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Dissolved carbon in groundwater and gas emissions from the soil reveal a powerful tool for volcano monitoring

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In volcanic areas, the gases released from magmatic reservoir at depth interact in various extent with groundwater and are then discharged from soils or fumaroles. Water [U+F02D] gas interaction is an ordinary process occurring in these areas and the volcanic system of Vulcano (Aeolian islands) is an excellent natural laboratory to investigate interaction between volcanic-hydrothermal gases and groundwater.
This study focuses on both the CO_2 dissolved in groundwater and the CO_2 emissions from soils in the Vulcano Porto area. The comparison of contents and isotope composition of carbon dissolved in groundwater with soil CO_2 flux and isotope composition of has been aimed to a more accurate definition of the interactions among the volcanic/hydrothermal gases, the thermal groundwater and the air/biogenic component of CO_2 in this area. In particular, the chemical-physical parameters of the groundwater, the total dissolved inorganic carbon (TDIC), the amount and the isotopic composition of the CO_2 dissolved in groundwater have been investigated. Both the partial pressure and the carbon isotope composition of CO_2 dissolved in groundwater were computed from the TDIC through an equilibrium model. These data have been compared with the same data from dissolved gases collected through passive sampling method. The results of groundwater investigations show as the high partial pressure of dissolved CO_2 correspond to the isotope signature of volcanic/hydrothermal gases typical for Vulcano.
As regard the CO_2 emission from the soils, both the carbon isotopic composition of CO_2 and the CO_2 flux values have been acquired. The isotopic dataset of the soil gases indicates a three components mixing among the CO_2 of hydrothermal origin, the air and the biogenic sources.
The comprehensive evaluation of the dataset indicates as groundwater and soil gases show the same qualitative information, and give an overall picture of the main degassing zones of a volcanic system, while the soil gas discharge provides an evaluation of the mass released by the deep feeding system. The good agreement between the areas with high gas input from depth with those having high rate of CO_2 discharge indicates that the investigation of the groundwater provides a comprehensive and qualitative information on the water [U+F02D] gas interaction processes on a wide area. Furthermore, the main degassing areas follow the main tectonic alignments clearly showing as faults and fracture behave as preferential pathways for upflow of both heat and fluids from deep origin. By coupling flux data with the CO_2 isotope composition in volcanic and geothermal areas it is possible to quantify the gas budget and to estimate the contribution of each source to the surface degassing. Knowing the groundwater storage, the circulation and the discharge, this approach give a complete evaluation of the total mass of fluids released in the peripheral part of a volcanic system.
Hence, the combined use of isotope and chemical-physical parameters of groundwater coupled with those of soils gas emissions results in a more detailed models of fluids circulation of a volcanic or geothermal system, becoming a powerful tool for volcano monitoring.