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The Somma-Vesuvius Volcano (Southern Italy): Structure, Dynamics and Hazard Evaluation

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We review the main results, giving some new analyses and insight, obtained in recent times about the structure, present dynamics and hazard evaluation at Somma-Vesuvius volcanic complex. We present a global review and interpretation of structural features, both at local and regional scale, constrained both by seismic and petrological data. The local structure of Somma-Vesuvius is reviewed in three depth ranges, shallow, intermediate and deep. The shallow velocity structure is inferred by the joint inversion of shot and local earthquake arrival time data. The main feature pointed out at shallow depth is a high velocity anomaly at the crater axis, extending down to about 5 Km of depth. Such an anomaly, first observed at Vesuvius, seems to be common to many other volcanoes. It can be interpreted in terms of the presence of solidified residual magma in the shallow conduits, accumulated in last eruptive cycles. The local seismicity is strongly clustered around this anomaly, due to the focusing effect of the rigidity contrast. The seismic occurrence appears as a result of the superposition of a background level, mainly due to gravitational instability of the Vesuvius cone, and of intense activity episodes, which possibly reflect episodic internal activity. Two main zones of magma accumulation in the upper crust are evidenced by the joint interpretation of seismic and petrological data. The first one, located in the depth range 4-6 km, is mainly constrained by the crystallisation depth of phonolitic magmas which fed Plinian and sub-Plinian eruptions; the second one, around 11-15 km of depth, is mainly constrained by reflected-converted seismic waves, and in agreement with crystallization depths inferred for the moderate eruptions. The study of the deep structure, performed by regional tomography with teleseisms, further points out magma roots at higher depths (15-30 km). An additional result for the deep structure, studied at regional scale and very important for geodynamic interpretations of the Tyrrhenian volcanisms, has been the evidence for a subducting slab under the Apennines, in an area

where previous models hypothesised a slab window. New original studies of crystal growth (phenocrystals and microlites) on the eruptive products allow to infer typical times of magma rising from such reservoirs, which appear very low, on the order of minutes to tens of minutes. Static deformation at this volcano, in the last 30 years, has been detected by the joint use of levelling, GPS and DifSAR techniques. It indicates subsidence, very concentrated in the crater area and in a narrow strip all around the volcanic edifice, with maximum rates less than 0.01 m/year. Static deformation in the crater area appears in agreement with the mechanism of gravitational instability generating local volcano-tectonic seismicity, while the peculiar pattern around the volcanic edifice is probably due to the combination of extensional stress and volcanic loading, generating a ring normal fault-like structure. While the key results about structure and dynamics help to define pre-eruptive scenarios, a new probabilistic procedure to combine volcanological data and computer simulations has been used, in this paper, to build hazard maps giving the probability, at each location in the area, to be hit by a pyroclastic flow or to experience a destructive fall-out deposit. The review and new results of this work give then the first complete picture of the state of the art in our knowledge about Somma-Vesuvius volcano.