porosity must decrease, very rapidly below that depth. This compared with depths of 4-6 km interpreted from gravity, magnetic, and seismic reflection data. The difference is probably due to a thickness of sub-horizontal Adelaidean sediments. These would have to be weakly magnetic and lower in density than the surrounding crystalline rocks. The situation is not uncommon in onshore basins.

It appears that associated structure may extend through the crust into the upper mantle, although resolution north of the boundary is poor at those depths. Also suggested in this section is a drop in resistivity at a depth of 200-250 km, which appears consistently in layered inversions of the TE components. This compares with depths of 90-100 km for a similar feature in the Cooper Basin of northeastern South Australia and the western Murray Basin of New South Wales.

Proterozoic sediments are common in Australia and they are difficult to distinguish from Phanerozoic sediments without costly seismic velocity analysis. For this reason alone, the (relatively inexpensive) MT method has wide application in evaluating Australia's onshore sedimentary basins.

Acknowledgements

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CONCENTRATIONS OF NATURAL TELLURIC CURRENTS AND THEIR RELATION TO THE BASEMENT STRUCTURE OF THE EROMANGA BASIN, SOUTHWEST QUEENSLAND

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Introduction

This paper concerns the use of a natural-source, electromagnetic (EM) technique for investigating the electrical conductivity structure of the earth, known as geomagnetic depth sounding. The method is similar to the more familiar magnetotelluric method in that both use natural fluctuations of the earth's magnetic field as their EM source fields.

Although most time-variations of the geomagnetic field have their origin external to the earth, they cause eddy currents to be induced within the conductive earth and these telluric currents have themselves an associated magnetic field which adds to the external field. In the geomagnetic depth sounding method one simply measures three orthogonal components of the total external source field plus internal response. Spatial anomalies of this measured field are attributed to spatial variations of the induced telluric currents which in turn indicate areas of laterally anomalous electrical conductivity structure within the earth.

The Australian National University has been carrying out geomagnetic depth sounding studies in various parts of Australia since 1970 using up to 25 simultaneously recording, magnetic variometers. Most of these studies have been carried out to investigate large scale structural features of the crust and upper mantle over areas of typically 350,000 km^2. An array study in 1976 in central Australia revealed an anomaly in southwestern Queensland which was subsequently detailed by a smaller array in 1977, covering an area of only 60,000 km^2. It is data from this 1977 array which is the subject of this paper.

Data Analysis

From the many weeks of data recorded by the magnetometers in the southwest Queensland array, a few isolated magnetic variation events of one or two hours duration have been selected for further analysis. First, the records from the most easterly station of the array were subtracted point-by-point from the records of all other stations in order to separate the internal anomalous response from the regional external and internal fields. The resulting "difference" records vary considerably in amplitude from station to station but have basically the same morphology. This result indicates that the anomalous telluric currents flow essentially "in-phase" through southwest Queensland and can therefore be considered in a simple Ohm's law manner instead of as a more complicated situation of electromagnetic induction.

The next step taken in the analysis of the data was to scale off the subtracted records peak amplitudes of the anomalous fields and then plot these amplitudes on two separate lines passing through the array. Both the vertical component and a resolved horizontal component were plotted in this manner for a number of different variation events; an example is shown in Figure 1a. All events examined produced essentially the same anomalous field profiles indicating that to a first approximation the anomalous telluric currents in south-

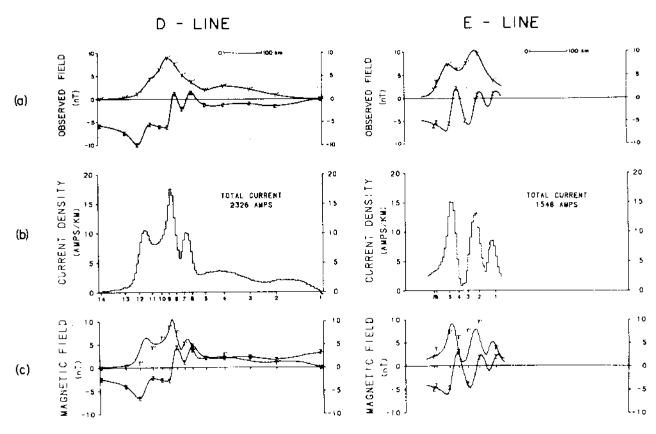

FIGURE 1

(a) Observed anomalous magnetic fields along two lines of stations shown in Fig. 2; Y′ is the horizontal component resolved to an axis 25° south of east, Z is the vertical component. Fields have been smoothly interpolated and extrapolated between the points.
(b) Current density solutions from inversion of the vertical fields for a simple 2-D sheet model at a depth of 1 km. The baseline of the Z data has been adjusted to equalize the positive and negative areas of the Z profile.
(c) Generated vertical and horizontal fields from the current distributions above. The fit to the observed Z values is, by computation, exact. Misfit to the observed Y′ values is due no doubt to departures of the real situation from a simple 2-D sheet model.

west Queensland always flow in the same geographic positions regardless of the form or period of the source field.

Current Inversion

In order to determine the spatial distribution of the anomalous telluric currents, the simple model of a two-dimensional current sheet consisting of many infinite-length elements was considered. The current in each element was found by performing a direct matrix inversion of the anomalous magnetic field profiles shown in Figure 1a, to produce the current density profiles shown in Figure 1b. These current distributions are for a sheet model at a depth of 1km. Other current distributions were found for sheets at greater depths, but as is to be expected from potential field theory, they show sharper variation of current with traverse distance. In fact, for depths greater than 5 km, physically implausible positive and negative current distributions are required to produce some of the more pronounced lateral variations in the vertical field.

Geologic Interpretation

Because it is known from many resistivity and magneto-telluric studies that the sedimentary rocks of the Eromanga Basin are highly conductive, the authors suggest that the anomalous fields observed in southwestern Queensland are the result of anomalous telluric current flow within the Eromanga Basin itself. Further, we contend that the sheet current distributions depicted in Figure 1b, although relating to a simple 2-D sheet model, represent the telluric current distribution in the basin sediments during a magnetic disturbance.

That this particular part of the Eromanga Basin should have high concentrations of telluric currents is probably a result of electromagnetic induction on a continental scale. The second-order features of the current distributions apparent in Figure 1b may be related to localized geologic structures within the basin:

(1) The current drops abruptly to zero just west of station D12 indicating this is the western margin of the current carrying sedimentary rocks. This position is some 300 km east of the mapped surface boundary of the basin, although it is coincident with the edge of a shallow basement structure known as the "Boulia Shelf" as inferred from aeromagnetic and gravity data.

(2) There is a marked low in current density between stations D7 and D8 coincident to the south with a major basement structure known as the "Betoota Dome" found by seismic exploration. Telluric currents may be forced to flow around this topographic high in the basement structure, thereby causing a low in the current density distribution flanked by two highs. This effect may also cause the low between stations D5 and D6 as this area is also coincident with a known geologic structure, the "Morney Anticline".

(3) A more pronounced low with flanking highs is apparent betweem statopms E3 and E4 (and also, to some degree, to the north between stations D10 and D11). This may result, in a similar manner, from a topographic high in the basement (here named the "Durrie" structure) between these two stations.

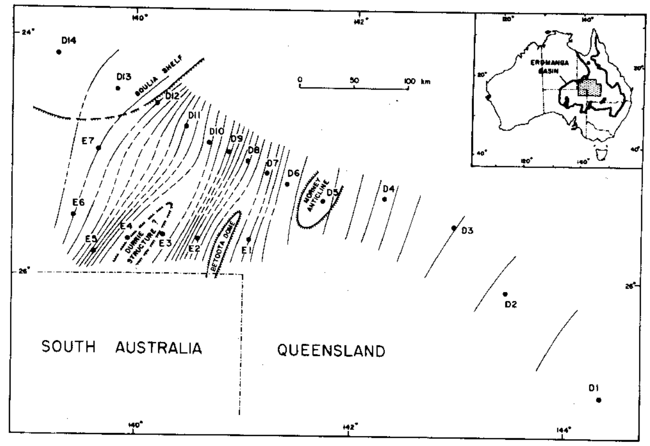

FIGURE 2

Telluric current flow in the Eromanga Basin sedimentary rocks of southwestern Queensland with known and interpreted basement structure. The magnetic variometer station positions are marked and labelled (positions are controlled mainly by the roads in the area). The Durrie structure is interpreted from the variometer data alone, other features are known from surface geology, well logs, seismic data, aeromagnetic surveys and gravity surveys.

Conclusions

We conclude this summary be referring to Figure 2 in which the southwest Queensland array stations are plotted on a map showing some of the major structural features in the Eromanga Basin. Flow lines of anomalous telluric current have been sketched on the map using the distribution profiles in Figure 1b to control the density of the lines, and the relative amplitudes of the two horizontal magnetic field components to define their direction. It should be remembered that the precision of these flow lines is a direct function of the detail of observations.

OFFSHORE GEOPHYSICAL SURVEYS FOR TIN IN SOUTHEAST ASIA

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With the depletion of easily accessible high grade onshore reserves of tin in the main producing countries of southeast Asia, the search for new deposits is turning increasingly to the continental shelf areas and the use of geophysical techniques, in particular seismic reflection profiling, in such exploration programmes, is also increasing.

It was recognised that, in order to make most effective use of seismic reflection profiles, it was necessary to understand the general geologic framework within which economic deposits of detrital tin occur, the elements of which could be recognised on those profiles. In addition characteristic features of the geomagnetic field associated with rocks containing primary tin mineralisation would also