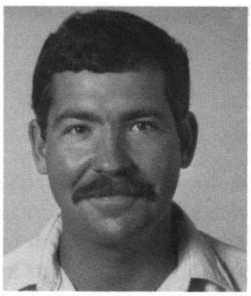

Tom Eadie graduated with a BSc(Hons) in geology and geophysics from the University of British Columbia in 1976. After a brief stint with Gulf Oil of Canada as a seismic interpreter, he worked for two years with Geoterrex as a party chief on field crews. Returning to university, he obtained an MSc in geophysics from the University of Toronto in 1980, working on electrical methods in oil exploration. He then joined Cominco, Vancouver, in part helping to develop EM field and interpretation methods for Pb/Zn exploration. From 1983 he has been on an Aberfoyle-Cominco exchange with Jovan Silic.

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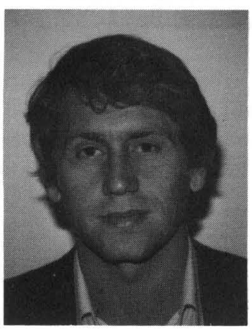

Jovan Silic graduated from the University of Western Australia in 1971 with first class honours in physics. From 1971 to 1975 he worked with the BMR on Australian National Antarctic Research as a geophysicist. From 1975 to 1979, still with BMR, he worked on research into electrical prospecting methods. He was also involved in acquisition and interpretation of regional geophysical data, emphasising automated inversion techniques on potential field data. In 1979, he joined Aberfoyle Exploration where he was in charge of the geophysical programme. From August 1983, he has been on an Aberfoyle-Cominco exchange with Tom Eadie.

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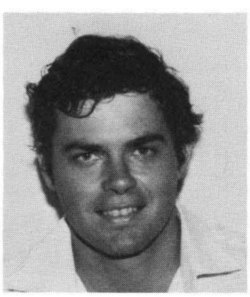

Doug Jack graduated in mining geology at the University of the Witwatersrand, Johannesburg, South Africa, in 1976. He then joined Union Carbide Exploration initially as a photogeologist working principally on Karoo uranium. From 1979 he ran an uranium exploration programme in Botswana where he spent 2½ years. In 1981 he was transferred to Australia where he worked on uranium exploration in the Northern Territory, Archean gold in Western Australia and tungsten in New South Wales. He joined Aberfoyle in January 1983, based in Tasmania where he was the field geologist immediately prior to the discovery of Hellyer.

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