Boat-Towed TEM - Investigation of the Furnas Volcanic Lake Hydrothermal System, Azores

P. Yogeshwar[1], M. Küpper[1], B. Tezkan[1], V. Rath[2], D. Kiyan[2], S. Byrdina[3], J. V. Cruz[4,5], C. Andrade[4] and F. Viveiros[5]

[1]University of Cologne, Germany; [2]Diaz, Ireland; [3]ISTERRE, France
[4]University of the Azores, Portugal; [5]IVAR, Azores/Portugal

Abstract
Water-covered areas may lead to gaps in surface electromagnetic surveys, causing reduced resolution and, in consequence, increased uncertainty in derived subsurface models. We describe a boat-towed floating central loop time-domain electromagnetic technique which allows mitigating this problem. It facilitates obtaining data with a spatial sampling density, which is rarely possible with standard instrumentation on land, and only requires moderate logistical effort. A unique field study on a shallow volcanic lake demonstrated that this method is feasible with only minor loss of accuracy when compared to anchored and land soundings. We show that the noise sources arising from the moving instrument and the boat engine can be neglected. The field survey was performed on the Lagoa das Furnas (São Miguel, Azores Islands, Portugal), which is located within an active volcanic area and characterized by fumarolic fields and CO2 degassing. The associated hydrothermal system is thus expected to extend below the lake. However, the character, geometry and extent of this system are unknown because of the lack of boreholes, and geophysical studies. A total of 600 soundings, combining towed profiles with anchored and land-based soundings, were acquired with an aim of imaging the hydrothermal system beneath the lake down to 200 m. The results from all three types of measurements compare well, and thus led to consistent one-dimensional inversion models. The inversion results delineate a highly conductive, smectite-rich cap layer dipping below the lake away from the main fumarole zone. Near this zone, the extent of the conductor agrees well with an area of intense dispersed CO2 degassing, which appears to be controlled by at least two, electrically distinctive fault zones where the conductor is found at greater depths.

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