both correlation analysis in the time domain, and comparison of Fourier amplitude and phase values, from several days of continuous data.

It is proposed that similar analyses be undertaken in Australia using the first-order data available, and supplemented, where possible, by selected data available from the base monitors of aeromagnetic surveys. These analyses should complement the information already available from previously mentioned array studies, the usefulness of which for magnetic survey reduction has already been suggested by Lilley (1982, 1984). First-order stations are re-occupied, on average, once every 5 years, with variometer recording having commenced about 1965. Thus the variability of station differences can be tested over several epochs. It may be that Australia can be divided into northern and southern zones on either side of the 40°S dip latitude, which is the approximate focus of the Sq current system. Sq variations in F and H are reversed in northern and southern Australia about this line, the position of which is variable from day to day (McGregor 1979). If an average latitudinal effect can be removed from the correlated data, it may be possible to produce a map which reflects mainly changes in the expected pattern of the daily variation across Australia due to geology. Figure 2 illustrates the high degree of correlation obtainable for selected days of total field measurements between Canberra Observatory and Mildura (similar latitude) and Moree (similar longitude). The spatial resolution is limited by the large average spacing between the first-order sites (approximately 500 km). Future large-scale array experiments across Australia will help define better the influence of geology and tectonics on the geographical pattern of the daily variation, and also short-period variations.

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Estimating the three-dimensional structure of the electrical conductivity of the earth

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One way to assess the three-dimensional structure of the electrical conductivity of the earth is to piece together as a mosaic the results from local studies. In part, the construction of such mosaics is the motivation for local studies. On the one hand they supplement the information available from an averaged global model; on the other, they define limits on the range of applicability of global models.

Another way is to use available world-wide geomagnetic data to identify global features in the earth's transient magnetic field, and to then derive, using these features, averaged three-dimensional electrical conductivity models. Numerous approaches have been suggested to overcome the following difficulties: the complexity of the earth's geomagnetic field, which consists of the external and internally-induced transient field, coupled with the internally-generated permanent and transient fields; the erratic sparse nature of the available geomagnetic data; and the need to stabilize, in some appropriate way, the inherent improperly-posedness of the underlying mathematical model of electromagnetic induction, which relates the observational data to the electrical conductivity. The obvious manifestations of these difficulties is the failure of the various methods to yield reasonably consistent models for the electrical conductivity. In fact, about their only common feature is the conclusion that electrical conductivity increases abruptly at a depth somewhere between 400 and 750 km. There is no agreement on either the size or the rate of the increase of this change. In addition, many of the resulting features of published models are artefactual consequences of the inversion techniques used (e.g. predetermined depth or shape of the abrupt change), though this fact is invariably ignored when models are compared.

More sophisticated global three-dimensional modelling of the electrical conductivity structure of the earth would therefore appear to be inappropriate at this stage; not only because of the abovementioned lack of consistency among published studies, but also because, mathematically, the nature of the electromagnetic induction problem does not permit a tomographic decomposition of geomagnetic data in a manner being successfully applied to seismic data to determine the elastic wave properties of individual three-dimensional cells within the earth (cf. Anderson & Dziewonski 1984). This fact relates directly to the differences between the physical processes (and hence mathematical models) involved (cf. Cleary & Anderssen 1979).

An electromagnetic counterpart to the use of tomography in seismology would appear to be the use of as much data as possible to accurately determine local three-dimensional structure, which is then pieced together as a mosaic to define the global structure. Another counterpart could be based on the interpretation of the individual spectral components in a Fourier analysis of the earth's transient magnetic field.

The former approach is crucial to a better understanding of the electromagnetic induction problem for the Earth. It would help clarify to what extent the abovementioned inconsistency among models is related to the three-dimensional variation in the electrical conductivity of the earth. If the structure of the earth is as three-dimensional as recent seismic evidence suggests, then some of the inconsistency must simply reflect the geographic variability within the data used, in the sense that, locally, each data set sees a totally different electrical conductivity profile as a function of depth.

In addition, if the conclusions from seismic tomography prove to be correct, then global averaging (i.e. radial symmetric modelling) of the electrical conductivity structure is of limited use except in generating a reference model.

For such reasons, a detailed comparison of one-dimensional transfer function models derived from geomagnetic data at various geographic locations around the Earth is being undertaken.

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The Tasman Project of Seafloor Magnetotelluric Exploration

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This paper is based on geophysical measurements made along a line of nine recording sites crossing the deep seafloor of the Tasman Sea. Simultaneous measurements were also made on the Australian continent, on an extension of the seafloor line inland (Fig. 1).

The floor of the deep ocean is a remote and a technically hostile environment in which to operate. The observations described here were made possible by special highly developed instruments brought to Australia from Scripps Institution of Oceanography, California. The instruments all free-fall to the seafloor, where they record continuously for a pre-set period (acting as temporary geophysical observatories).

Several different kinds of geophysical recordings were made in this study. Magnetometers were used to measure (temporal) fluctuations in the three components of the magnetic field. A second kind of instrument measured fluctuations in the two components of the natural horizontal electric (telluric) field. In addition, a third instrument type measured fluctuations in the vertical electric field and a fourth recorded the water pressure and temperature.

The magnetic and horizontal electric field recordings enable a magnetotelluric (MT) study to be made. These data as well as those from the other instruments have many applications for oceanographic studies as well as for solid-earth geophysics.

Seafloor magnetotellurics

In the same manner as land-based MT studies, seafloor magnetotelluric (SFMT) studies involve relating fluctuations in the horizontal magnetic field to the induced horizontal electric field, in order to investigate the underlying electrical conductivity structure. There are a number of characteristics unique to seafloor magnetic and horizontal electric field recordings.

First, the electric field contains a significant component of