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Ground deformation patterns at Mt. Etna from 1993 to 2000 from joint use of InSAR and GPS techniques

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We present an integrated InSAR-GPS approach in order to study the ground deformation patterns affecting Mt. Etna volcano during the recharging period following the big 1991-93 flank eruption. Data collected from GPS surveys carried out on the volcano networks between 1993 and 2000 were analysed. In particular, in order to allow the integration between GPS and InSAR results, particular comparisons among the 1993, 1997, 1998 and 2000 surveys were analysed. The radar images over Mt. Etna are taken by the European Remote sensing satellites (ERS1 and ERS2). The images were chosen considering the two following criteria: i) to obtain pairs of images having the minimum perpendicular baseline component and ii) to obtain interferograms covering the same periods investigated by GPS tecniques. Ground deformations due to the magma movements within the plumbing system of the volcano (magmatic sources) and ground deformation due to activity of several faults dissecting the volcano edifice (tectonic sources) have been detected. In order to interpret the ground deformation patterns, the inversions of the GPS data, for different time intervals, were performed using the Mogi (1958) and Okada (1982) formalisms. InSAR and GPS data show that since 1993 the magma started to fill the plumbing system of the volcano; only in 1995 the eruptions at the summit and on the flank of the volcano began. The inversion of GPS data for long-time periods (1993 - 1997 and 1993 - 2000) evidences some pressure sources beneath the upper western flank of the volcano, at 7 - 8 km b.s.l.. These pressure sources could represent the expression of a storage volume of magma, which probably fed the shallow intrusions that produced the eruptions occurred from 1995 to 2000. At shallow depths (1 - 2 km a.s.l.), the modelled source highlight that the NNW-SSE and NE-SW trends are the most frequent orientation of the magmatic intrusions

and tensile dislocations at Mt. Etna. These two primary structural trends can be recognizable both in the regional context and in the volcanic area. Moreover, both GPS and InSAR data show a continuous eastward to south-eastward motion of part of the eastern sector of the volcano. The northern and western structural boundaries of this unstable sector are defined by the Pernicana fault and the so-called Rift zones (both the North-East and South ones). The southern boundary is more debatable. However, interferograms provide new data on the activity and extent of the southern boundary: this boundary is given by the Mascalucia - Tremestieri - Trecastagni fault system. The analytical inversions of GPS data infer a plane dipping about 12°ESE, located beneath the eastern flank of the volcano at a depth of 1.5 km b.s.l.. This structural framework leads to interpret the eastern sector as a mega-block bounded by shallow trans-tensional faults, which progressively flatten at depth (1 - 2 km) into a main detachment “zone” which importance is confirmed in this study.