Noble-gas and nitrogen isotope geochemistry of geothermal fluids from the Caviahue-Copahue volcanic complex in the Southern Andes

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In the Southern Andes of Chile and 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). The Caviahue–Copahue volcanic complex (CCVC) is located at the border between Argentina and Chile, and hosts in its northeastern flank five geothermal areas with surface manifestations including thermal springs, bubbling pools and fumaroles. Two others areas (Chancho-co and Pucon-Mahuida) occur in close proximity to the volcanic-hydrothermal system in the northern and southern flank of the Copahue volcano, respectively.

The goal of the study is to understand the impacts of volcanic activity and fault-fracture networks on the evolution of the isotopic chemistry of geothermal fluids at CCVC. For this purpose, we present noble gas and nitrogen isotope data of thermal fluids from the seven main geothermal areas collected during 2014 and 2015. The R/Ra ratio varies between 3.65 Ra and 7.86 Ra and correlate positively with the $\delta^{15}N$ values (-0.86‰ to +4.9‰). If we exclude the air component, the magmatic-geothermal source of CCVC is characterized by a MORB-like mantle signature (high R/Ra: 8Ra), and by high $\delta^{15}N$ (+6.5‰) related to subducting sediments. These data suggest a significant degree of N_2 recycling, but low ^4He recycling. We link the high R/Ra and $\delta^{15}N$ values to the extensional tectonics of the region that allows uprising of fluids. On the other hand, Ne, Xe and Kr isotopic ratios are entirely of atmospheric origin but processes of boiling and steam separation have led to fractionation of their elemental abundances. The noble gas elemental abundances and low R/Ra for Chancho-co and Anfiteatro are explained by the injection of meteoric water that argues for a water recharge and mixing zone for both of them.