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Analysis of the Magmatic – Hydrothermal Volcanic Field of Tacora Volcano, Northern Chile, using Travel Time Tomography

Diana Comte[1], **Claudia Pavez**[2], Francisco Gutierrez[3], and Diego Gaytan[4]
[1]Universidad de Chile, Advanced Mining Technology Center, Department of Geophysics, Santiago, Chile (dcomte@dgf.uchile.cl)
[2]Geological Survey of Norway, Trondheim, Norway (claudia.pavez@ngu.no)
[3]GeoExpedition, Santiago, Chile (francisco@geoexpedition.cl)
[4]INFINERGEO SpA, Santiago, Chile

Tacora Volcano (17°43'S – 69°46'W) is a composite stratovolcano that lies at the southernmost end of a 10 km-long volcanic lineament that extends between Chile and Perú. Around Tacora volcano, current thermal manifestations are two active fumarolic fields located at the western flank of the stratovolcano and at the volcano summit, indicating active magma degassing in a shallow hydrothermal system. Beneath Tacora volcano is located the NW Challaviento reverse fault that belongs to the Incapuquio - Challaviento fault system of Middle Eocene age. To complement previous exploration results and conceptual modeling developed by INFINERGEO SPA, seventeen short period seismic stations were installed around Tacora volcano, between August and December 2014. Using the P and S wave arrival times of locally recorded seismicity, a 3D velocity model was determined through a travel time tomography. According with the results, we interpreted high Vp /Vs values as water-saturated areas, corresponding to the recharge zone of Tacora hydrothermal system. In addition, low values of ΔVp/Vp (%) and Vp/Vs ratio represent the location of a gas-saturated magmatic reservoir between sea level and 2 km depth and circulation networks of magmatic-hydrothermal fluids. Low Vp/Vs volumes (magma reservoir / high temperature hydrothermal fluids), the presence of fumarolic fields and surface hydrothermal alteration have a spatial correlation. The above suggests a structural control of the Challaviento fault in the hydrothermal flow as well as a primary influence in the emplacement and location of the magmatic-hydrothermal reservoir. Finally, we present a cluster analysis using the ΔVp/Vp (%) parameter. Through this analysis, we found a method for the identification of a key structure in depth composed by the magma reservoir (low Vp/Vs ratios, low ΔVp/Vp (%)), clay level areas (intermediate values of ΔVp/Vp (%)), and degasification zones (low values of ΔVp/Vp (%)) directly related with the surface thermal manifestations.