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Magmatic Evolution and plumbing system of ring-fault volcanism: the Vulcanello Peninsula (Aeolian Islands, Italy)

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Abstract: The Vulcanello peninsula is situated north of Vulcano, the southernmost island of the Aeolian Arc. It was built at the rim of La Fossa Caldera between 1000 and 1650 A.D. Erupted products are mafic to intermediate in composition, while the coeval products erupted inside the caldera are mainly rhyolitic. Therefore, Vulcanello's activity represents an anomalous mafic post-caldera volcanism in a convergent setting.

A petrographic and geochemical study was carried out on lavas and pyroclastic rocks representing the entire eruptive history of the volcanic centre. New data (major and trace elements and Sr isotope ratios on whole rocks, and major element compositions on mineral phases) and geochemical models were used to investigate shallow level differentiation processes (*i.e.*, fractional crystallisation, fractional crystallisation plus crustal assimilation, degassing, magma mixing/recharge).

The study suggests that the entire Vulcanello activity can be considered as the uninterrupted expulsion of a single deep magma batch of shoshonitic composition emitted from a NE–SW ring fault of La Fossa Caldera. The magma is genetically related to the shoshonitic basalts found as melt inclusions in the olivine crystals erupted in the products of the 1888–1890 ''*La Fossa*'' activity. This points to a possible single deep plumbing system for both La Fossa Cone and Vulcanello centres, strongly controlled by NW–SE to N– S regional structures.

The shoshonitic magma, undergoing fractional crystallisation, partly rose directly to the surface where two strombolian cones were constructed, while residual magma remained at depth, and, partially degassed and crystallised, it subsequently erupted both effusively to form a lava platform and explosively to form a third pyroclastic cone. The remaining magma evolved to latite by AFC process and was erupted both as a lava flow (Punta del Roveto) and in the form of pyroclastic products (*i.e.*, the upper part of the third cone), controlled by shallow ring faults of La Fossa Caldera.

Therefore the Vulcanello plumbing system is controlled by tectonic structures at depth and by shallower volcano-tectonic (caldera) fractures.

Key-words: Aeolian Arc, Vulcano, Vulcanello, AFC, plumbing system, ring-fault volcanism.

1. Introduction

Calderas are volcano-tectonic depressions occurring in all geodynamic settings and can be classified on the basis of the dominant composition of the erupted products or geometry (Cole *et al*., 2005, and references therein). Post-caldera activity generally occurs within the main depression and/or along ring faults. At convergent margins, where calc-alkaline volcanism develops, such activity is usually related to the emplacement of domes and/or pyroclastic rocks with differentiated compositions (*e.g.*, Walker, 1984; Lipman, 1997). The eruption of mafic magmas is typical of hot-spot shield volcanoes or calderas at divergent margins (*e.g.*, Galapagos Islands, Hawaii, Iceland). Basaltic, post-caldera volcanism is rather unusual at convergent margins (*e.g.*, Masaya volcano, Nicaragua, Williams & Stoiber, 1983; Walker *et al.*, 1993). Here, new petrographic, geochemical and isotopic data are reported for mafic to moderately differentiated (shoshonites and minor latites) products erupted from Vulcanello vents, which emplaced along a ring fault of La Fossa Caldera at Vulcano Island (Aeolian Islands), in a convergent-type geodynamic setting (Calabrian Arc, Italy) (Ventura *et al.*, 1999; De Astis *et al.*, 2003, and reference therein; Blanco-Montenegro *et al*., 2007). La Fossa Caldera represents an active volcanic area: the last eruption occurred in 1888–1890 A.D. at La Fossa Cone inside the depression. Currently, ground deformation, seismicity, high temperature fumaroles (up to 600 °C in 1980) and intense soil degassing occur. Therefore, the reconstruction of the magmatic evolution of Vulcanello could be relevant for the study of ring-fault volcanism and hazard forecasting. For this purpose, the relationships between the magmas feeding Vulcanello and La Fossa Cone activities were investigated.

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