Coupled magma chamber inflation and sector collapse slip observed with SAR interferometry on Mt. Etna volcano

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Abstract: Volcanoes deform dynamically due to changes in both their magmatic system and due to instability of their edifice. Mt. Etna is the largest volcano in Europe and one of the most active on Earth. It features vigorous and almost persistent eruptive activity from its summit craters (strombolian activity, lava fountaining and lava overflows) and periodic flank eruptions forming parasitic cones and large lava flows. Even though its shape is that of a large stratovolcano, its structure features two rift systems and a flank collapse structure similar to Hawaiian shield volcanoes. Here we analyze satellite interferometric synthetic aperture radar (InSAR) deformation data for Mt. Etna spanning its quiescence from 1993 through the initiation of renewed eruptive activity in late 1995. Comparison of independent interferograms covering the first two years of the inflationary period, with interferograms spanning the summer and early fall of 1995, suggest that the rate of uplift increased prior to the resumption of strong summit fire fountaining during late fall of 1995. To examine whether this apparent increase in uplift rate might be due to atmospheric noise we calculate the range change effects due to differential tropospheric path delays based on meteorological data from Trapani, Sicily. We find that the apparent increase in uplift rate is not diminished when we consider the troposphere. Joint inversion of interferograms from ascending and descending satellite tracks require both inflation from a spheroidal magmatic source located beneath the summit at 5 km below sea level and displacement of the east flank of Etna along a basal decollement. Both sources of deformation were contemporaneous within the resolution of our data and suggest that inflation of the central magma chamber acted to trigger slip of Etna's eastern flank. These results demonstrate that flank instability and recharge of a volcano's magma system must be considered together for understanding how volcanoes work and in any evaluation of hazard.