Geophysical Research Abstracts
Vol. 14, EGU2012-7473, 2012
EGU General Assembly 2012

Soil gases and SAR data reveal hidden faults on the sliding flank of Mt. Etna (Italy)

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From October 2008 to November 2009, soil CO_2, radon and structural field surveys have been performed on Mt. Etna, in order to get insights upon active tectonic structures in a densely populated sector of the South-Eastern flank of the volcano, which is affected by the volcano's flank dynamics, as highlighted by satellite data (SAR). The investigated area extends about 150 km2, in a portion of the volcano where SAR data detected several lineaments not well defined from previous geological surveys. Soil CO_2 and soil radon measurements were performed along transects roughly orthogonal to the newly detected faults, with measurement points spaced about 100 m. In each transect, the highest CO_2 values were found very close to the lineaments evidenced by SAR observations. Anomalous soil CO_2 and radon values were also measured in correspondence of old eruptive fractures. In some portions of the investigated area soil gas anomalies were rather broad over transects, probably suggesting a complex structural framework consisting of several parallel volcano-tectonic structures, instead of a single one. Soil gas measurements proved particularly useful in areas at higher altitude on Mt. Etna (i.e. above 900 m asl), where SAR data are poorly informative, as they allowed recognizing the prolongation of some tectonic lineaments towards the summit of the volcano. At lower altitude on the volcanic edifice, soil gas anomalies strikingly define the active structures indicated by SAR data, down to almost the coastline and through the northern periphery of the city of Catania. Cross-correlation among geological, structural, geodetic and soil gas data allowed to shed more light on the complex dynamics of the sliding eastern flank of Mt. Etna, gathering a wealth of information that the single disciplines would not have obtained alone. In particular, the multidisciplinary approach here adopted allowed the detection of many hidden faults as buried segments of active structures without surface evidence. The shear zones revealed by this study are linked to the active S Rift of Mt. Etna and probably accommodate both the different velocities of ground deformation along the faults that bound the unstable blocks of the volcano, and the E-W extensional strain associated with magma emplacement within the volcano.
Furthermore, the information acquired improved our understanding of the nature of diffuse soil degassing on Mt. Etna in relation both to faults and to local geology. This approach may significantly contribute to improve the structural hazard assessment and geodynamic modeling of Mt. Etna.