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Modelling of ground deformation related to geothermal processes at La Fossa Crater (Vulcano Island, Italy)

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Since the last eruption in 1888-90, the volcanic activity of Vulcano Island (Aeolian Archipelago, Italy) has been limited to fumarolic degassing, concentrated near the active cone of “La Fossa” crater in the northern sector of the island. Ground deformation at Vulcano has been monitored, since the end of 1970s, through EDM, GPS and levelling campaigns and by permanent tilt and GPS networks. During the period 1990-1996, the areal dilatation pattern of the "La Fossa" area showed no significant variation; on the contrary, single distance measurements showed an extension (up to 7 cm) between lines connecting benchmarks positioned on the edifice and the more external ones. Moreover, high precise levelling revealed a subsidence from the base of the crater versus the summit up to 5 cm in the same period. These measurements indicate a general deflation and contraction of the volcanic cone; we inverted EDM and levelling data to infer the position and geometry of the source using the ellipsoidal model defined by Davis (1986). The best fitting source for the 1990-96 deflation is a shallow sub-vertical prolate spheroid positioned roughly under the Crater. Our observations are consistent with a model of an increase of the underground shallow water evaporation testified by the increase of steam emission and temperature at the crater fumaroles. These results suggest that a fluid loss from a shallow geothermal reservoir is the cause of ground deformation recorded at La Fossa cone in the same period. We estimated that the volume decrease causing the deformation represents approximately the 10-15% of the increased amount of steam output discharged from fumaroles in the same period (Italiano et al., 1998); this fact indicates that most of the discharged fluid has been replaced probably by an augment in the seawater permeating under the volcanic edifice.

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axial ellipsoidal cavity in an elastic half-space, with reference to Kilauea, J. Geophys. Res. 91 7429-7438. Italiano, F., G. Pecoraino, and P. M. Nuccio (1998), Steam output from fumaroles of an active volcano: Tectonic and magmatic-hydrothermal controls on the degassing system at Vulcano (Aeolian arc), J. Geophys.Res., 103, 29,829-29,842.