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Model for origin and evolution of water at volcanoes in São Miguel, Azores (Portugal), based on geochemical and isotopic data set

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A conceptual model is presented to better constrain the origin and evolution of discharges at Sete Cidades, Fogo and Furnas Volcano, using geochemical and isotopic analyses of rock and water as well as recalculated gas composition. The evolution of thermal water clearly reveals that Na-HCO_3 and Na-SO_4 type of springs have their origin in meteoric water as isotope data are close to the local meteoric water line ($\delta^{18}O_{H2O}$ =-3 $\pm$ 1 ‰ V-SMOW; δD_{H2O}= -13 $\pm$ 7 ‰ V-SMOW) with exception of a Na-Cl spring named Ferraria, Sete Cidades area ($\delta^{18}O_{H2O}$ = 0.45 ‰ V-SMOW ; δD_{H2O}= 4.18 ‰ V-SMOW). Analysed solutions are chemical evolved by evaporation, uptake of volcanic gas, leaching of local basaltic rocks, precipitation of solids, partly admixture of sea water and/or biological activity. Following the individual concentrations supports this model e.g.: HCO_3 concentration and the recalculated isotopic composition of gaseous CO_2 ($\delta^{13}C_{CO2}= -4\pm$ 2.5 ‰ V-PDB) reflect evolved magmatic CO_2 uptake and the subsequent leaching progress; High SO_4^{2-} concentration of up to 16.5 mmol L^{-1} with $\delta^{34}S_{SO4}$ = 0.35 $\pm$ 0.3 ‰ (V-CDT) reflects magmatic origin which mainly control water chemistry of boiling pools of both Fogo and Furnas lake; $\delta^{18}O_{SO4}$ = 10.5 ‰ (V-SMOW) suggests organic origin and fits together with the observation of stromatolitic structures in the related precipitates; Molar Mg/Caratio ($\approx$ 0.77) of all thermal discharges reflects leaching of analysed local basalt (Mg/Ca $\approx$ 0.78). Furthermore, shallow and evolved outgassing effects can be distinguished. Equilibrium temperatures for various minerals given in SI vs. T plots and further geothermometers (e.g. Na-K, Na-K-Ca geothermometers) were discussed to estimate temperatures of reservoirs.