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Shallow heterogeneities and seismic activity of Mt. Vesuvius

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Introduction

The last eruption of Mt. Vesuvius occurred in 1944 and was accompanied by 1500 seismic events (Casertano, 1956a). After that there was weak to nil seismicity on Mt. Vesuvius up to 1964 when, during a seismic crisis, some hundreds of events were recorded (Casertano 1956b). Still now (1995) generally several hundreds of events per year are recorded.

The seismic data collected by the permanent network and during four field surveys, carried out in the years 1986-87, 1989, 1993 and 1994, provided a set of information that allowed us to draw a quantitative picture of the present seismic behaviour of the Mt. Somma-Vesuvius volcanic complex.

Data analysis and conclusions

For location purposes, a simple velocity model was obtained on the basis of a direct modelling of both first arrival delays and time-differences between paired arrivals of direct and converted phases. In fact, a shear phase arrival, intermediate to P- and S-wave arrivals, was observed on horizontal recordings. This pattern, by particle motion analysis, was attributed to a P-to-S conversion that could be linked to the abrupt impedance contrast between the consolidated bottom of Mt. Somma's caldera and its pyroclastic fill. The calculated depth of this interface (about 500 m b.s.l.) is in agreement with the reconstruction of the volcanic environment in respect to the carbonatic basement's trend, as obtained by volcanological and geophysical data (Cassano and La Torre, 1987; Principe *et al.*, 1987).

An high velocity zone beneath the Vesuvius cone is strongly marked by negative P-residual observed at the stations located in the central area of the volcanic complex, as well as by the remarkable signal amplitude's differences observed between peripheral stations and those located on the crater. This feature was already observed in other volcanic districts (e.g. Mt. Etna and Vulcano Island) and was interpreted as either old buried volcanic structures or intrusive bodies (Hirn *et al.*, 1991; Ferrucci *et al.*, 1991). For the Vesuvius framework, this high velocity anomaly could be linked to the collapse of the feeding conduit after the 1944 final eruption and its cementation due to the percolation of hydrothermal fluids within the broken-down walls and roof. Another possibility could be that the positive velocity anomaly marks the thermo-metamorphic zone surrounding the feeding system.

From a seismic point of view, low activity both in energy and in events number occurs at Mt. Somma-Vesuvius volcanic complex at the present stage of volcanic quiescence. No tremor-like events are observed. Indeed, monochromatic low-frequency events are recorded in the Vesuvian area, but they results from artificial blasts originated by smuggling fishermen.

The events location, performed by merging

the 148 best recorded earthquakes within a three-dimensional heterogeneous medium, revealed that the seismic activity had most of its epicenters located around the crater area.

The whole seismicity analyzed in this study displayed locations confined in depth within five kilometres from the top of the volcanic cone. In particular, this seismicity consisted primarily of extremely small events ($M < 1$) associated with cracking inside the volcanic cone of the Vesuvius. On the other hand, the larger magnitude seismic events ($1.1 < M < 3.2$) showed deeper locations and may be well associated with tectonic faulting. In fact, Mt. Somma-Vesuvius complex is emplaced on a regional NE-SW-trending faults system (Marzocchi *et al.*, 1993). Best fault-plane solutions, for the deeper seismicity analyzed in this study, showed the presence of a plane approximately along the NE-SW direction. This suggested that, at the present, the most energetic seismicity affecting the Mt. Somma-Vesuvius volcanic complex is mainly governed by the stress field acting on a regional scale.

The role played by regional dynamics in the seismic behaviour of this area was also evidenced by the occurrence of seismic activity related to seismogenetic structures, pertaining to the tectonic lineaments with NE-SW trend, located close the volcanic complex. For istance, the earthquake occurred on June 16th, 1987, (M=2.9) was located along the NE-SW lateral discontinuity, inferred from DSS data (Castellano *et al.*, 1988; Ferrucci *et al.*, 1989), separating the Phlegrean Fields from Mt. Somma-Vesuvius volcanic areas. Moreover, a short sequence of four earthquakes occurred on August 1991 ($1.8 < M < 3.3$) were located at about 40 km outside the Gulf of Naples along the prolongation of one of the faults that, from the volcano basement propagates towards SW into the Neapolitan Gulf (Milano *et al.*, 1991).

In conclusion, Mt. Somma-Vesuvius volcanic complex displays an highly heterogeneous structure and a very low level of activity at present time. In fact, as already pointed out by Berrino *et al.* (1993), no significant variations of geophysical parameters, such as ground deformation or gravimetric anomalies, have been observed at Vesuvius in the last 20 years.

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