Delayed inflation triggerd by regional earthquakes at Campi Flegrei Caldera, Italy

Matteo Lupi[1)], Marcel Frehner[2)], Philipp Weis[2)], Alasdair Skelton[3)], Erik Saenger[4)], Nicola Tisato[5)], Sebastian Geiger[6)], Giovanni Chiodini[7)] and Thomas Driesner[2)]

[1)] University of Geneva, Switzerland
[2)] ETH Zurich, Switzerland
[3)] Stockholm University, Sweden
[4)] International Geothermal Center, Bochum University of Applied Sciences, Germany
[5)] University of Texas at Austin, USA
[6)] Heriot-Watt University, Edinburgh, UK
[7)] INGV Rome, Italy

What if earthquakes were affecting volcanoes more than we currently think because their effects are not immediately visible? Earthquake-volcano interactions promoted by dynamic and static stresses are considered seldom and difficult-to-capture geological processes. The Campi Flegrei caldera, Italy, is one of the best-monitored volcanic systems worldwide. We use a 70-years long time series to suggest a provocative and intriguing hypothesis to explain bradyseismic activity at Campi Flegrei.

By comparing ground elevation time series at Campi Flegrei with seismic catalogues we show that uplift events at Campi Flegrei follow within 1.2 years large regional earthquakes. The accelerated uplifts are over-imposed on long-term inflation or deflation trends. Such association is supported by (yet-non definitive) binomial tests.

Due to the non-definitive nature of the statistical tests we carried on additional numerical tests. We simulate the propagation of elastic waves showing that passing body waves impose high dynamic strains at the roof of the magmatic reservoir of the Campi Flegrei at about 7 km depth. Such elevated dynamic strains promote a brittle behaviour in an otherwise ductile material (i.e. the crystal mush) at near-lithostatic conditions. Such failure allows magma and exsolved volatiles to be released from the magmatic reservoir. The fluids would ascend through a plastic zone above the magmatic reservoir and inject into the shallow hydrothermal system where they phase-separate and expand causing a delayed effect, i.e. inflation. This mechanism and the associated inherent uncertainties require further investigations. However, the new concept already implies that geological processes triggered by passing seismic waves may become apparent several months after the triggering earthquake.