Lockwood K. (1977), 'A geophysical assessment of the Outer Band Arc with emphasis on gravity measurements in Eastern Timor', unpublished MSc Thesis, Flinders University, South Australia.
Parker A. J. & Lemon N. M. (1982), 'Reconstruction of the Early Proterozoic stratigraphy of the Gawler Craton, South Australia', *J. Geol. Soc. Aust.* **29**, 221–238.
White A. & Polatajko O. W. (1978), 'The coast in geomagnetic variations in South Australia', *J. Geomag. Geoelectr.* **30**, 109–120.
White A. & Polatajko O. W. (1985), 'Electrical conductivity anomalies and their relationship with the tectonics of South Australia', *Geophys. J. Roy. Astr. Soc.* **80**, 757–771.
White A., & Hopgood D. N. (1979), 'The island and coast effect in geomagnetic variations around St. Vincent Gulf, South Australia', *J. Geomag. Geoelectr.* **31**, 479–484.
White A. & Milligan P. R. (1984), 'A crustal conductor on Eyre Peninsula, South Australia', *Nature* **310**, 219–222.
Wilhjelm J. & Friis-Christensen E. (1974), 'The Igdlorssuit geomagnetic variation anomaly in the rift-fault zone of northern West Greenland', *J. Geomag. Geoelectr.* **26**, 173–189.

The Tamar conductivity anomaly

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The Tamar Lineament follows an approximately straight line from near the mouth of the Tamar River to near the Tasman Peninsula. The pre-Carboniferous geology is very different on the two sides of this line. On the north-east side Devonian sediments are of deep water facies, typified by the Mathinna Beds. On the south-west side Devonian and older sediments are of shallow water origin, such as the Owen conglomerates and Gordon limestone. The granites in the north-east side are slightly older than those on the south-west side. There are also geophysical differences. The magnetic anomaly structure is smoother in the north-east and earthquakes are less frequent. This paper reports a striking conductivity anomaly coinciding with the Tamar Lineament.

Magnetic fluctuations within a certain period band are usually found to be polarized so that the vectors representing them lie in a plane. The plane is often horizontal, but if it is inclined at an appreciable angle it indicates a gradient of conductivity underground, the plane tilting upward towards the better conductor. This can be indicated on a map by an 'induction arrow' whose direction is the direction of upward tilt, and whose length indicates the angle of tilt.

Field measurements have been made in Tasmania with three-component EDA fluxgate magnetometers and Memodyne digital cassette recorders. Only two instruments are available so the technique of deriving and plotting induction arrows has been used rather than that of synoptic contour plots. It is found that all the induction arrows in eastern Tasmania point towards the Tamar Lineament, indicating that it is the location of a linear conducting body (Fig. 1).

Superimposed on the effects of such a conductor is the effect of the oceans surrounding Tasmania. At long periods of 100 min or more, the effect of the oceans dominates, and all induction arrows point towards SSE. As the period decreases induction arrows at sites to the north-east of the Tamar Lineament turn to a WSW direction and those at sites to the south-west of the Lineament turn to an ENE direction, both pointing towards the Lineament for less than 30 min periods. The effect of the oceans is more marked near the east and south coasts, where the effect is superimposed on the effect of the conductivity anomaly. Thus, for example, at Fingal, about 30 km from the east coast, the induction arrow points almost south, even for short periods.

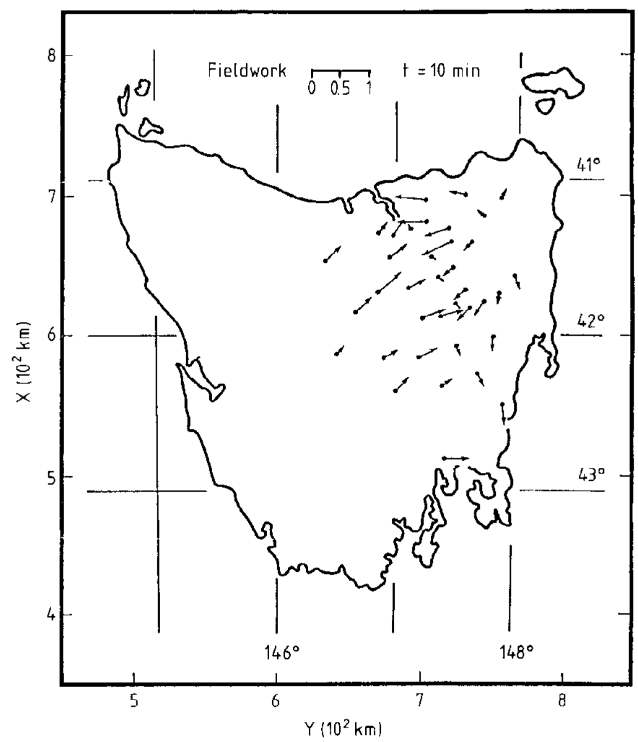

Fig 1 Induction arrows for north-east Tasmania showing the presence of the Tamar conductivity anomaly. The arrows indicate the directions of horizontal magnetic field change which cause maximum vertical magnetic field change at each site. The lengths of the arrows indicate the effectiveness of the process. The arrows point towards a zone of high electrical conductivity.

Professor Dosso and Dr Nienaber of the University of Victoria, British Columbia, have made a physical model in which the induction in sea water is simulated for Tasmania with its surrounding oceans and Bass Strait (Dosso *et al.* 1985). This has enabled us to evaluate, and to a certain extent compensate for, the effects of the oceans.

A striking feature of the anomaly is that it extends a great distance to the west. The influence is clearly visible at Bronte Park, in the centre of the island. It appears to be wider in the north where its western limb may curve to the west passing under Deloraine and Mole Creek. However, because of the effect of Bass Strait, this is difficult to verify. However, along most of its length it is sufficiently close to a two-dimensional structure to be modelled as such. The Jones and Pascoe program was used to search for models that approximated the field results. Two magnetotelluric studies carried out by Bindoff (1983) and Sayers (1984) show that the conducting body is shallow and very conductive, (i.e. a depth of 2 km and a conductivity of between 1 and 2 S m^{-1}). Using these restraints the best fitting models consist of a rather thin (3 km thick) highly conducting (2 S m^{-1}) body either dipping or tapering to the west and with a total width of about 30 km in the centre and up to 70 km further north.

Some geologists (e.g. Powell 1984), consider that the Tamar Lineament is part of what has been called the 'Tasman Line', which consists of rifts and transform faults. It runs from near Cairns through the Flinders Ranges, then via a transform fault (the 'Gambier-Beaconsfield fracture') to Bass Strait and thence southward as the Tamar Fracture Zone. It is considered to represent the eastern margin of the Australian continent in Cambrian times. An interesting feature of this concept is that practically all the important conductivity anomalies found in Australia lie on or near this Tasman Line.

It is not easy to identify the cause of the high conductivity associated with the Tamar anomaly. The presence of semiconductors, except possibly graphite, is precluded by the absence of a significant magnetic anomaly coinciding with the conductivity anomaly. The shallow depth makes the presence of graphite unlikely and a sufficiently high temperature is out of the question. The most likely cause seems to be fractured rock saturated with highly conducting fluids. Archie's Law suggests that a porosity of 20–40% is necessary with a fluid conductivity of the order of 10 S m^{-1}. Fluids with such a high conductivity have been reported, but are generally confined to oilfields.

References

Bindoff N. (1983), 'A preliminary magnetotelluric survey of northeastern Tasmania', Thesis, University of Tasmania.

Dosso H. W., Nienaber W. & Parkinson W. D. (1985), 'An analogue model study of electromagnetic induction in the Tasmania region', *Phys. Earth Planet. Inter.* **39**, 118–133.

Powell C. (1984), *in* J. J. Veevers ed., *Phanerozoic Earth History of Australia.* Oxford University Press, Oxford.

Sayers J. (1984) 'Magnetotelluric survey of the Midlands Area, Tasmania', Thesis, University of Tasmania, Hobart.

Geomagnetic induction studies in central New Zealand

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A series of magnetovariational and magnetotelluric studies are currently under way in central New Zealand. These include:

(1) A magnetovariational study of the lower part of the North Island.

(2) An investigation into the channelling of induced currents through Cook Strait.

(3) A magnetotelluric traverse across the Wellington region.

(4) A magnetotelluric investigation of a known seismic boundary in the Egmont-Ruapehu region.

The magnetovariational results obtained to date (Ingham 1985a) indicate that at periods of 3000 s and above the main factor affecting geomagnetic variations on the north side of Cook Strait is the presence of induced currents in the Pacific Ocean. However, there is evidence of the channelling of these currents through the Strait. This has been clearly demonstrated by Boteler *et al.* (1985) by means of simultaneous measurements of the magnetic field on either side of the Strait and the voltage in a cable across the Strait (Fig. 1).

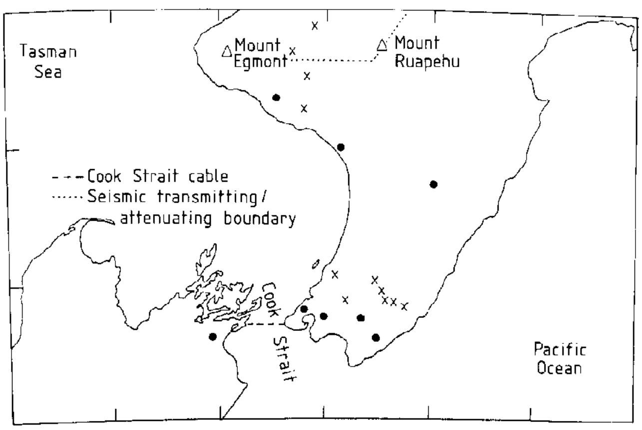

Fig 1 Map for geomagnetic induction studies in central New Zealand. • denotes magnetovariational site for geomagnetic depth sounding (GDS). x denotes the site for magnetotelluric sounding and GDS.