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Soil gas composition from the 2001-2002 fissure in the Lakki Plain (Nisyros Island, Greece): evidences for shallow hydrothermal fluid circulation

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Nisyros volcano (Aegean Sea, Greece) is currently classified in the "Very High Threat" category (Kinvig et al., 2010). Although the last volcanic activity, consisting of phreatic eruptions, occurred in the 19th century, Nisyros experienced an intense seismic activity during 1996-1998 accompanied by ground deformation and changes in the chemistry of fumarolic gases (Chiodini et al., 2002), pointing to a renewed unrest. Between November 2001 and December 2002, a NNE-oriented 600 m long fissure opened in the vegetated central part of the Lakki Plain. The fissure, 1-5 m wide and up to 15-20 m deep, showed neither vertical displacements nor gas release. No changes in the seismic and volcanic activity were observed during or after this event, which was interpreted as related to collapse of the upper caldera floor fine sediment cover (<50 m thick) induced by hydrothermal fluid circulation (Vougioukalakis and Fytikas, 2005). In June 2015, diffuse CO_2 flux measurements, in combination with sampling and chemical analysis of the interstitial soil gases, were performed in (i) the fissure bottom, (ii) the adjacent vegetated areas in the Lakki Plain, (iii) the near hydrothermal craters (Stefanos, Kaminakia, Lofos domes), and (iv) sites located outside the caldera (blank values). The fissure showed neither temperature (<30 °C) nor CO_2 fluxes (<10 gm-2d-1) anomalies with respect to the blank sites and the Lakki Plain, with values strikingly lower than those measured in the hydrothermal craters (up to 98 °C and 208 gm-2d-1, respectively). Contrarily, the CO_2 concentrations in the interstitial soil gases from the fissure (up to 513 mmol/mol) were markedly higher than the background values and comparable with those measured in the craters (up to 841 mmol/mol). Relatively high H2S, H2 and CH4 contents in soil gases from the fissure confirm the hydrothermal origin of these soil gases. However, their $CH4/CO_2$ ratio were lower than those measured in the soil gases from the craters, suggesting the occurrence of oxidation processes during the underground migration of the hydrothermal fluids toward the peripheral areas of the caldera. While the low-permeable sediment cover in the Lakki Plain conceals the underneath hydrothermal gas flow, preventing the typical surface manifestations (high temperature and CO_2 flux), the chemistry of the interstitial gases reveals that deep-sourced fluids circulate within the deep permeable layers beneath the Lakki Plain enhancing alteration processes and formation of shallow collapsing structures.

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