Preliminary results of a high-resolution multidisciplinary investigation of the SW sector of Mt. Vesuvius

P.P. Bruno[1], S. Maraio[2], T. Ricci[2], P.M. De Martini[2], L. Improta[3], V. Materni[4], V. Sapia[4], F. Muccini[4], R. Civico[2], A. Rindinella[5], F. Villani[2], A. D'Alessandro[3], F. Pisciotta[6], A. Sciarra[2], S. Speciale[3], A. Finizola[7,8], G. Aquilina[9], N. Giugliano[10], S. Pucci[2], G. Vitale[3], L. Beltramone[5], M. Pischiutta[4], S. Scudero[3], S. Bongiovanni[11], E. Bagnato[12], M.A. Di Vito[12]

[1] *Dipartimento di Scienze della Terra, dell'Ambiente e delle Risorse, Università degli studi di Napoli 'Federico II', Napoli, Italy.*
[2] *Istituto Nazionale di Geofisica e Vulcanologia, Sezione Roma 1, Roma, Italy.*
[3] *Istituto Nazionale di Geofisica e Vulcanologia, Osservatorio Nazionale Terremoti, Roma, Italy.*
[4] *Istituto Nazionale di Geofisica e Vulcanologia, Sezione Roma 2, Roma, Italy.*
[5] *Centro di GeoTecnologie, Università di Siena, San Giovanni Valdarno, Italy.*
[6] *Istituto Nazionale di Geofisica e Vulcanologia, Sezione di Palermo, Palermo, Italy.*
[7] *Université de La Réunion, Laboratoire GéoSciences Réunion, F-97744 Saint Denis, France.*
[8] *Université de Paris, Institut de physique du globe de Paris, CNRS, F-75005 Paris, France.*
[9] *SOCOTEC Italia s.r.l., Ferrara, Italy.*
[10] *TECNO IN s.p.a., Napoli, Italy.*
[11] *Dipartimento di Scienze della Terra e del Mare, Università di Palermo, Palermo, Italy.*
[12] *Istituto Nazionale di Geofisica e Vulcanologia, Osservatorio Vesuviano, Napoli, Italy.*

The data presented here have been acquired under the MIUR-INGV project "Pianeta Dinamico". One of the targets of this project is the understanding of the near-surface structure of volcanic areas at the local and superficial scale (depth < 1 km) to improve our knowledge of their internal shallow structure for multiple purposes such as the reconstruction of the recent eruptive history, to understand the volcano dynamics and to support volcanic hazard assessment.

Due to its position and eruptive history, Mt. Vesuvius is one of the key areas to be investigated for the above-mentioned purposes. We present the preliminary results of a multidisciplinary, high-resolution geophysical investigation that targeted the SW sector of the volcano. Our intent was the imaging of the shallow structure of this key sector of the volcano to establish the link between tectonic structures and volcanic evolution through the integration of a multivariate dataset. The high-resolution seismic dataset consists of a 2.5 km-long seismic reflection profile,

acquired with a vibrating seismic source and with an unconventional layout which allows a meaningful integration of seismic reflection with refraction tomography. The seismic profile is complemented by gravimetric, magnetic and electrical resistivity profiles overlapping the seismic data, as well as CO_2 exhalation flux and soil concentration and self-potential measurements.

The 2-D ERT resistivity section shows a very high resistive uppermost layer, about 50 m thick to the West which drastically thins toward the east. Below this layer, high and lower resistivity layers are embedded down to a depth of about 150 m. These electric properties overlap with prominent shallow features in the preliminary seismic reflection image which shows unexpectedly high quality, considering the harsh environment where it has been obtained. A clear, strong low-amplitude reflector, with complex morphology can be followed with continuity along the entire profile at an average two-way-time of about 300 ms (i.e. 200-250 m from the surface). This reflector can be interpreted as the seismic signature of the buried Caldera related to the Avellino Plinian Eruption (Cioni et al., 1999), for which a large debate exists in terms of the exact position within the Mt. Vesuvius edifice.

The magnetic measurements were performed on the same line of the other surveys. Measures have been taken with a spacing of 4.0 m with the sensor placed at an elevation of 2.0 m above the ground. The magnetometric data have been filtered in order to highlight features at longer wavelengths. The resulting magnetic section shows anomalies suggesting lateral variations in the layout of volcanic rocks.

The horizontal-to-vertical spectral ratio (HVSR) of ambient noise measurement was used to estimate a site's resonance frequency (f0). For this purpose, 18 measurements were made using a single station (Nanometrics Trillium Compact Horizon with 20 s bandwidth). The stations recorded the signals for a duration between 7 e 19 hours with a sampling frequency of 200 Hz along 3 lines. The computation of the H/V rations was made by means of the Geopsy tool (www.geopsy.org) in which we chose 110-s-long windows and an anti-trigger algorithm STA/LTA to remove the transient. In 11 sites, the peak of fundamental frequency was recognized, showing a clear pattern with frequency and amplitude respectively increasing and decreasing moving down the southwestern flank of the volcano

The average CO_2 flux from the soil reveals values lower than those commonly considered as the threshold to define background emissions in the typical range of vegetated soil respiration. Soil gas data highlight the presence of an area characterized by higher CO_2 flux and concentration values (between 850-110ms), in agreement with SP values indicating the rising of fluids, suggesting that the enriched gas emissions present in that sector are controlled by tectonic structures.

References

Cioni, R., Santacroce, R. & Sbrana, A. Pyroclastic deposits as a guide for reconstructing the multi-stage evolution of the Somma-Vesuvius Caldera. *Bull Volcanol* **61**, 207–222 (1999). https://doi.org/10.1007/s004450050272