J. Geophys. 41, 537–540, 1975

Electromagnetic Induction at Dili, Portuguese Timor

F.H. Chamalaun and A. White

School of Earth Sciences, Flinders University of South Australia

Key words: Timor – Geomagnetic deep sounding – Electromagnetic induction – Crustal structure.

The island of Timor lies in the Outer Banda Arc, a pronounced physiographic and tectonic feature marking the boundary between the Indian Ocean and Australian plates. The whole Indonesian-Philippine area is of great geophysical complexity and Timor has attracted particular attention because of its structurally complex geology. It has been suggested (Audley-Charles, 1968) that Timor may have been part of the Australian continental margin, at least since the Permian. If Timor formed part of the leading edge of the Australian continent and collided with an island-arc subduction zone in its northward drift from Antarctica it is probable that it now lies just to the south or perhaps over the subduction zone. Alternative hypotheses suggest that the welding between Australia and Eurasia may now be identified by the Timor Trough (Beck and Lehner, 1974; Fitch and Hamilton, 1974). Unfortunately the location of the subduction zone is not easily identified on the basis of seismic activity.

Since there is very little geophysical data available we have initiated a programme involving a variety of geological and geophysical techniques that may assist in defining the actual location of the subduction zone. In this note we present the results of a pilot geomagnetic depth sounding study carried out in August 1973 at Dili, Portuguese Timor. The technique uses natural variations of the geomagnetic field to detect lateral inhomogeneities in the subterranean electrical conductivity structure. The data are commonly displayed as induction "arrows" of length Z/B and having the direction of B, where Z is the vertical component and B is the horizontal component showing the strongest correlation with Z (Schmucker, 1970). At stations near to deep oceans there is nearly always a strong "ocean edge effect" (Parkinson, 1962) but the induction can be strongly influenced by high conductivity zones associated with active tectonic regions, notably in Peru (Schmucker *et al.*, 1966).

In Fig. 1 we reproduce Parkinson's (1964) arrows for Kuyper, Wyndham and Darwin. As expected, the arrow at Kuyper points straight towards the deep

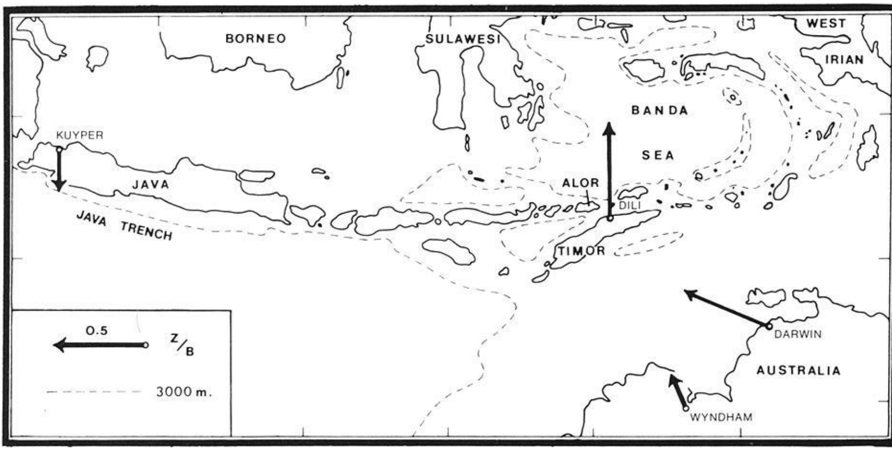

Fig. 1. Map of the Indonesian region. Induction arrows at Kuyper, Wyndham and Darwin from Parkinson (1964). Arrow at Dili is the in-phase arrow for 1 c.p.h.

water of the Java trench which is the site of a northward dipping lithospheric slab in preference to the very shallow water (< 200 m) to the north. The arrows at Wyndham and Darwin, though pointing towards the sea, are not strongly correlated with the nearest deep water. Both arrows point to a region south of the island of Timor and the possibility therefore existed that they indicate a zone of high conductivity possibly associated with a subduction zone at or near the Timor Trough. To see if the electromagnetic induction effects in Timor were at all influenced by a zone of high conductivity to the south or by the (extinct) vulcanism to the north, we recorded magnetic variations at Dili on the north coast of Portuguese Timor during August 1973. A three-component fluxgate magnetometer was used, especially developed at Flinders University to be cheap, portable and robust and of low power consumption. To provide thermal stability the magnetometer was buried under a meter of soil. Its performance was checked at Toolangi Geophysical Observatory. The recordings at Dili showed a noticeably strong correlation between the H and Z components. Three 24-hour lengths of data were digitized at 2-minute intervals, the in and out-of-phase components of the transfer functions were obtained in the manner described by Schmucker (1970) and White (1973). Fig. 2 shows the associated induction arrows for a range of periods. The in-phase arrow for 1 c.p.h. is also shown in Fig. 1, for comparison with Parkinson's arrows.

The results show two features, firstly that at the shorter periods the induction arrow is large and points due north, secondly that at longer periods it shortens and swings west. The in-phase ratio Z/B at 1 c.p.h. is 0.625 (± 0.025) which is slightly higher than that at Darwin and more characteristic of coastal stations adjoining deep water. This is most probably caused by the proximity of the Banda Sea which is generally over 3000 m deep. There is no apparent correlation with the Darwin result and we must therefore suppose that the Darwin arrow points to a conductivity structure much closer to Darwin than to Timor.

The fact that the arrow at Dili decreases and swings west for longer period variations is probably explicable in terms of a zone of high conductivity associated

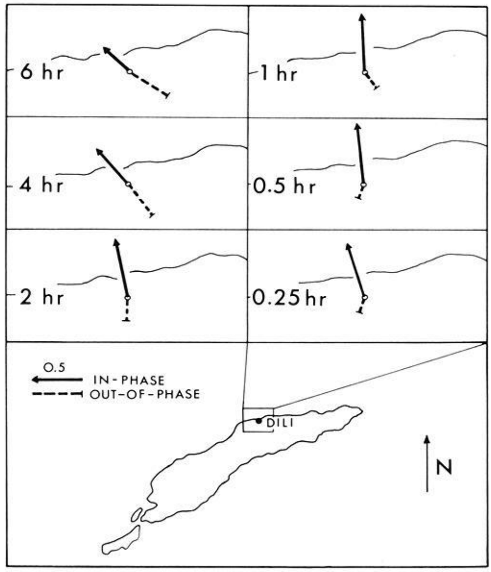

Fig. 2. Induction arrows for a range of periods at Dili, Portuguese Timor

with the still active volcanic inner arc west of Alor. Because of the deeper penetration of longer period variations one would expect this phenomenon to be associated with deep crustal or mantle conductivity contrasts. A longer recording period is desirable to investigate this.

We conclude that the induction arrows at Darwin and Wyndham are not related to a subduction zone south of Timor, but are probably the result of crustal inhomogeneities in the Sahul Shelf. On the other hand, the induction arrow at Dili is more obviously correlated with the Banda Sea. However, the induction effect is unexpectedly large, bearing in mind the relatively restricted nature of the Banda Sea. We therefore suspect that it is not simply due to the coast effect alone but may well in part be related to a subduction zone close to the north coast of Timor.

We are indebted to our colleagues in the Flinders University Outer Banda Arc Project, to Mr. J. Brandwyk for help in designing the magnetometer, and to Mr. and Mrs. Favaro for their hospitality in Dili and the use of the magnetometer site.

References

Audley-Charles, M.G.: The Geology of Portuguese Timor. Geol. Soc. Lond. Mem. **4**, 1–76 (1968)

Beck, R.H., Lehner, P.: Oceans, New Frontier in Exploration. Am. Assoc. Petrol. Geol. Bull. **58**, 376 (1974)

Fitch, T.J., Hamilton, W.: Reply. J. Geophys. Res. **79**, 4893–4895 (1974)

Parkinson, D.W.: The influence of continents and oceans on geomagnetic variations. Geophys. J.R. Astr. Soc. **4**, 441–449 (1962)

Parkinson, D.W.: Conductivity anomalies in Australia and the ocean-effect. J. Geomagn. Geoelectr. **15**, 222–226 (1964)

Schmucker, U., Forbush, S.E., Hartman, O., Giesecke, A.A., Casaverde, M., Castillo, J., Salgueiro, R., del Pozo, S.: Electrical conductivity anomaly under the Andes. Carnegie Institution of Washington, Yearbook **65**, 11–28 (1966)

Schmucker, U.: Anomalies of geomagnetic variations in the south-western United States. Bull. Scripps Inst. Oceanogr. **13**, University of California Press, 1970

White, A.: A geomagnetic variation anomaly across the northern Gulf of California. Geophys. J.R. Astr. Soc. **33**, 1–25 (1973)

Dr. A. White
Dr. F.H. Chamalaun
School of Earth Sciences
The Flinders University of South Australia, Bedford Park, South Australia 5042

Received April 7, 1975