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Letter

The "breathing" Earth at Solfatara-Pisciarelli, Campi Flegrei, southern Italy (2005–2024): Nature's attenuation of the effects of bradyseism

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Abstract

Campi Flegrei (CF) is a large volcanic complex west of Naples, in a densely populated region at high volcanic risk due to recurrent ground uplift and subsidence (bradyseism) that has been ongoing since at least Greco-Roman times. We compare the current period of unrest beginning in 2005 with that of the bradyseism crisis of 1982–84. Despite the similarity in the quasi-radially symmetric pattern of ground deformation suggesting a similar source location and overpressure, the current uplift rate is about 8 times lower, and the seismic release energy is an order of magnitude lower than in 1982–1984 and mainly located in isolated regions below the Solfatara-Pisciarelli area. We interpret the recent earthquake swarms at Solfatara-Pisciarelli as a reflection of the activation of a fault system that was inactive during previous bradyseism crises. Furthermore, the increase of Solfatara-Pisciarelli fumarole mass flux is the manifestation of fluid discharge that significantly reduces the uplift rate of the ongoing bradyseism event. As a result, the effects of bradyseism in the CF system have self-attenuated through increased fluid expulsion ("breathing or exhalation") from the deep, lithostatically pressured reservoir. Having gained a clear understanding of the causes of bradyseism at CF, we suggest that modern geoengineering approaches developed to exploit high-temperature geothermal reservoirs may be employed to manage fluid flow and reduce the pressure exerted by geothermal fluids in the Solfatara-Pisciarelli area with the aim of minimizing the risk of phreatic eruptions and, concomitantly, reducing uplift and seismicity. This approach requires concerted and cooperative efforts between geoscientists, engineers, government officials, and the general public.

Keywords: Campi Flegrei, bradyseism, magmatic fluids, hydrothermal system, hydrofracturing and seismic activity, supercritical geothermal systems, pumping of subsurface fluids, ground deformation