



## **25 years long-term deformation at Mt. Etna Continuous Borehole Tilt and Vertical GPS Displacements recordings**

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In the 1980s, shallow borehole tilt measurements saw a reprise in the monitoring of geodynamic active areas, while from the beginning of the 1990s the Global Positioning System (GPS) development also provided the opportunity to repeat geodetic measurements in geodynamic and volcanic areas. At Mt. Etna, the continuous measurements from shallow borehole tiltmeters have been successfully used to infer the mechanisms of magma accumulation and intrusive processes that foreran and accompanied the several eruptions occurring during the last thirty years on this very active volcano. The long-term deformation, associated with unrest and/or eruptive phases, is expected to be larger than tectonic deformation and therefore significant long-lived trends could be detected. For the first time, we present 25 years (1990 – 2014) of continuous borehole tilt recorded at Etna volcano at different stations and vertical displacement periodically measured by GPS. We analyze long-term series that comprise several main flank eruptions, which we believe are unique in the landscape of instrumental monitoring of geodynamic active areas. The good similarity of the patterns obtained from the two independent long-term measurements (borehole tilt and GPS) confirms the long-term stability of the borehole signals, the overall reliability of vertical GPS variations and provides robust support to the interpretation on the volcano dynamics. The tilt and GPS data series reveal that during this lengthy period, there were two primary volcanic phases: i) a major recharging in the period 1994 - 2001 that culminated with the two major explosive-effusive flank eruptions in 2001 and 2002-2003, and ii) a subsequent prolonged period of re-equilibrium that was accompanied by three other effusive flank eruptions and 44 episodes of lava fountains in 2011-2013. This highlights that, in the long-term (tens of years), a single strong recharge phase may not imply a following single main eruption, but could even require several eruptions to re-equilibrate the plumbing system.