



Effects of lateral dyke propagation and pre-existing fractures on dyke-induced deformation: field data from the Etna 1947 eruption

Alessandro Luppino¹, Alessandro Tibaldi^{1,2}, Massimo Cantarero³, Noemi Corti¹, Emanuela De Beni³, Federico Pasquarè Mariotto⁴, and Fabio Luca Bonali^{1,2}

¹Department of Earth and Environmental Sciences, University of Milan Bicocca, Milan, Italy

²CRUST – Interuniversity Centre for 3D Seismotectonics with Territorial Applications, Chieti, Italy

³National Institute of Geophysics and Volcanology, Section of Catania, Italy

⁴Department of Human and Innovation Sciences, Insubria University, Como, Italy

Mount Etna, one of Europe's most active volcanoes, has experienced a variety of eruption settings throughout its history, including summit, flank, and eccentric eruptions. In this study, we provide a detailed analysis of the structures formed during the 1947 eruption, which occurred along the NE Rift, drawing on historical accounts, archival images, and contemporary field and drone data. Photogrammetric processing of 1932 and 1954 historical aerial photos enabled us to identify and map the structures formed before and during the eruption, in order to focus the effects of the direction of the dyke propagation, and of pre-existing fractures on the 1947 deformation pattern. Several data collected through recent field missions allowed us to classify the structures into different types including extensional fractures, normal faults, and eruptive fissures, and to determine their kinematics (pure extensional, right-lateral component, and left-lateral component). We also extracted information on the structures' length, azimuth, vertical offset, vectors and opening amount, to characterize the surface deformations resulting from the magmatic event. Furthermore, we reconstructed a detailed chronology of the eruption's day-by-day development based on available historical data. This information allowed us to characterize the event as a lateral propagation of magma along a N-S to NE-SW-striking dyke. This produced the formation of various structures, with different geometry and deformation amount. In particular, our reconstruction of the fault-slip profiles obtained at both sides of multiple grabens, show that fault scarps taper towards NE. This is consistent with the assumption that lateral dyke propagation can induce the formation of normal faults with asymmetric slip profiles.