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## Numerical Modelling of Injection-induced Seismicity at Campi Flegrei Caldera, Southern Italy

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Modelling volcanic processes at active volcanoes often requires a multidisciplinary approach, which adequately describes the complex and ever-dynamic nature of volcanic unrests. Campi Flegrei caldera (southern Italy) is an ideal laboratory where numerical modelling of injection-induced seismicity could be tested to match the observed seismicity. In the current study, thermal-hydraulic-mechanical (THM) effects of hot-water (fluid) injections were investigated to ascertain whether the observed seismicity (past and ongoing seismic swarms) could be quantitatively reproduced and modelled in isothermal or non-isothermal approximations. Fluid-flow modelling was carried out using a coupled TOUGHREACT-FLAC<sup>3D</sup> approach to simulate THM effects of fluid injections in a capped reservoir, where the sealing formation serves as a geological interface between supercritical reservoir and fractured shallow layers of the caldera. Results from previous seismic, deformation, tomographic and rock physics studies were used to constrain the model for realistic volcano modelling. The results indicated that fluid injections generated overpressure beneath the caprock and subjected it to different stress regimes at its top and bottom, and this prompted deformation. Thus, caprock deformation, triggered by injection-induced basal compressional forces and top extensional fractures, is a critical factor determining the required timing for pressure build-up and fault reactivation, and magnitudes of seismicity. Higher fluid injection rates and temperature contrasts, heterogeneity due to fault and its contrast with the host rock, and caprock hydraulic properties were among the identified secondary factors modulating fault reactivation and seismicity. Simulation results revealed that seismicity can be better modelled in isothermal (HM) approximations. A comparative study of the THM-modelled seismicity and 4-month-long (August 5<sup>th</sup> to December 5<sup>th</sup>, 2019) seismic monitoring data recorded at the Osservatorio Vesuviano showed that our model reproduced the magnitudes and depths (~2.5 Ms within 2 km) at the onset of the ongoing unrests on October 5<sup>th</sup>, 2019. However, the model could not adequately reproduce the highest magnitude (3.3 Ms at 2.57 km) seismicity on April 26<sup>th</sup>, 2020 observed since 1984 major unrests.