AN EXPLORATION CASE STUDY FOR OLYMPIC DAM STYLE MINERALIZATION ON THE STUART SHELF, S.A.

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Introduction

The Olympic Dam deposit was discovered by Western Mining Corporation (WMC) in 1975. The deposit is situated on the Stuart Shelf, South Australia (Fig. 1), and has been reported to contain a resource of 2000 million tonnes with average grades of 1.6% copper, 0.6 kg/t uranium oxide, 0.6 g/t gold and 6 g/t silver. It also contains significant concentrations of rare earths.

This paper will review the geophysical exploration techniques used by Carpentaria Exploration Company (CEC) and Geopeko (and prior to 1983, Seltrust) to explore for further Olympic Dam style mineralization in the joint venture exploration areas shown in Fig. 1. The results are presented together with an interpretation combining all available data.

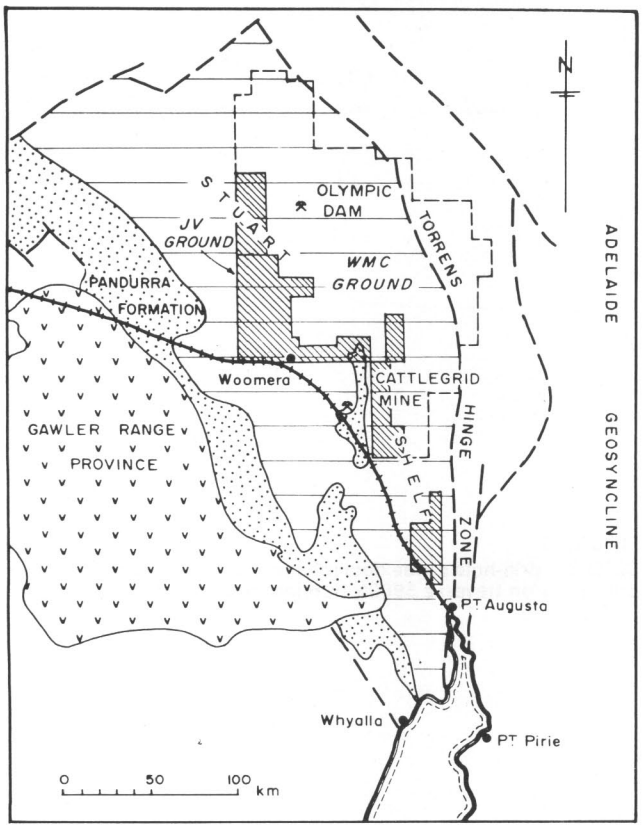

FIGURE 1
Location and simplified geology map showing the areas held on the Stuart Shelf by the CEC/Geopeko joint venturers and WMC as of late 1985.

Exploration Models

The Stuart Shelf is a vast area west of the Adelaide Geosyncline (Fig. 1). It is a geological province characterized by a thin (a few hundred metres) sequence of flat lying Adelaidean sediments. These have transgressed onto the stable basement of the Gawler Craton.

Up to the early 1980s, only limited information was available on the geology of the Olympic Dam deposit itself. It was believed to be located in a graben within unstressed granites thought to be equivalent to late stage granites of the Gawler Range Volcanics. The mineralization was in a hematitic granitic breccia 300 m beneath Adelaidean cover rocks.

The discovery was made by drilling a coincident magnetic and gravity anomaly during WMC's search for copper mineralization thought to have been derived from basic volcanics and deposited in nearby sediments. The coincident anomalies were thought to be caused by basic volcanics in relatively shallow basement. Although this was shown not to be the case, this positive exploration strategy led to the discovery of the deposit.

Using these limited data, the joint venturers produced a model to explain both the geology and geophysics. The model required a gabbroic plug providing both iron rich mineralizing fluids and a heat source to drive a vast mineralizing system. Mineralization was thought to have been emplaced in suitable sedimentary environment such as a graben formed during rifting. This model is shown in Figure 2. It was considered that the hematized sediments would produce a gravity anomaly and possibly a magnetic residual anomaly. The gabbro should produce a magnetic anomaly and possibly a gravity anomaly. These are also shown in Figure 2.

Exploration Strategy

Depths to basement in the joint venture areas were thought to be in excess of 400 m. Thus it was considered that direct detection of mineralization using electrical methods was not feasible. Indirect detection by locating the hematitic enriched zone and the gabbroic source, using magnetics and gravity, was considered the only viable alternative.

The regional airborne magnetic presentation as contours was adequate for the interpretation of large features such as gabbroic plugs, however, this presentation did not allow a residual style analysis. To enable this, the original 1962 data were digitized in conjunction with SADME (South Australian Department of Mines and Energy) and CSR. The data were image processed using various enhancements. A copy of the magnetic image for the Andamooka and Torrens 1:250 000 Sheets is shown in Figure 3.

The gravity coverage, on a 6.4 x 6.4 km grid, was considered too coarse and consequently additional gravity data were required. To establish survey requirements, forward modelling was undertaken. A 1000 million tonne body (the assumed size of Olympic Dam as of 1982) with a density of 3.5 $t.m^{-3}$ at a depth of 600 m was calculated to produce a 20 $\mu m.s^{-2}$ anomaly with a half width of 0.7 km. To detect such a body,

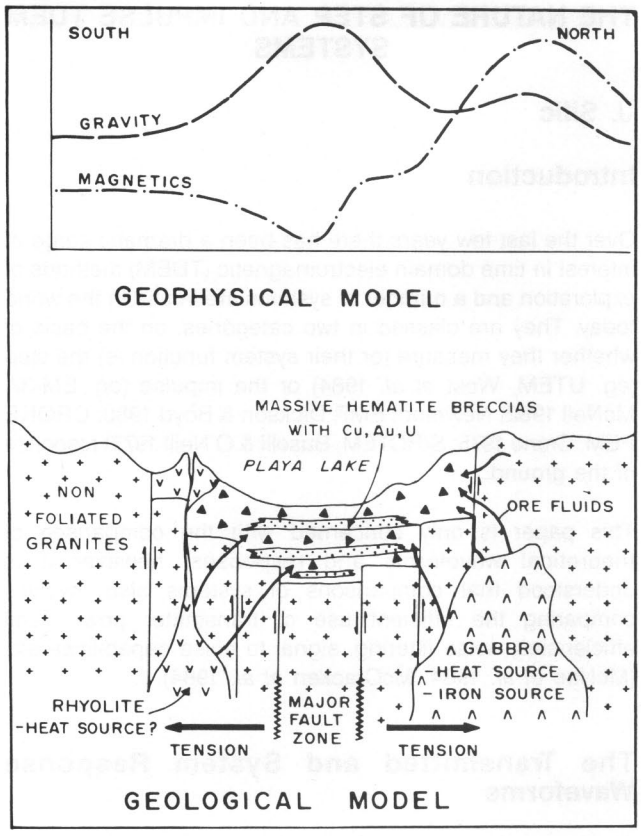

FIGURE 2
Diagrammatic representation of the geological and geophysical models used to guide exploration in 1983.

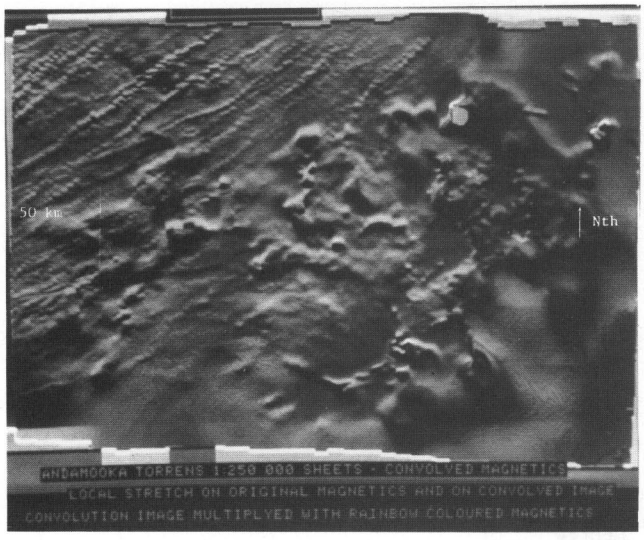

FIGURE 3
Reprocessed airborne magnetics for the Andamooka and Torrens 1:250 000 Sheets—white high, black low.

in an efficient manner, a barometrically controlled survey was commissioned with 500 m station spacing at 1 or 2 km line spacing, depending on the prospectivity of the area. A total of 2200 line km or 4400 stations were collected.

Seven significant gravity anomalies were located via this approach. Of these, two were thought to have low potential, as the sources were considered to be Beda Dykes of the Adelaidean age. One has yet to be fully evaluated. The remaining four were verified using optically controlled gravity methods. This was considered necessary because, even though good quality control was maintained throughout the survey, it was acknowledged that height control using barometric methods could produce spurious anomalies. This verification of anomalies was done by surveying at least two optically controlled lines normal to each other over the anomaly.

Of the four anomalies requiring verification, one 15 μm.s^{-2} anomaly was reduced to 5 μm.s^{-2} when optically tested, and no further work was carried out.

One other 15 μm.s^{-2} residual anomaly was upgraded to a 17.5 μm.s^{-2} anomaly. Modelling suggested this could represent a graben filled with denser rocks. This was tested by drilling, which intersected pre-Adelaidean basement of hematized breccias at 520 m, which was denser than the overlying sediments.

The third anomaly, of 35 μm.s^{-2}, was confirmed by optically controlled gravity. In this case, although shallow sources were indicated by modelling, no such source was encountered by drilling.

The final anomaly was a 15 μm.s^{-2} anomaly situated on the flank of a larger anomaly. This was again confirmed by optically controlled gravity methods. Modelling of the data suggested a dense source at 750 m. This was tested by drilling, which intersected two bands of hematitic sediments with a total thickness of 300 m and average density of 3.5 t.m^{-3}. Trace mineralization was discovered in these bands.

Thus, of the three targets tested by drilling, one was considered a failure. Another was partially successful, and a third successful.

Interpretation

To complement the above, a review of the Stuart Shelf was undertaken, The aim of this study was to interpret pre-Adelaidean basement geology and define areas prospective for further Olympic Dam style mineralization. The study relied heavily on the digital magnetic and gravity data. Three examples are shown in Figures 3, 4 and 5.

Three magnetic/gravity provinces have been identified.

1. Roxby Downs Province—in the northern part of Figures 3 and 4. It is characterized by a series of complex, long wavelength coincident magnetic and gravity anomalies. This province contains the Olympic Dam deposit. It is terminated to the south by an east-west feature depicted in Figure 5.

2. Arcoona Province—in the central part of Figures 3 and 4. The province is dominated by a circular gravity high surrounded by several discrete magnetic anomalies.

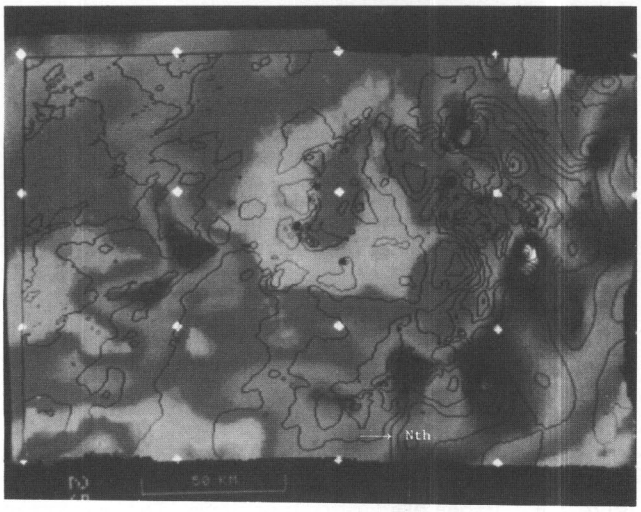

FIGURE 4
Combined magnetics (black contour lines) and pseudo coloured gravity (white high, black low) for the Andamooka and Torrens 1:250 000 Sheets.

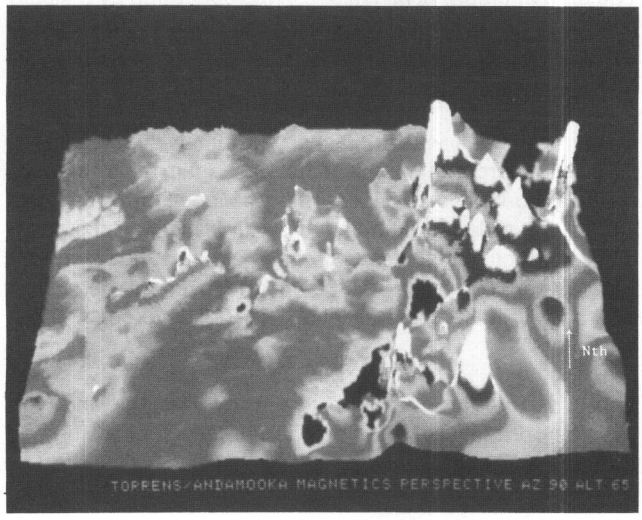

FIGURE 5
Perspective view of airborne magnetics from the west at 65° altitude—white high, black low.

3. Pernatty Province—southern part of Figures 3 and 4. This area has a zone of coincident elongate magnetic and gravity anomalies.

An interpretation is presented which proposes a tectonic model for the geological evolution of the Stuart Shelf. It defines areas where it is considered that little potential exists for further Olympic Dam style deposits and delineates zones where potential is considered to exist.

THE NATURE OF STEP AND IMPULSE TDEM SYSTEMS

J. Silic

Introduction

Over the last few years there has been a dramatic surge of interest in time domain electromagnetic (TDEM) methods of exploration and a number of systems are in use in the world today. They are classed in two categories, on the basis of whether they measure (or their system function is) the step (eg. UTEM, West *et al.* 1984) or the impulse (eg. EM-37, McNeil 1982; Newmont EMP, Dickson & Boyd 1980; CRONE PEM, Crone 1975; SIROTEM, Buselli & O'Neill 1977) response of the ground.

This paper is only concerned with the comparison of theoretical waveforms and responses, however it is understood that comparisons of systems also involves comparing the efficient use of transmitter power, coil efficiencies, noise filtering, signal to noise capabilities etc. (McNae *et al.* 1984; McCracken *et al.* 1984).

The Transmitted and System Response Waveforms

Because the most commonly used sensing device is a coil and of the need to stack the data, the step and impulse TDEM systems use periodic triangular and square pulses (see Fig. 1) as their transmitting waveforms.

All practical Impulse systems, turn the current off in some controlled fashion and the most common of these is a linear ramp turn off, (EM-37, SIROTEM, Newmont EMP), which for the purpose of this paper will be referred to as the linear ramp impulse system (Fig. 1).

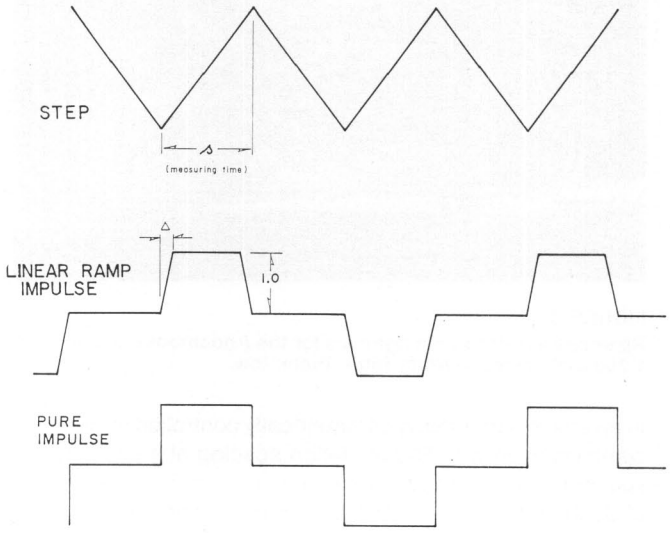

FIGURE 1
Transmitter current waveforms.