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LAND AND OCEAN EM INDUCTION STUDIES

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Introduction

Gravity and magnetic surveys are routinely used to map deep seated structures by exploiting the variation in density or magnetic properties of crustal rocks. Gradations in electrical conductivity provide another physical property that can similarly be exploited. The workshop session on induction studies provided a timely reminder that modern advances in electro-magnetic techniques, now provide a sound basis to attempt a systematic study of the Australian lithosphere. The two techniques most commonly used are magnetometer arrays in which the spatial variations of the geomagnetic variation field is mapped over a given area, and the magneto-telluric technique (M.T.) in which the telluric currents are also recorded. Magnetometer arrays are effective in providing rapid aerial coverage, but their depth resolution is poor. MT has good depth resolution but is logistically complicated and expensive for dense aerial coverage.

Nevertheless, as Jim Cull pointed out in his address the two should be combined. MT coverage of Australia is still very minimal, but the overview presented by Jim, showed that the new generation of inversion algorithms, the ability to acquire digital data, and in-field quality checking, produces robust 2D and 3D models of the subsurface electrical conductivity structure which provide exciting new geological insights. There is still the vexed problem of anisotropy, but it may be minimised by joint inversion of MT, and seismic data.

An essential part of EM techniques is the processing of time varying signals to extract impedance functions. Traditionally they are treated as stationary time series, but this is clearly an over simplification of natural signals. It is however possible to treat non-stationary time series with an algorithm developed by Lyn Hastie and co-workers, and in response to questions Lyn indicated that his work was approaching a stage where the algorithm could be made more widely available.

In recent years a major advance in delineating the broad scale conductivity structure of the Australian crust, has been achieved through experimental observations in the AWAGS project, in which 54 temporary stations were established across Australia, and the numerical studies by Corkery and Lilley. It appears that apart from the coast effect, the induction is dominated by the conductive sediments in the major sedimentary basins, with the induced currents flowing around the pre-Cambrian cratonic terranes. Locally these currents are concentrated by faults, shear zones and basement highs, giving rise to the local anomalies reported previously.

An AWAGS-like large scale magnetometer array study in New Zealand, is reported by Chamalaun and McKnight. While the removal of the coast effect through numerical modelling, does suggest a difference between the conductivity below North and South Island, it is clear that deep-seated signal is difficult to recover in the presence of a strong coast effect.

For an island continent like Australia it is important that appropriate technologies are developed for underwater EM studies. The technological problems are quite enormous and so the instrumental developments reported by Vrbancich and Heinson and White were particularly impressive. Vbrancich demonstrated the characteristics of an underwater EFL instrument built at the DSTO while Heinson and White demonstrated the effectiveness of the deep sea magnetotelluric unit constructed at Flinders University, by reporting on results from a recent deployment cruise off the coast of California.