A Three Dimensional Model Simulation of the Off-End Electrical Response of the Elura Orebody

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Introduction

This note presents a three-dimensional (3D) model simulation of the induced polarisation (IP) and resistivity response of the Elura orebody for a 200m dipole-dipole array. Figs. 1, 2 and 3 show the model results for a polarisable conductor of 0.3 ohm m with an elliptical cross-section and infinite depth extent, buried beneath a 100m thick, 10 ohm m overburden which overlies a 500 ohm m country rock.

The models were computed by Dr Abijit Dey of Chevron Resources Co., California in May, 1980 so as to illustrate the likely change in electrical response of the Elura orebody with increasing profile line offsets from the conductor. Dey's method of computation is the only published scheme for modelling arbitrarily shaped 3D structures beneath an overburden cover (Dey and Morrison, 1979). The IP response was computed for an intrinsic orebody percent frequency effect (PFE) of 30%, however, the IP response is presented here as a percentage of the intrinsic IP effect (B_2%) so that it applies to any IP parameter; chargeability, PFE, or phase angle (Hohmann, 1975). This dimensionless parameter therefore represents the dilution of the IP effect.

The Off-End Electrical Response of the Model and its Implication to Electrical Prospecting

The characteristics of the 3D resistivity and IP model anomaly for the profile line directly over the body (Fig. 1) is discussed elsewhere by Tyne, Haren and Webster (this volume). Briefly, the apparent IP pseudosection pattern shows a typical "pants-leg" anomaly with distinct maxima lobes on the outer flanks of the anomaly. This is reflected as a double-peaked anomaly in profile form. The apparent resistivity pseudosection shows a similar form with minima lobes on the outer flanks of the anomaly. The electrical contact between overburden and conductive body ensures significant current gathering or channeling into the conductor from the overburden. This acts to enhance the IP anomaly due to the polarisable body. The maximum IP effect of 35.5% occurs at the largest dipole separations on the outer edges of the anomaly.

Fig. 2 presents the model results for an edge profile. Both IP and resistivity anomalies are very similar to the centre profile model anomalies (Fig. 1). The IP anomaly pattern shows no diagnostic change and the maximum IP effect decreases to 28.1%; only 7.4% lower than for the centre profile.

The model results for Figs 1 and 2 indicate that a polarisable conductor intersected by a profile line anywhere along its strike length will be detected as a moderate to strong IP anomaly. The apparent resistivity anomaly due to the conductor will also be detected, however it is not as diagnostic as the IP anomaly and may be partly ascribed to conductive inhomogeneities within the overburden or to undulations in bedrock topography.

Fig. 3 presents the model results for a profile 300m or 1½ dipoles off the end of the conductor. Both apparent resistivity and IP anomalies have changed dramatically in character compared to Figs 1 and 2. The anomalies have lost the typical 3D character and show similarities to 2D anomaly shapes (Tyne, Haren and Webster, this volume).

The IP anomaly shows only meagre anomalous effects for dipole separations of n=1 to 3. The maximum IP effect of 6.6% occurs in the centre of the broad anomaly and is recorded for n=6. Assuming a realistic intrinsic chargeability of 100ms for the conductor, the maximum IP effect would become 6.6ms. The IP anomaly for this "off-end" profile would therefore be clearly detectable if background or host rock IP effects were negligible and if layered earth EM coupling could be rejected by a suitably long off-time chargeability integration period or sufficiently low frequency IP measurement.

Although the apparent resistivity profile does reflect the presence of the conductor off the line, this anomaly cannot be considered as diagnostic as the IP anomaly.

The IP detectability of this model by a 200m dipole-dipole array located 300m off the end of the conductor implies that reconnaissance IP profiling under the most favorable conditions would detect a 200m strike extent orebody like Elura for a line spacing of 4 dipoles or 800m. However, this optimistic line detection spacing would only be effective if the polarisable conductive target could be guaranteed to be in electrical contact with the conductive overburden. If such a target is insulated from the overburden by the host rock then it is unlikely that it will be detected by an "off-end" dipole-dipole profile (Tyne, Haren and Webster, this volume).

Comparison of Off-End IP Model Response with Elura Field Data

Fig. 4 compares the "off-end" 3D model response of Fig. 3 with a field profile obtained at Elura by Tschaikowsky and Le Brocq (this volume). This profile is located about 300m along strike of the orebody as for the model profile.

The background response of the field profile is of the order of 2ms. If this background level is subtracted from the anomaly centred at 62400E then the amplitude and shape of the field anomaly show a close correspondence with the model anomaly. This comparison appears to confirm that the field anomaly on line 550400N is caused by the Elura orebody, some 300m to the north.

Acknowledgements

Dr Abijit Dey of Chevron Resources Co., California, very kindly computed the 3D models presented in Figs 1 to 4 at the request of Professor Keeva Vozoff (Macquarie University, Sydney). This contribution to the understanding of the off-end electrical response of a polarisable conductor such as the Elura orebody is of importance in future exploration strategy for many of the arid areas of Australia. It is therefore greatly appreciated.

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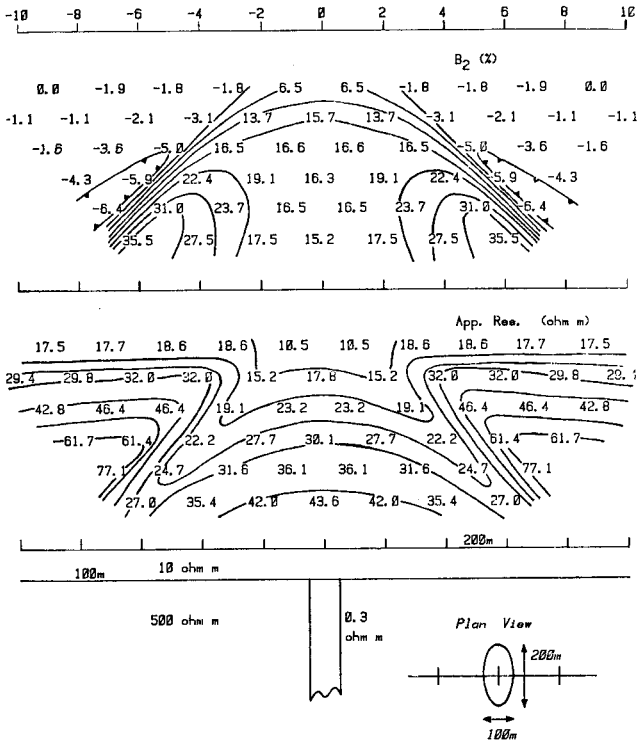

FIGURE 1

3D Dipole-Dipole Model for centre profile — 0.3 ohm m polarisable body covered by a 100m thick, 10 ohm m overburden; 200m dipole spacing (computed by Dr A. Dey, Chevron Resources Co.)

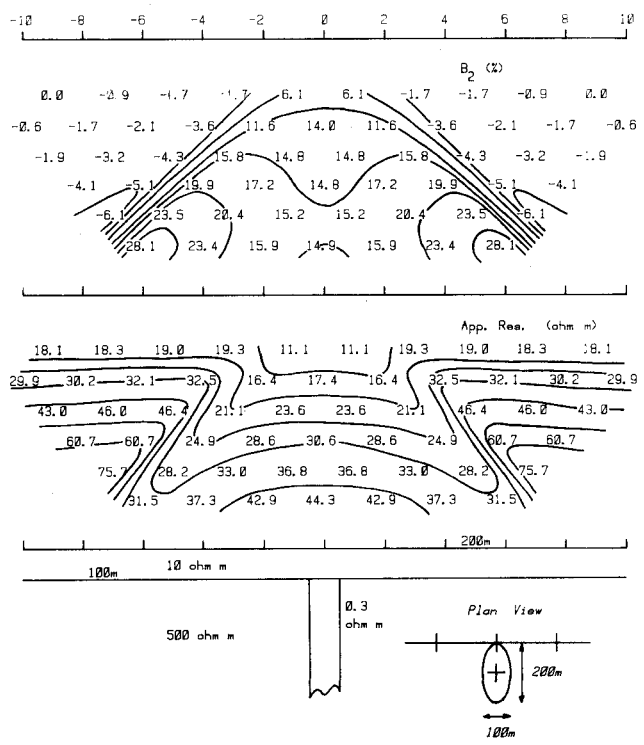

FIGURE 2

3D Dipole-Dipole Model for an 'edge' profile — 0.3 ohm m polarisable body covered by a 100m thick, 10 ohm m overburden; 200m dipole spacing (computed by Dr A. Dey, Chevron Resources Co.)

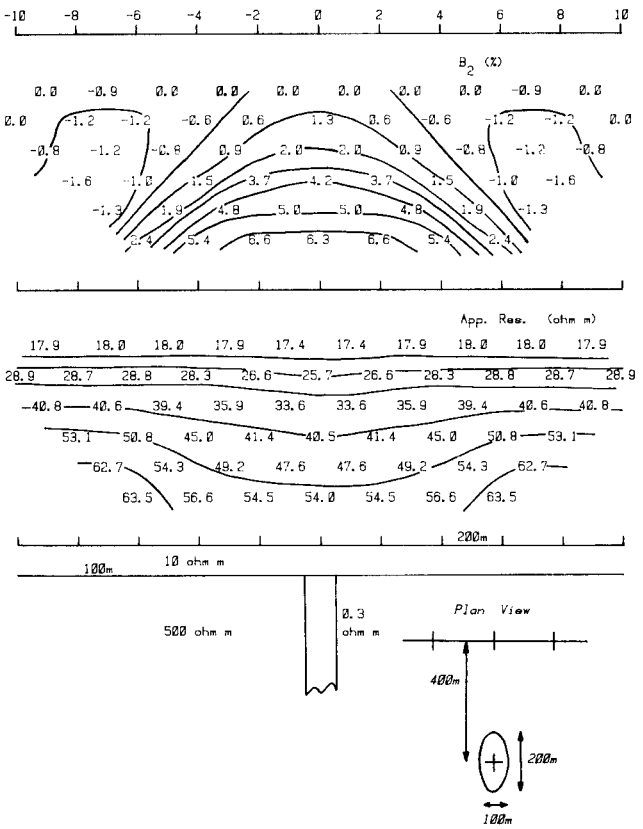

FIGURE 3

3D Dipole-Dipole Model for an 'off-end' profile — 0.3 ohm m polarisable body covered by a 100m thick, 10 ohm m overburden; 200m dipole spacing (computed by Dr A. Dey, Chevron Resources Co.)

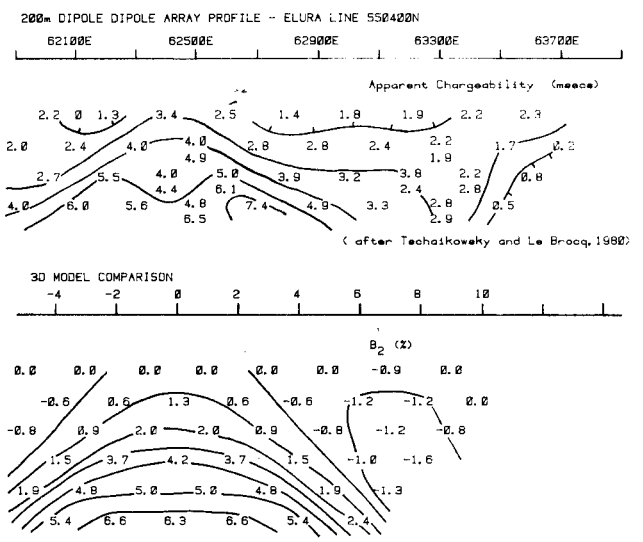

FIGURE 4

Comparison of 3D Model 'off-end' profile with field data from Elura — Line 550400N

References

DEY, A., and MORRISON, H. Frank, 1979. Resistivity modelling for arbitrarily shaped three-dimensional structures. *Geophysics,* v. 44, p. 753.

HOHMANN, G. W., 1975. Three-dimensional induced polarisation and electromagnetic modelling. *Geophysics,* v. 40, p. 309.