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Composite ground deformation pattern forerunning the 2004-05 Mt. Etna eruption

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After the end of the 2002-2003 eruption, Mt. Etna activity was characterized only by gentle degassing at the summit craters and some earthquake swarms. Suddenly, an eruption started on September 7, 2004 with total absence of summit crater volcanic activity, seismicity or seismic tremor, and ground deformation. This is the first time that magma poured out passively without associated volcanic and/or geophysical phenomena. The primary key to understanding this event is represented by the ground deformation pattern recorded through GPS measurements during the year before the eruption. The displacements measured on the western side of Mt. Etna, in agreement with the previous pre-eruptive periods, highlight a net inflation that reveals a re-charging phase of the plumbing system of the volcano, while the seaward sliding of the eastern flank of the volcano produces the most evident effect on the ground deformation pattern during the year preceding the eruption, at a rate never observed before in a non-eruptive period. The images from satellite radar interferometry confirmed this pattern. From the onset of the 2002 eruption to summer 2004, the dynamics of the eastern flank showed exceptionally high velocities for a non-eruptive period, which predominated the net inflation of the volcano edifice and represented the first order of ground deformation. The upper part of edifice underwent the maximum tension with a main extension along a NNE-SSW direction that favored the opening of ESE-WSW tensile fractures such as the eruptive ones. The already resident magma, even though not yet ready for a classic eruption, emerged passively from this fracture system induced by the tension of the sliding flank without the usual final precursors (degassing, strombolian activity, tremor, seismicity, etc.). This peculiar framework produced the first passive eruption to be observed at Mt. Etna since the volcano has been instrumentally monitored.