Gas geochemistry of geothermal fluids from the Copahue Caviahue Volcanic Complex (Argentina)

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Copahue volcano is part of the Caviahue Copahue Volcanic Complex (CCVC) which is located in the southwestern sector of the Caviahue volcano tectonic depression. This depression is a basin accommodating stresses between the southern Liquine Ofqui strike slip and northern Copahue Antinir compressive fault systems in a back arc setting with respect to the Southern Andean Volcanic Zone.

During the last 250 years at least 12 phreatic and phreatomagmatic eruptions occurred. In 2000 a phreatomagmatic event caused ash falling that affected the nearby villages.

Since November 2011 the discharge rate of fluids from the Copahue summit has significantly increased up to December 2012 when a new phreatomagmatic eruption occurred. In this study the chemical and isotopic compositions of fumaroles and bubbling gases collected in 2006 and 2007 and 2012 prior and during the last volcanic crisis from five thermal areas surrounding the Copahue volcanic edifice are presented and discussed. The main aims are to i) investigate the fluid source regions and their relationship with the peculiar tectonic assessment of this volcano and ii) describe the chemical evolution of the fumarolic fluids caused by the ongoing activity.

The He isotopic ratios are the highest observed for a Southern American volcano (R/Ra up to 7.94). Nitrogen isotope values (+5.3 to +5.5 ‰ vs. ATM) point to a source of nitrogen mainly from subducted sediments.

Despite these gases show a clear mantle isotopic signature magmatic gases are below the instrumental detection limit being likely affected by scrubbing processes within a hydrothermal reservoir constituting the main source feeding the CCVC gas discharges.

Gas geothermometry suggests that CO and hydrogen equilibrate in a vapor phase at 220 celsius degrees.

Rock fluid interactions controlling carbon dioxide and methane production from Sabatier reaction and propane dehydrogenation seem to occur within the hydrothermal reservoir at temperatures ranging from 250 to 300 celsius degrees.

Fumarole gases sampled in 2006 and 2007 show relatively low nitrogen/He ratios and high R/Ra values with respect to those measured in 2012 and prior to the 2000 phreatomagmatic eruption. Such compositional and isotopic variations were likely caused by an injection of fresh magma that likely triggered the 2000 eruption.

Presently it is difficult to assess the effects caused to the hydrothermal system by the current phreatomagmatic activity. This can likely be evaluated by intensifing the geochemical monitoring in the thermal areas located at the foothills of Copahue to verify the presence of possible magmatic signals.