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Inversion of magnetotelluric data for the characterization of geothermal structures in the Paucarani zone, Tacna, Peru

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ABSTRACT

The region of Paucarani zone, Tacna (Peru) is formed mainly by mountains, hills, and volcanoes, in addition to wetlands. It is mainly composed of dasitic and andesitic rocks from the Holocene. The regional structural geology is characterized by fault planes in the NW–SE direction, which correspond to the fault system of Apurimac-Caylloma-Maure. This research work presents models of the geoelectrical structure after the analysis, processing, inversion, and interpretation of magnetotelluric data collected in the geothermal area of Paucarani, in order to determine areas of high electrical conductivity that are generally associated with anomalous temperatures, which are of great interest for the possible generation of geothermal energy. The data were acquired by the Instituto Geológico Minero Metalúrgico of Perú in the 2017 campaign covering an area of 120 km^2. Forty-three longband MT soundings with frequencies ranging from 10^{-3} Hz to 10^3 Hz were processed and distributed in 9 NE–SW profiles. The distribution of soundings was conditioned by the varied topography. Data processing required several steps, such as the determination of apparent impedances, dimensionality analysis using the WALDIM method, strike analysis from geological (regional faults) and geophysical (magnetic prospecting) information. After processing the raw data, the 2D inversion was performed using the WinGlink software. This program builds a geoelectric model from data inversion by iterative processes and smoothness constraints from an initial model that is composed of a mesh with a given resistivity. As a product of all these steps, geoelectrical sections were generated capable of identifying resistivity variations throughout the study area. The results indicate that the most conductive zones, of greatest interest for the study of geothermal sources, are located in the western part of the study area.

1. Introduction

Geothermal energy has the potential to play a very important role in the energy transition, which is one of the greatest challenges we currently face as a society. To realize this potential, it is essential for a country to understand in detail its available geothermal resources.

In the case of Peru, extensive geological and geophysical surveys have been conducted to study the country's possible geothermal systems since the 2010 s (Cruz et al., 2019). As part of this effort, a large magnetotelluric survey was conducted in the geothermal area of Paucarani, Tacna, in the southern part of the country, in 2017. This paper presents the inversion and interpretation of the data gathered in that study.

Peru is a country with great potential for renewable energy, such as hydroelectric, solar, geothermal, and wind. However, the current electricity matrix depends predominantly on two sources: natural gas and hydroelectric. Non-conventional renewable energies contribute less than five percent of total electricity generation, even though their use could contribute not only to the diversification and decentralization of generation but also to the mitigation of greenhouse gases caused by the use of fossil fuels in the sector.

Despite having great geothermal potential, Peru currently lacks a working geothermal power plant. The General Directorate of Electricity of the Ministry of Energy and Mines (DGE-MINEM) issued the

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