GEOELECTROMAGNETIC STUDIES IN THE CENTRAL SOUTHERN ANDES REGION

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RESUMEN: Se exponen resultados de estudios magnetotelúricos y magnetovariacionales realizados en zonas de Argentina y Chile adyacentes a los Andes, y que han significado una contribución para la individuación de capas conductoras en la corteza y el manto, como también para la discusión de los efectos de distorsión en las curvas de resistividad aparente y del nivel hipotético de la conductósfera.

KEY WORDS: Argentina; Chile; Magnetotellurics; Asthenosphere; Conductosphere; Geothermal Fields.

INTRODUCTION

The magnetotelluric method was introduced in South America by H.G. Fournier, and many preliminary results are contained in his *Rapport de mission* (Fournier, 1981). Here a review of studies carried out in the central-southern Andes region in Argentina during the past years is presented, as well as results of magnetotelluric (MT) soundings done between the Coastal Range and the Andean volcanic zone in the area of southern Chile. The areas discussed in this contribution lie between latitudes 26°S and 39°S.

Modelling programs by Kisak and Silvester (1975) and Wannamaker et al. (1987) were used in these studies.

SANTIAGO DEL ESTERO-TUCUMAN GEOTHERMAL AREA

This area in NW Argentina is centered at about 26°S; 67°30'W in the back arc region. 2 D modelling of six MT soundings shows a zone of high conductance (2500-27000 Siemens) from 0 to 75 Km depth. This zone is limited at the south of the area (27°S) by structures of great resistivities (3000 - 20000 ohmm) where seismic activity -absent in the high conductance zone- reinitiates with foci at intermediate depths. Many hot springs are known in

the zone of high conductance, and temperature gradients in water wells are generally of about 100°C/Km.

Modelling of this zone has shown that 3 D distorting effects -which in some situations can be stronger in the E-polarization mode- are acting in some of the MT soundings (Muñoz et al., 1992).

AREA AT 33°S LATITUDE IN ARGENTINA

Near the Andes Cordillera -at longitude 69°W- MT soundings indicate conductive layers at depths of about 16 Km, 34 Km and 80 Km. Towards the south direction the depth of the second conductive layer is shallower (heat flow is here possibly higher). At 64°W longitude only two conductive layers are encountered: one at 40 Km and another at more than 200 Km depth, and both descending in the east direction (Borzotta et al., 1993).

PETEROA ACTIVE VOLCANO AREA (ANDES CORDILLERA, ARGENTINA).

Four MT soundings in an extension of 40 Km at latitude 35°30'S show a monocline conductive layer crossing the crust in the EW direction. At the West end the top level of this layer is at 32 Km depth, and its thickness is of about 12 Km. Under the East extreme of the profile the top of this layer is at only 5 Km depth; its thickness is of about 6.5 Km. Hot sulphurate water springs are found in the centre of the MT sounding profile. Magnetovariational sounding results suggest a conductive zone in the crust, possibly under the Atuel Valley, 25 Km at the NE of the MT profile (Fournier et al., 1993).

AREA BETWEEN THE PACIFIC OCEAN AND VILLARRICA VOLCANO (39°25'S; 71°57'W) - CHILE

1D models give a conductive layer for three sounding sites in the zone of Villarrica active volcano. This conductive layer lies in the depth range between about 40 to 100 Km. Resistivity of this layer is between 20 to 80 ohmm. In the boundary at 500 Km depth -which may be the conductosphere top level- the 1 D modelling gives a resistivity of 2 ohmm which manifests the procedure of tying in of the distorted curve to the geomagnetic global value (Muñoz et al., 1990a).

These results contrast wih 2D models which consider the effects due to heterogeneities in the crust and upper mantle structure from the Pacific Ocean to the volcanic zone in the Andes. In order to construct a more reliable model of the earth's structure of continental Chile at latitude 39°S, a scheme including oceanic structures has been assumed and subjected to nearly 80 model parameter variations (Muñoz et al., 1990b, 1992). The conductive layer under the ocean has been characterized by resistivity values of about 0.1-100 ohmm with its upper level at a depth of nearly 45 Km. Coast effect and diversity of oceanic mantle clearly changes the resistivity pattern under the continental area. Under the area of Villarrica volcano and to the east (Andes Cordillera and Argentina) a resistive lower crust has to be considered; in the eastern region the transition to the upper mantle is also characterized by a high resistivity. The source of magma of Villarrica volcano seems to be

concentrated at depths between 70 and 80 Km but there is not a simple connection with an 'asthenospheic layer' in the upper mantle. The case may be that the asthenosphere in the transition zone of the continent is subjected to cooling by the subsiding oceanic lithosphere. The hypothetical resistivity scheme also gives a conductive layer (200 ohmm) of variable thickness (10-15 Km) which ascends from the Pacific Ocean (30 Km top level) to the Andean Range (25 Km top level) and penetrates into the back arc region in Argentina.

The scatter of data does not allow a reliable determination of the upper level of the conductosphere, but different resistivity values in the range of 20-0.1 ohmm strongly control the coast effect over a large period range.

Hypothetical magma chambers in the crust have not been individuated under the zone of Villarrica volcano. 2D model tests carried out for this area have shown that, besides the quality of data, the discovery of magma chambers by using the MT method may depend on the topography of the region, the type of magma and the extended resistivity distribution pattern. During the *10th Workshop on Electromagnetic Induction in the Earth* (Ensenada, México, 1990), George Keller presented serious objections to such an enterprise, but Mark Berdichevsky objected that one of his colleagues have already done it. Who stands to reason? This is a question difficult to answer, as follows from the literature concerning this problem (e.g., Newman et al., 1985; Sibett, 1988)

CONCLUSIONS

Magnetotelluric studies in the central-southern Andes region are giving important results concerning the thermo-electrical structure of the crust and upper mantle in the arc-trench and back arc regions. These results should be useful for studying the volcanic and geodynamic processes, and for the assessment of geothermal fields in view of energy applications.

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