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The Ischia Island hydrothermal system: an integrated multidisciplinary (geochemical, geophysical and geological) study

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Ischia Island is the emergent portion of a large volcanic complex on the Gulf of Naples (Southern Italy). Ischia volcano has undertaken a complex evolution since 150 ka b.p., with prolonged cycles of effusive and explosive eruptions alternated with quiescence periods (the most recent of which started after the 1302 A.D. Arso eruption). Currently, hot springs (with discharge temperature up to 90°C), fumarolic gas emissions with CO2 up to ∼97%, and diffuse soil degassing testify a persistent activity state of the Ischia volcano.
Ischia Island is a very good example of an active volcano hosting a large hydrothermal system and, in particular, its south-western sector has long been known to be the most-actively degassing area, characterized by a pervasive hydrothermal circulation. Di Napoli et al. (2009) have recently suggested that thermal manifestations in this sector of the island are fed by a shallow hydrothermal reservoir located at 150–300 m of deep with equilibrium temperatures ∼150°C. The presence of a relative shallow depth thermal aquifer represent a threat to populations living in the surroundings of volcanoes. Indeed, the supply of volatiles and thermal energy from the deep-seated magmatic reservoirs may prompt pressurization of hydrothermal aquifer, increasing the probability of phreatic explosions Here, we report the results an integrated multidisciplinary (geological, geochemical and geophysical) investigation aimed at a comprehensive characterisation of the hydrothermal setting in the south-western sector of Ischia. Geological investigations, hydrogeochemical determinations (with a focus on dissolved gases) and soil diffuse CO2 fluxes surveys, and electrical resistivity tomography and TEM soundings, have simultaneously been carried out and interpreted, with the ultimate objective of building up a model of fluid circulation in the shallowest (< 0.5 km) part of the hydrothermal system. Results show that fluids circulation, in the investigated area, is governed by a very complex structural setting schematised in three main sectors: extra caldera, caldera floor, and resurgent caldera. In particular, the caldera floor sector is the portion of the study area to which gas-rich fluids can be transferred from underlying deeper and hotter hydrothermal reservoirs. Indeed, the aquifer geometry, and the dense network of faults and fractures, force hot and gas-rich fluids to preferentially flow towards (and thus accumulate within) this sector of the volcano.
Our model of fluid circulation may serve as a basis for interpreting changes in the hydrothermal regime associated with any future unrest that could potentially escalate towards an eruption in this densely populated island.