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Geochemistry of fluids emitted at the CA1 borehole (Alban Hills volcano, central Italy): new insights on deep fluids circulation and origin

luca pizzino, daniele cinti, nunzia voltattorni, alessandra sciarra, and fedora quattrocchi
Istituto Nazionale di Geofisica e Vulcanologia, Seismology and Tectonophysics, Rome, Italy (luca.pizzino@ingv.it, ++39-0651860507)

In the framework of a multidisciplinary project funded by the Italian Department of Civil Protection, focused on the Alban Hills volcano (Central Italy), a 350 m deep borehole (named CA1) was drilled near Santa Maria delle Mole village, adjacent to the western rim of the Tuscolano-Artemisio caldera, where several phenomena of unrest recently occurred. In the period 1989-90 a seismic swarm affected this area and a related uplift was recognized by geodetic investigations and satellite images analysis. In addition, this area is affected by high gas concentrations (mainly CO2, radon and H2S) both in aquifers and soils. Episodes of gas exhalation from soil and/or gas burst occurred in the past, causing illness and casualties among local inhabitants and animals, marking the considered area as exposed to a high Natural Gas Hazard.

During the phase of hydraulic fracturing tests a blow-out occurred, allowing the collection of issuing fluids for their chemical and isotopic characterisation, in order to emphasise their origin. New geochemical data provided additional information about both the deep volcanic circulation of fluids and their possible connection to a deep-seated magma chamber. We present a general and schematic hydro-geochemical-structural model of the most degassing sector of the volcano, by merging all the information acquired in the last 15 years.

Geochemical features highlight some peculiarities in both chemical and isotopic composition of the emitted fluids. Water shows a Na-HCO3 chemistry and a very high salinity never found till now throughout the Alban Hills district (TDS=7 g/l), probably due to the prolonged interaction of the CO2-rich fluids with clays. Activity plots were used to identify the main gas-water-rock interaction processes. Stable O and H isotopes reveal a meteoric origin of water, excluding any other source (juvenile and/or connate). Water is tritium-free, pointing to a long residence time of water in the aquifer. Gas phase is CO2-dominated, with N2 as second most important component. Minor gases are represented by CH4, H2 and He; in particular, He content is the highest of the entire volcanic district. 3He/4He isotopic ratio indicates both a crustal and a magmatic contribution. Carbon isotopes of CO2 suggest a high temperature origin of this gas, probably due to the methamorphism of carbonates caused by a cooling magma chamber hosted in the deep Mesozoic carbonate basement.