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Long time series of soil CO_2 degassing measurements at Solfatara of Pozzuoli (Campi Flegrei, Italy)

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Since 1998, 28 extensive soil CO_2 flux surveys, each including 400-500 measurements by accumulation chamber method, were performed over a large area (about 1.45 km2) covering the Solfatara crater and its surroundings. The statistical analysis of CO_2 flux values, coupled with the measurement of the CO_2 efflux isotopic composition, allowed to characterize the different CO_2 sources feeding soil degassing and to investigate their temporal variability. Using a geostatistical approach the spatial structure of the degassing area, as well as the total amount of released CO_2, have been defined. The area is characterized by a well defined diffuse degassing structure interested by the release of deeply derived CO_2 (Solfatara DDS), which geometry is strongly controlled by volcanic and tectonic structures. The extension of the Solfatara DDS varied in the time with two major enlargements, the first consisted in its doubling in 2003-2004 and the second in further enlargement of about 30% occurred between 2011 and 2012. Both DDS enlargement mainly interested the area external to the crater in correspondence of the NE-SW fault system of Pisciarelli area. This area is also characterized by a very large increase in fumarolic emissions, in terms of both flow rate and discharge temperatures since 2005. The first event of DDS enlargements was previously correlated with the occurrence in 2000 of a relatively deep seismic swarm, which was interpreted as the indicator of the opening of an easy-ascent pathway for the transfer of magmatic fluids towards the shallower portion of the hydrothermal system; the second enlargement well correlates with the recent unrest phase of the system, characterized by an acceleration of the ground uplift. The amount of released CO_2 has been estimated ranging between about 700 t/d and about 1500 t/d (with errors between 9 and 15 %) until the January 2015 when there was an increase up to 2800 t/d. After this maximum emission rate the flux slightly decrease during 2015 reaching again an CO_2 output of 1500 t/d at November 2015. The CO_2 variations in the last two years seems to follow the trend depicted by ground deformations, with increases of fluxes during the uplift accelerations and decreases of fluxes during the phases of relative “no-uplift”. The comparison of the CO_2 flux data with the chemical composition of the main fumaroles suggests that the variation of in the DDS extension is correlated to processes of condensation of the vapor plume feeding the Solfatara manifestation accompanied by an overall increase of the temperatures, caused by the arrival of increasing amounts of magmatic fluids