Geophysical Research Abstracts,
Vol. 11, EGU2009-4530, 2009
EGU General Assembly 2009

Deformation and eruptions at Mt. Etna volcano (Italy): a lesson from 15 years of observations

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We performed a joint interpretation of space borne Differential Synthetic Aperture Radar Interferometry (DInSAR) deformation measurements and volcanic activity at Mt. Etna volcano (Italy) in the period 1992-2006. DInSAR is a microwave imaging technique allowing us to investigate Earth surface deformation with a centimeter to millimeter accuracy.
In particular, we processed 107 ascending (Track 129, Frame 747) and 102 descending (Track 222, Frame 2853) SAR data acquired by the ERS-1/2 and ENVISAT sensors, for the investigated time period. From SAR data we generated 283 interferograms for the ascending orbit and 289 for the descending one which are subsequently inverted by applying the Small BAseline Subset (SBAS)-DInSAR algorithm. This approach permits to resolve both the spatial and temporal evolution of the surface volcanic deformation. We also benefit from the use of multi-orbit (ascending and descending) data which permit us to discriminate the vertical and east-west components of the volcano edifice displacements. This dataset represents an exceptional opportunity to monitor how volcano deform during the rise, storage and eruption of magma.
In the analyzed 15 years we distinguished two main volcano-tectonic behaviors: (1) between 1993-2000, Etna inflated with a starting deformation rate of Ĩ cm/yr that progressively reduced with time, nearly vanishing between 1998-2000; moreover, low-eruptive rate summit eruptions occurred, punctuated by lava fountains; (2) between 2001-2005, Etna deflated, feeding higher-eruptive rate flank eruptions, along with large displacements of the entire East-flank.
We suggest that these two behaviors result from the higher rate of magma stored between 1993-June 2001, which triggered the emplacement of the dike responsible for the 2001 and 2002-2003 eruptions. Our results clearly show that the joint interpretation of volcano deformation and stored magma rates may be crucial in identifying impending volcanic eruptions.