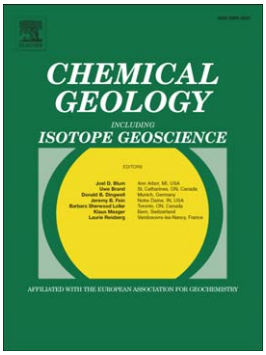

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Hydrological versus volcanic processes affecting fluid circulation at Mt Etna: inferences from 10 years of observations at the volcanic aquifer

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Abstract

The time series of geochemical data available for the network of wells and drainage galleries at Mt Etna has been analyzed to identify the changes in water chemistry related to the input of volcanic CO_2 and those related to hydrogeological dynamics. The dynamics of hydrological systems is mainly affected by changes in the rainfall, since this influences the yields of both springs and drainage galleries and the height of the water table of unconfined aquifers. In addition, the characteristics of hydrological systems can change with the fluid pressure. These mechanisms are probably enhanced by changes in the crustal strain, which can cause interbasin transfer of water. The changes in water circulation are paralleled by variations in physicochemical characteristics of groundwater, since water transfer probably occurs among water bodies with different temperatures and compositions.

Based on the above mechanisms, the contribution of different water types has been estimated according to their chemical composition: it has been assumed that water circulating in the volcanic pile has a typical HCO_3^--rich composition, whereas Cl^-, $SO_4^=$, and NO_3^- could be contributed by rainfall, anthropogenic pollution, and sedimentary fluids rich in Na^+ and Cl^-. The compositionally different end members have been identified based on the results of factor analysis, which allowed those chemicals accounted for by a single water end member to be grouped within the same factor. In some cases the $SO_4^=$ enrichment is related to the dissolution of $SO_4^=$-bearing alteration minerals contained in volcanic sequences, and in such cases this is associated with HCO_3^-. We hypothesize a binary mixing between the HCO_3^--rich volcanic end member and an end member polluted with Cl^-, $SO_4^=$, and NO_3^- related to water circulation at shallow levels. These two end members are identified by their $HCO_3^-/(Cl^- + SO_4^= + NO_3^-)$ ratio and Cl^-, $SO_4^=$, and NO_3^- contents measured at each sampling site. The extent of mixing between these different water types changes over time, probably due to changes in their circulation patterns, with water being transferred from/to water bodies with different compositions. Once the proportion of the HCO_3^- content related to the binary