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Volcano plumbing system geometry: The result of multi-parametric effects

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Magma is transported from magma chambers towards the surface through networks of planar structures (intrusive sheets) spanning from vertical dikes to inclined sheets and horizontal sills. This study presents an overview of intrusive sheets at several volcanoes located in different settings in order to contribute to assess the factors controlling the geometry of magma plumbing systems. Data have been mainly acquired in the field and secondarily through a collection and analysis of geophysical publications; data include local lithology and tectonics of the substratum surrounding the volcano with special reference to local fault kinematics and related stress tensor, regional tectonics (general kinematics and far-field stress tensors), crustal thickness, geology and shape of the volcano, topographic setting, and characteristics of the plumbing system. Data from active volcanoes and eroded extinct volcanoes are discussed; the shallow plumbing system of active volcanoes has been reconstructed by combining available geophysical data with field information derived from outcropping sheets, morphometric analyses of pyroclastic cones, and the orientation and location of eruptive fissures. The study of eroded volcanoes enabled to assess the plumbing system geometry at lower levels in the core of the edifice or under the volcano-substratum interface. Key sites are presented in extensional, transcurrent and contractional tectonic settings, and different geodynamic areas have been investigated in North and South-America, Iceland, Southern Tyrrhenian Sea and Africa. The types of sheet arrangements that are illustrated include swarms of parallel dikes, diverging rift patterns, centrally-inclined sheets, radial dikes, bi-modal dike strikes, circum-lateral collapse sheets, and mixed members. This review shows that intrusive sheet emplacement at a volcano depends upon the combination of several local and regional factors, some of which are difficult to be constrained. While much progress has been made, it is still very challenging to forecast the likely paths and geometry of sheet propagation and emplacement during volcanic unrest events.