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The enigma of geomagnetic transfer functions in the Chilean forearc

H. Brasse, G. Kapinos and L. Mütschard
Fachrichtung Geophysik, FU Berlin (h.brasse@geophysik.fu-berlin.de)

Near a continental margin strong electrical currents - themselves induced by natural geomagnetic variations - flow in the ocean parallel to the coastline. They give rise to a vertical magnetic field which is indicative for the integrated current density in the ocean and the resistivity of the continent. Plotted against the horizontal magnetic field, the resulting transfer function (tipper) should have a dominant or even sole component perpendicular to the coastline if the resistivity distribution in the continent is not too three-dimensional. In Chile this would mean a dominance of the EW component due to the basically NS run of coast and trench. But this is not the case in any of the study areas visited so far in the central and the southern Andes. Indeed, there is not a single profile from the 7 traverses investigated so far, where the expected characteristics are observed. Instead, a strong NS component of the tipper is present everywhere, with the EW component being even zero in some places.

Thus the underlying assumption of two-dimensionality cannot be perpetuated. The situation is particularly enigmatic for data in South Chile (between 38°S and 41°S), where 3-D modeling attempts did not yield any geologically reasonable model with an acceptable data fit. The simplest approach is to assume a pseudo- or macro-anisotropic distribution of conductivity as an image of a deeply fractured continental crust reaching well under the ocean until the trench, as was corroborated by offshore measurements showing the same effect as on the continent. The derived preference directions (i.e., orientation of the conductive axis) are in striking correlation with the run of major faults traversing the continent obliquely to the coast. On the oceanic plate this behavior of the tipper is not observed anymore. Here resistivities are low, even for periods of 100-1000s, indicating a surprisingly conductive oceanic crust and also uppermost mantle. This may be due to the numerous fracture zones on the Pacific plate and may furthermore support the hypothesis of seawater influx into the upper mantle.