SHALLOW VELOCITY STRUCTURE AND HETEROGENEITY OF MT. VESUVIUS, ITALY, FROM SEISMIC ARRAY ANALYSES

Data from dense short-period arrays set up for the TOMOVES experiments (1994 and 1996, Gasparini et al. 1998), and for VESARRAY experiment (November 1997-May 1998) have been used to study the velocity and heterogeneity shallow structure of Mt. Vesuvius, Italy. The correlation method has been applied on time windows of background seismic noise having length up to several minutes. The obtained results allowed to infer the shallow P- and S-wave velocity structure, down to 500 m, in three different sites around the volcano. The correlation-frequency curves for several sets of distances have been then calculated and fitted with Bessel functions from which dispersion curves have been determined. Velocity models have been derived from the dispersion patterns using a trial and error procedure. The results are well consistent, in spite of the low resolution for the deeper layer, with those from travel times and provide a good constraint for high-resolution ray tracing. In particular the obtained results confirm lower seismic velocities beneath the crater as compared to those obtained along the flanks of the volcano. Seismic array data from the recorded shots have also been used to infer the role of the surface topography on the scattered coda waves. Heterogeneity appears to be located at surface, indicating that topographical irregularities play an important role in the generation of high frequency seismic phenomena.

A high-resolution image of the compressional wave velocity structure in the shallow edifice of Mount Vesuvius has been then derived from simultaneous inversion of travel times and hypocentral parameters of local earthquakes. The robustness of the solution has been improved by adding to the earthquake data a set of land based shots, used for constraining the travel time residuals. The results give a high-resolution image of the P-wave velocity structure with details down to 300-500 m. The relocated local seismicity appears to extend down to 5 km depth below the central crater, distributed into two clusters, and separated by an anomalously high Vp region positioned at around 1 km depth. A zone with high Vp/Vs ratio in the upper layers is interpreted as produced by the presence of intense fluid circulation alternatively to the interpretation in terms of a small magma chamber inferred by petrologic studies. In this shallower zone the seismicity has the minimum energy, whilst most of the high-energy quakes (up to magnitude 3.6) occur in the cluster located at major depth, characterized by high P-wave velocity. The tomography results and the pattern of relocated seismicity consequently exclude the presence of shallow magma reservoirs. These should be located at depth higher than that of the base of the hypocenter volume, as evidenced by previous studies.
Fig. 1 - NS cross sections of the P-wave velocity structure at Mt. Vesuvius. White circles show the relocated hypocenters having size proportional to magnitude. The shallow high velocity bodies located beneath and Southward to the crater, are evidenced with a semi transparent zone filled by blue crosses. The low velocity layer toward N is linked to the deepening of the limestone basement. Camaldoli della Torre is the main lateral cone of the highly fractured zone extending Southward the crater.

REFERENCES