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Electrical resistivity imaging of the near-surface structure of the Solfatara volcano

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We describe the results from an high-resolution study of the near-surface electrical resistivity structures carried out in the Solfatara area, located in the central part of the Campi Flegrei (CF) composite caldera, west of Naples, Italy. This area represents the most active zone within the CF area. It has been the site of an intense hydrothermal activity since Greek times, and currently exhibits the most impressive degassing manifestations. A direct relationship has always been observed between the increase of hydrothermal activity and ground uplift in the caldera. For this reason, dynamic of the Solfatara zone is considered a direct indicator of the volcanism taking place in the CF caldera. Since 2005 a new gradual increase of the hydrothermal activity and ground uplift has been observed. A steep growth of these effects has been recorded from 2012, accompanied by seismic events with hypocentres mostly concentrated below the area of Pozzuoli at depths ranging between 1 and 3 km, and highest magnitude of 1.8. It is thought that a further increase of the activity might lead to more critical conditions, including the occurrence of phreatic explosions.

The detailed recovery of the structure and features of the shallow aquifers, mainly in the largest fumarole areas, is a crucial step for interpreting the ground movements and to improve our capability to forecast future pre-eruptive scenarios. Electrical resistivity results particularly sensitive to the presence of aqueous fluids and partial melts. By electrical imaging the volume of subsurface fluids can be constrained and the rheology of the subsoil can be reconstructed.

To this aim, we have carried out eight profiles for electrical resistivity imaging, crossing the fumaroles field, deducting an electric model of the structural setting of the hydrothermal system in the first 100 m depth. Six of the profiles were 250 m long, with an electrodic distance of 5 m. Two longer profiles, up to 750 m, characterised by an electrodic distance of 10 m, was also realised, that crosses the whole Solfatara crater in the N-S and NE-WSW direction, respectively. The main electric features has been reconstructed and ERT results have been utilised to the aim of detailing the outlines of the fumarolic field defined by previous ground temperature, CO_2 soil degassing, seismic noise, Bouguer anomaly mapping. A further analysis of the correlation between the recorded physical parameters and the main electric discontinuities has been realised.