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Chemico-physical modeling of degassing process at Solfatara hydrothermal system (Phlegraean Fields, South Italy)

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The Phlegraean Volcanic District (PVD), located in the densely populated Neapolitan region (South Italy), is an active high-volcanic risk area, including Campi Flegrei (CF) and the islands of Procida and Ischia. At present the more evident manifestations of a persisting magmatic activity are located at Solfatara of Pozzuoli, a volcanic crater generated about 4ka BP.

Repeated 'geophysical' crises (bradyseism) at Solfatara and its surroundings are documented by seismic activity and ground deformation, occurred in the last 30 years. The major bradyseismic events occurred in 1969-1972 and in 1982-1984. At Solfatara the volcanic system releases a large amount of energy through the expulsion of hydrothermal fluids to the atmosphere. A corresponding heat loss of about 100 MW was calculated coupling soil CO_2 flux measurements with the conceptual geochemical model, which explains the chemical evolution of gases separated at the top of the hydrothermal system. The validity of such a conceptual model was confirmed by recent re-elaborations of geochemical data collected at Solfatara fumaroles since 1982 and by the application of numerical modeling of the hydrothermal circulation. The results of the modeling highlighted that periods of enhanced fluid injection at bottom of the hydrothermal system are consistent with the chemical variations observed at Solfatara fumaroles during the crises of 1982-1984, and during three minor episodes occurred in 1989-90, 1994-95 and 2000. Nevertheless, this approach adopts, as gaseous source feeding the hydrothermal aquifer, a H_2O-CO_2 mixture of the composition similar to that observed at fumaroles, due to the fact that available geochemical models bring

no information about the chemistry of (magmatic?) fluids feeding the hydrothermal system. Filling such a gap of knowledge is a major task for the chemical and energetic assessment of processes involved in the Solfatara geothermal field. Aiming at reconstructing the geochemical process to be adopted in the study of geochemical and ground-level variations, a new methodological approach, based on a mass-isotopic-energy balance of the fumarolic fluids has been applied, showing that collected data at surface may carry some basic information on the composition of magmatic gas feeding the hydrothermal system. The estimate of the composition of the magmatic gas feeding the hydrothermal system, coupled to the physico-numerical modeling gives new results about the dynamics of the Solfatara hydrothermal system and provides a valuable tool for the assessment of bradyseismic crises and for the purposes of volcanic forecasting.