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Study of a Bolivian Altiplano geothermal field: geological and conceptual interpretations

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The Sol de Mañana/Apacheta geothermal field, well-known since the 1970's as the Laguna Colorada geothermal project, is located in SW of Bolivia (Altiplano) and appears as a target for geothermal development. The aim of this study is to improve the knowledge of this geothermal reservoir, by studying the local geology, i.e. the structural pattern and the petrophysical properties of the reservoir.
The geothermal field is composed by Miocene to Pleistocene volcanic rocks: andesites highlight the well-marked volcanic structures and ignimbrites are marked by a more or less flat topography. Field investigations show brittle structures organized according to four main orientations: NW/SE, NE/SW, N/S and E/W, leading to a compartmentalization of the geothermal reservoir. These factures/faults result of the complex tectonic evolution, at different scale, of this area. Moreover, numerous non-tectonic structures are also identified, marked by complex curve shapes, with free apertures reaching few centimeters, average extensions of several meters long and without specific orientation. Also, ignimbrites and andesites display evidences of magmatic flow, marked notably by the orientation of minerals, vacuoles, volcanic glass, clasts... Hydrothermal conditions in the reservoir could use such features to generate schistosity structures, which could form more or less horizontal draining zones for deep fluids.
Matrix properties are analyzed through petrological and petrophysical (porosity, permeability, thermal conductivity, P-waves velocity) studies. The two types of rocks present similar properties: porosity ranges from 5 to 20%, permeability from 0.01mD to more than 1D and thermal conductivity from 0.8 to 3W.m-1.K-1. Non-altered andesitic and ignimbritic facies show properties that seem to be favorable to fluid storage and transfer, whereas the properties of altered facies are less favorable.
Field data, petrological and petrophysical studies are references to build a 3D conceptual geological model for the Sol de Mañana/Apacheta geothermal field. This new model establishes that the fault and fracture corridor system is governed by grabens and horsts, and that faults tend to become horizontal at large depths. About the conceptual understanding of the geothermal system, convective cells that are controlled by the major discontinuities are expected.