

The 2021-22 unrest of La Fossa volcano (Vulcano Island, Aeolian Archipelago) by the side of fumarole chemistry: clues on the magmatic source

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La Fossa volcano (Vulcano Island, Italy), since its last eruption in 1888-1890, remains in a quiescence state, sometimes interrupted by phases of unrest. These episodes are always marked by an increase in the vapor output, generally paired with an increase in local seismicity. During the volcano unrest, the composition of the fumarolic vapor, which is interpreted as the result of a mixing between magmatic and hydrothermal fluids [1 and references therein], responds to the increased input of magmatic volatiles, overwhelming the background contribution of hydrothermal H₂O-rich vapor. Besides being a marker of the relative contribution of magmatic and hydrothermal fluids, the fumarole composition can reveal some insights into the magmatic or hydrothermal sources that contribute fluids. It has been speculated that some of the observed unrest phases, like in the 2004-05 period, would have involved only the shallowest ponding zone of a latitic reservoir [2]. Other unrest phases, like the period 1988-93, would have been triggered by fluids coming from the deepest parts of the reservoir. The involvement of the deepest, more primitive magma reservoirs or the degassing of the shallowest, more evolved ones has crucial implications regarding the amount of fluids entering the volcano-hydrothermal system, potentially able to induce pressurization and disrupt its equilibrium.

In this paper, we present the data on the chemical and isotopic composition of the vapor collected in the high-temperature fumaroles of La Fossa volcano in 2011-2024, encompassing the last unrest episode, which started in September 2021. We provide a comprehensive interpretative framework of the sources of fluids feeding the crater fumaroles over time. The presented data reveal that a 3-year-long preparatory phase heralded the 2021 unrest. The breakthrough of the 2021 unrest stimulated different gas or magma reservoirs, whose contribution was never noticed in the past. We tentatively provide some insights into the nature and location of these newly-appeared magmatic sources.

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