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Origin and fluxes of the gases emitted at Vesuvio (Italy)

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At present, Vesuvio volcano is characterised by relatively weak volcanic-hydrothermal activity manifested by widespread fumarolic emissions and diffuse soil CO2 degassing in the crater area, CO2-rich groundwaters along the southern flank of the volcano and in the adjacent plain, submarine gas emissions south of the volcano close to the Tyrrhenian coast and by low seismic activity, with epicentres clustered inside the crater. High temperature (400- 500°C) of the system was estimated based on C-H-O gas equilibria of crater bottom fumarolic fluids. The temperature estimates are confirmed by the H-S-O and H-N-O gas equilibria, and by the H2-Ar geoindicator. Based on a hydrostatic model, the hydrothermal reservoir have been located at depths of 2 - 4 km within the carbonate sequence, which is present at depths $>$ 2.5 km underneath the volcano. This is the same area where most of the earthquake epicentres of Vesuvio concentrate. A survey of the soil CO2 fluxes allowed to estimate that about 150 t/d of CO2 are released by diffuse degassing that is mostly concentrated in the inner slopes of the crater. The shape of the CO2 flux and soil temperature anomalies, and the sharp change of flux values at the crater rim, point out hat the morphology of the crater is the primary factor controlling the CO2 degassing and the related subsurface steam condensation, acting as a separator-condenser for the rising volcanic-ydrothermal fluids. The active degassing processes, present in the highest part of the volcano edifice, and the geological-volcanological setting of the volcano strongly influence the groundwater compositions. The infiltrating waters at Somma-Vesuvio caldera, enriched in volcanic gases, are forced to flow towards the southern sector to an area of high pCO2 groundwaters. This conceptual model is supported by the results of a reaction path modelling involving gas-water-rock interaction that reproduced through theoretical models the measured chemical and isotopic composition of groundwaters and dissolved gas. These results suggested the coexistence of three main processes controlling ground-

water evolution: input of a gas phase of volcanic origin; isochemical dissolution of volcanic rocks under an externally controlled pCO_2; degassing when total pressure exceed the hydrostatic pressure. Based on the computed total inorganic carbon dissolved by the groundwater and on their flow rate, a total CO_2 amount of about 150 t/d has been estimated to be dissolved by groundwater. This value is a minimum estimate because it does not take into account groundwater degassing. Mapping of TDIC shows a unique area of high values situated south, south-east of Vesuvio volcano. Coupling together the results obtained by the two approach about 300 t/d of CO_2 has been estimated as the minimum input of CO_2 in the system. The hydrothermal system of Vesuvio that feed the CO_2 degassing and affect the groundwater play an important role also in the seismicity of the volcano. In fact the high fluid pore pressure, and the possible discharge of these overpressures through fracturing could partly explain the relatively frequent seismic crises that affected Vesuvio apparatus. It is note worth that the seismic crisis of 1999, during which the strongest earthquake of the last decades occurred, was accompanied by important changes in the CO_2 fluxes.