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Magmatic versus sedimentary $^{87}Sr/^{86}Sr$ signature in groundwater circulating in a basaltic volcanic systems: Mt. Etna

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Volcanoes can host large aquifers and thereby represent important water resources. Groundwater interacting with volcanics dissolves volcanogenic elements that subsequently flow through the aquifers. Volcanic systems often overlie a crustal basement. At Mt. Etna, groundwater mainly circulates in the permeable volcanics that overlie impermeable terrains composed by allochthonous series of flysch and postorogenic clayey sediments. The use of Sr isotopes is a well-established approach for tracing fluids in the crust. Since the $^{87}Sr/^{86}Sr$ ratio of the volcanics at Mt. Etna exhibits a range that differs significantly from that of the sedimentary basement, the Sr-isotope composition provides a useful tool for evaluating the interaction between shallow groundwater circulating in the volcanics and deep brines circulating in the sedimentary basement. Nowadays it is well known that the main aquifer on Mt. Etna is hosted in the volcanics. Samples from 14 sites were collected and analyzed for their chemical composition and Sr-isotope ratios. While the most common approach of coupling $^{87}Sr/^{86}Sr$ ratios with the concentration of dissolved Sr is not effective in distinguishing between the deep brine and possible seawater contributions, we suggest that the Sr/Cl ratio is a useful complementary parameter that needs to be considered when attempting to clearly identify the Sr sources. The obtained data indicate that the Sr-isotope signature of groundwater is determined by the volcanics of the aquifer. The volcanic isotopic signature is modified by very small amounts of brines (<1%), characterized by a high concentration of Sr and a $^{87}Sr/^{86}Sr$ ratio typical of sedimentary environments, but only at sites where the groundwater circulates almost in contact with the sedimentary basement. The proposed approach is potentially very effective for tracing the circulation of groundwater not only at Mt. Etna but also at volcanic edifices that overlie a bedrock with different $^{87}Sr/^{86}Sr$ ratios as well as at volcanic islands where freshwater overlies seawater.