# Gas geochemistry of 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 Caviahue volcano-tectonic caldera (Argentina-Chile), a pull-apart basin between a southern strike slip and a northern compressive fault system, in the Southern Andean Volcanic Zone. During the last 250 years, at least 12 low-magnitude phreatic and phreatomagmatic eruptions occurred. In 2000 a phreatomagmatic event (VEI 1-2) caused ash fall that affected the nearby villages. Since November-December 2011 the discharge rate of fluids from the Copahue summit has significantly increased up to December 22nd 2012, when a new phreatomagmatic eruption occurred. In this study, the chemical and isotopic ($\delta$13C of $CO_2$ and $CH_4$, $\delta$D of $CH_4$ and $H_2O$, $\delta$18O of $H_2O$, $\delta$15N, 3He/4He and 40Ar/36Ar) compositions of fumaroles and bubbling gases collected in 2006, 2007 and 2012, i.e. 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 origin of fluids and their relationship with the tectonic setting, and ii) describe the evolution in fumarolic fluids chemistry and relate it to the changing volcanic activity.

The He isotopic ratios, the highest observed for a Southern American volcano (R/Ra up to 7.94), and $CO_2$/3He ratios (from 1.4 to 8.8*$10^9$) suggest a non-classic arc-like setting, but rather an extensional regime due to asthenospheric thinning. $\delta$15N values (+5.3 to +5.5 ‰vs ATM) point to a source of $N_2$ mainly from subducted sediments. Although these gases show a clear mantle isotopic signature, magmatic gases, such as $SO_2$, HCl and HF are not detected, suggesting gas scrubbing by the hydrothermal reservoir that feed CCVC. Gas geothermometry in the $H_2O$-$CO_2$-$CH_4$-CO-$H_2$ system suggests that CO and $H_2$ re-equilibrate in a vapor phase at 200-220°C. On the contrary, rock-fluid interactions controlling $CO_2$, $CH_4$ production from Sabatier reaction and $C_3H_8$ dehydrogenation seem to occur within the hydrothermal reservoir at temperatures ranging from 250 to 300°C. Fumarole gases sampled in 2006-2007 show relatively low $N_2$/He ratios and high R/Ra values with respect to those measured in 2012 and prior to the 2000 eruption. Such compositional and isotopic variations were likely caused by an injection of fresh He-rich 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. A high-frequency geochemical monitoring in the thermal areas located at the foothills of Copahue is necessary to identify possible magmatic signals.