Geophysical Research Abstracts
Vol. 17, EGU2015-2894, 2015
EGU General Assembly 2015

Investigation of hydrothermal activity at Campi Flegrei caldera using 3D simulations: extension to high temperature processes

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Hydrothermal activity at Campi Flegrei caldera is simulated by using the multiphase code MUFITS (www.mufits.imec.msu.ru). We provide a brief description of the simulator covering the mathematical formulation and its applicability at elevated supercritical temperatures. Then we apply, for the first time, the code to hydrothermal systems investigating the Campi Flegrei caldera case. We consider both shallow subcritical regions and deep supercritical regions of the hydrothermal system. We impose sophisticated boundary conditions at the surface to provide a better description of the reservoir interactions with the atmosphere and the sea. Finally we carry out a parametric study and compare the simulation results with gas temperature and composition, gas and heat fluxes, and temperature measurements in the wells of that area. Results of the parametric study show that flow rate, composition, and temperature of the hot gas mixture injected at depth, and the initial geothermal gradient strongly control parameters monitored at Solfatara. Comparisons with observations show a very good match and suggest that the best guesses for the injected hot ($\sim$700 C) fluid mass flow rate is about 50-100 kg/s and the initial geothermal gradient is 120 C/km.

Of particular interest resulted the comparison between the simulated thermal profiles and those measured in geothermal wells. Keeping in mind the uncertainties due to the heterogeneities of the system, the good match obtained for the wells in the eastern and north sectors of the caldera (located some km far from Solfatara) suggest that the model can reproduce the gross features of the Campi Flegrei hydrothermal system and implicitly support the hypothesis of a single (or major) deep source of magmatic fluid located close to the centre of the caldera. Surprising results were also obtained by comparing simulated and observed (Agnano well) temperature profiles in a zone close to the gas plume: in this case the simulations clearly suggested that the magnitude of the source is of $\sim$100 kg/s.