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Abstract

Fluids discharged from volcanic systems are the direct surface manifestation of magma degassing at depth and provide primary insights for evaluating the state of volcanic activity. We review the geochemical best practice in volcanic surveillance based to a huge amount of monitoring data collected at different active volcanoes using both continuous and discontinuous approaches. The targeted volcanoes belong to the Aeolian Arc located in the Tyrrhenian Sea (Italy), and they have exhibited different activity states during the monitoring activities reported here. La Fossa cone on Vulcano Island has been in an uninterrupted quiescent stage characterized by variable solfataric activity. In contrast, Stromboli Island has shown a persistent mild explosive activity, episodically interrupted by effusive eruptions (in 1985, 2002, 2007, and 2014). Panarea Island, which is the summit of a seamount rising from the seafloor of the southern Tyrrhenian Sea, showed only undersea fluid release. The only observable clues of active volcanism at Panarea Island have been impulsive changes in the undersea fluid release, with the last submarine gas burst event being observed in November 2002. The geochemical monitoring and observations at each of these volcanoes has directly involved the volcanic plume and/or the fumarole vents, thermal waters, and diffuse soil degassing, depending on the type of manifestations and the level of activity encountered. Through direct access to the magmatic samples (when possible) and the collection of as much observable data related to the fluid release as possible, the aim has been (i) to verify the thermodynamic equilibrium condition, (ii) to discern among the possible hydrothermal, magmatic, marine, and meteoric sources in the fluid mixtures, (iii) to develop models of the fluid circulation supported by data, (iv) to follow the evolution of these natural systems by long-term monitoring, and (v) to support surveillance actions related to defining the volcanic risk and the evaluation and possible mitigation of related hazards. The examples provided in this review article show the close relationships among data analysis, interpretation, and modeling. We particularly focus on describing the fieldwork procedures, since any theoretical approach must always be verified and supported by field data, rather than just by experiments controlled in laboratory. Indeed the natural systems involve many variables producing effects that cannot be neglected. The monitored volcanic systems have been regarded as natural laboratories, and all of the activities have focused on both volcanological research and surveillance purposes in order to ensure that these two goals have overlapped. An appendix is also included that explains the scientific approach to the systematic activities, regarding geochemical monitoring of volcanic activity.