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The geothermal system of Caviahue-Copahue Volcanic Complex (Chile-Argentina): New insights from self-potential, soil CO_2 degassing, temperature measurements and helium isotopes, with structural and fluid circulation implications.

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Geothermal systems represent natural heat transfer engines in a confined volume of rock which are strongly influenced by the regional volcano-tectonic setting controlling the formation of shallow magmatic reservoirs, and by the local faults/fracture network, that permits the development of hydrothermal circulation cells and promote the vertical migration of fluids and heat.
In the Southern Volcanic Zone of Chile-Argentina, geothermal resources occur in close spatial relationship with active volcanism along the Cordillera which is primarily controlled by the 1000 km long, NNE Liquiñe-Ofqui Fault Zone (LOFZ), an intra-arc dextral strike-slip fault system, associated with second-order intra-arc anisotropy of overall NE-SW (extensional) and NW-SE orientation (compressional). However there is still a lack of information on how fault network (NE and WNW strinking faults) and lithology control the fluid circulation. In this study, we propose new data of dense self-potential (SP), soil CO_2 emanation and temperature (T) measurements within the geothermal area from Caviahue-Copahue Volcanic Complex (CCVC), coupled with helium isotopes ratios measured in fumaroles and thermal springs. We observe that inside the geothermal system the NE-striking faults, characterized by a combination of SP-CO_2 and T maxima with high 3He/4He ratios (7.86Ra), promote the formation of high vertical permeability pathways for fluid circulation. Whereas, the WNW-striking faults represent low permeability pathways for hydrothermal fluids ascent associated with moderate 3He/4He ratios (5.34Ra), promoting the infiltration of meteoric water at shallow depth. These active zones are interspersed by SP-CO_2- T minima, which represent self-sealed zones (e.g. impermeable altered rocks) at depth, creating a barrier inhibiting fluids rise. The NE-striking faults seem to be associated with the upflow zones of the geothermal system, where the boiling process produces a high vapor-dominated zone close to the surface. The WNW-striking faults seems to limit to the south the Copahue geothermal area.