Magnetotelluric Investigations at the Casiri-Kallapuma Geothermal Zone, Tacna, Peru

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ABSTRACT

The studied area is located 91 km from the city of Tacna, in southern Peru. The study area was determined based on geological information and an inventory of thermal sources, and grid of 40 MT stations was deployed. The collection consisted of a series of readings for 22 hours on average, with each station separated by 1000 m to 1500 m. Data and time series were processed using standard techniques, with remote reference, static displacement correction, structural impact and dimensionality analysis based on tensor decomposition. MT data were inverted into a fully two-dimensional (2D) resistivity model along two profiles NE-SW (profile 1), NW-SE (profile 2) with an investigation depth of ~ 10 km. A three-dimensional inversion was also applied to the data. The resistivity data were used to develop a subsurface model that has three layers with different resistivity values and thicknesses, which were interpreted based on geological and tectonic studies. The resistive surface layer (R1: 50-100 Ohm-m) is located SW of profile two and has an average thickness of approximately 1000m from the surface. According to geological information, this layer could be associated with volcanic rocks (andesites, trachyandesites) from Casiri hill and the Jucure volcano. The conductive zone (C1: <10 Ohm-m) emerges on the surface between stations MT13, MT12, MT35 (at the north-eastern end of the Chungara ravine) and extends below resistive layer R1 with an average thickness of 1600m. This conductive layer is strongly correlated with hydrothermal alteration of volcanic rocks and fractures, which is associated with the possible clay cap of the volcanic geothermal system. Under the conductive layer appears the lower intermediate resistive layer (R2: 11-60 Ohm-m) at a depth of approximately 4000 m with an average thickness of 1000m and reaching greater depth to the SW and between stations MT13, MT12 and MT35 at the north-eastern end of the Chungara ravine. According to the local geology, this layer is characterized by the fractured andesites of the Tacaza and Toquepala Group, which could correspond to the geothermal reservoir. Finally, the lowest layer with high resistivity values (R3:> 100 Ohm-m) occurs at depths of more than 5000 m and is still not understood, but the regional geological model suggests a probable association with the basement rocks from Cretaceous period.