Analysis of historical and present earthquakes at Vesuvius for seismic hazard evaluation

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Introduction

At Vesuvius about 600,000 people live on the volcano and the risk associated to a large eruption is very high, but its complete evaluation includes also the potential damage due to earthquakes accompanying eruptions. Moreover low-moderate energy earthquakes are also observed in volcanic active areas during quiescent periods. Generally such events are shallow and produce high intensities in the epicentral area. Today at Vesuvius the high housing density and economic value exposed make the area of considerable importance for mitigating seismic risk. To evaluate the effects of the earthquakes at Vesuvius, data are required on the location, source mechanism and damage levels of historical earthquakes, in addition to understanding how Vesuvius works. A damage map of the maximum earthquake recorded is proposed.

Historical earthquakes

The oldest seismic event in the Vesuvian area was recorded by Classical fonts, buildings and represented on marble reliefs (10,11,12). In the last years of the Roman Empire, the sources describe a large eruption at Vesuvius in the 5th century well known to volcanologists, but for this period there are no data on seismicity. In Medieval times the available sources record no significant seismic activity in the Vesuvian area. By contrast, some large eruptions occurred.

The largest eruption in modern times occurred in 1631: there is evidence that the seismogenetic structures may fall under the volcano and the surrounding area. Today at Vesuvius the high housing density and economic value exposed make the area of considerable importance for mitigating seismic risk. The greatest pre-eruptive event, however, was rated at M=4.0, a value that corresponds to those recorded in recent times.

Recent seismicity

Since 1944, seismicity of Vesuvius has been marked by few hundreds events per year concentrated in the summit caldera. The most significant event recorded before the development of the surveillance seismic network at Vesuvius in 1970, was that of 11 May 1964 (V MCS degree), in the crater floor. Several periods of greater activity were recorded in 1989, 1990, and more recently in 1995 and 1996. The strongest occurred on 25 April 1996 (ML=3.4, h=2.1 km) and was clearly felt all over the Vesuvian region, including some areas in the Phlegrean Fields and on the island of Capri. In the early months of 1999 seismicity increased slightly. During August 1999 a seismic sequence began and culminated in the most energetic event on 9 October (M7.2), Epicenter-crat area: ML=3.6; h=3-4 Kms.

A macroscopic study of the 9 October 1999 event was carried out from an analysis of questionnaires sent out to all secondary schools in each municipality of the Vesuvian and Neapolitan area and surrounding towns (4). The area of maximum intensity (75%) covers the whole Vesuvian area. The felt index weaken strongly in NE and SE directions, toward Naples a slighter decrease is observed.

Seismic hazard

An integrated analysis of both historical and current seismicity as well as the geological conditions of Vesuvius and the surrounding areas, evidence that the seismogenetic structures may fall within a crater area and at the boundaries of the volcanic complex. In order to provide an estimation of expected effects it is necessary to consider that vesuvian earthquakes are as much as one to two epicentral intensity degrees greater than equivalent magnitude events occurring in the near seismogenic Apennines Chain.

Damage map expected for maximum earthquake recorded

To sum up:
• The earthquakes from 1631 to 1944 do not appear to cross the threshold of M=4.5
• The seismic crisis preceding the 1964 eruption is characterized by inactivity similar to that of 1999, temporally limited to hours preceding the eruption
• The years preceding the eruption of 1979 on the eastern side were also characterized by sensible seismic precursors and probably ground deformation too. The maximum earthquake occurred on Feb. 5, 62 AD (M=5).

References

6. Zobin (2001), focal depth h=3.00, Zobin
7. John and Zobin (2001), focal depth h=3.00, Zobin
8. M = 0.53 I + 0.28
9. R2 = 0.903
10. Del Pezzo (2001), focal depth h=3.00, Zobin
11. M = 0.53 I + 0.28
12. R2 = 0.903