THE SEISMICITY OF THE CAMPANIAN PLAIN: PRELIMINARY RESULTS

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INTRODUCTION

In areas affected by active volcanism, the knowledge of the interrelationships between volcanism and tectonic is fundamental to progress in understanding of the volcano dynamic. In fact, regional tectonics controls the emplacement of the volcano and possibly the deep magma supply rate (Ellis and King, 1991); it may also controls the distribution of eruptive fractures. Example of normal-faulting earthquakes closely associated with eruptions are seen worldwide. In the Campanian area, statistical investigations had shown that large earthquakes occurring in the campanian segment of the Apennines Chain often preceded eruptions of the Vesuvius volcano typically by less than a decade (Nostro et al., 1998).

Earthquake monitoring on both a local and regional scale play an important role for the definition of the volcanic hazard of an area. In fact, an increase of the magnitude level of the local quakes occurring in the high risk volcanic area of Mt. Vesuvius, accompained by migration of the foci and/or a change in the focal volume, is considered as an indicator of the change in the volcano-dynamics. Moreover, previous studies on the pre-eruptive seismicity of Mt. Vesuvius have recognized a middle/long term correlation between the activation of some faults, that from the volcano basement propagate towards SW into the Neapolitan Gulf, and the sub-surface dynamics of magma rising (Imbò, 1974). Following Imbò (1974) the seismic activity of Mt. Vesuvius may be divided into two groups: seismicity connected with eruptions with superficial hypocenters, and deep seismicity, pre-post eruption, that can be located outside the volcano edifice. On this point of view, the study of the background seismicity occurring in the peripherial areas of the Vesuvius versus the local seismicity, inside the volcanic edifice, could be considered a further indicator of the change in the volcano-dynamics.

For the above consideration, the existence of correlation between geodynamic processes of an area – sub superficial dynamic of a volcano is a result that could be also utilized for the definition of the volcanic hazard of an area like the Campanian Plain.

The aim of this report is to provide information about the seismicity occurring in a restrict area around the Mt. Vesuvius and Flegraean Fields volcanoes in the period 1992-1999. This area includes the Campanian Plain. Seismicity occurring at a distance grater than 40 km from the town of Napoli, offshore of the Gulf of Napoli as well as the local seismicity of the Vesuvio and Flegraean Fields are excluded by this report.

DATA AND LOCATION OF THE EVENTS

For this report, the data recorded by the seismic stations of the Permanent Surveillance Network of the Osservatorio Vesuviano between 1992 and 1999 have been utilized (Fig. 1). The station NL9, running from 1992, has been choose to select the events. This station is located between the Vesuvius and the Apennine Chain on the first outcrop of the Chain. Data from the catalogue of the O.V. have been selected choosing the events recorded first at NL9 station. The evaluation of the magnitude of the events was computed from the duration of the seismograms recorded at SGG station. When available, the data of the seismic stations of the Istituto Nazionale di Geofisica running in the Campanian area have been utilized, too.

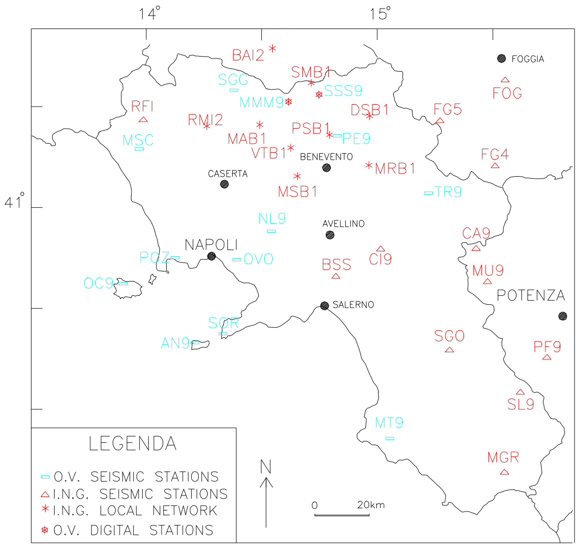

Figure 1: Spatial distribution of all seismic stations operating in the Campanian Area.

The detected seismicity in the area under study between 1992 and 1999 is characterized by isolated events of low energy. The magnitude of these events was generally much less than 2.5 and only occasionally was grater than 3.0. Relatively to the above time interval, about 16 events had magnitude greater than 2.5, of which only 4 with magnitude between 3.0 and 3.4.

Due to the low energy of these events, not all the detected seismicity can be located with sufficient accuracy. In fact, the precision of hypocentral co-ordinates of earthquakes may be influenced by the number and quality of P and S time picking, the azimuthal coverage of the seismic stations around the seismogenic area and the velocity model (James et al., 1969; Gomberg et al., 1990, Milano et al., 1994; Digiovambattista & Barba, 1997). Then, a number of trials designed to estimate the reliability of earthquake location and its dependence of the above factors have been performed. First, a preliminary location of the selected events has been performed. The events located in land with epicentral distances higher than 40 km from Napoli have been excluded from the data set because they are related to the dynamic of the Apennine Chain (which is excluded from the present study). Then, on this data set an accurate revision of the P and S phase reading has been carried out focusing the attention on the S phase; in fact, the accurate reading of this phase ensured the reliability of the focal depth.

The location of the events recorded at least 5 stations and with at least 2 S-phase reading has been performed by means of HYPO71 algorithm (Lee and Lahar, 1975) using the 1-D velocity model proposed by Del Pezzo et al. (1983). This velocity model is in use at O.V. for routine location of the events with epicenter in the campanian segment of the Apennine Chain. Among the few 1-D velocity models available for this area, the adopted velocity model minimize also the residual at the stations distant more than 60 km from the epicentral area (Milano et al., 1999). The Vp/Vs ratio, obtained by a trial and errors procedure, is 1.78. In figure 2 the epicentral distribution of the well located events is shown.

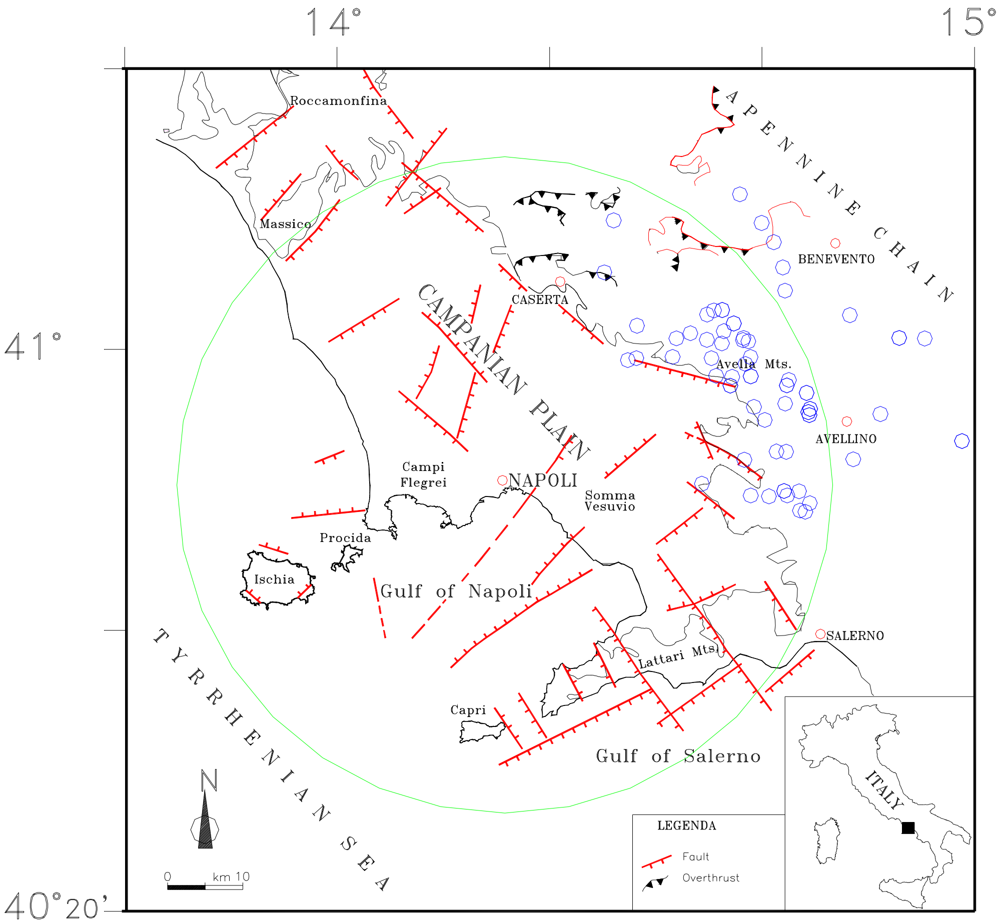

Figure 2: Epicentral distribution.

From figure 2 it is evident that no events are located in the campanian plain and, in particular, between the two active volcanic areas (Vesuvius and the Flegraean Fields) and the first outcrop of the Apennine Chain. The epicentral distribution shows that earthquakes are located on the first outcrop of the Apennine Chain with a concentration in the area of the Avella mountains. Hypocentral distribution along NW–SE (apenninic) and SW–NE (anti-apenninic) cross-sections (figure 3) display a quite homogeneous distribution of the events between 5 and 12 km in dept. The events with focii deeper than 10 km are prevalently located outside the circular area in figure 2. This circular area represents the area centred on Napoli with radius of about 40 km.

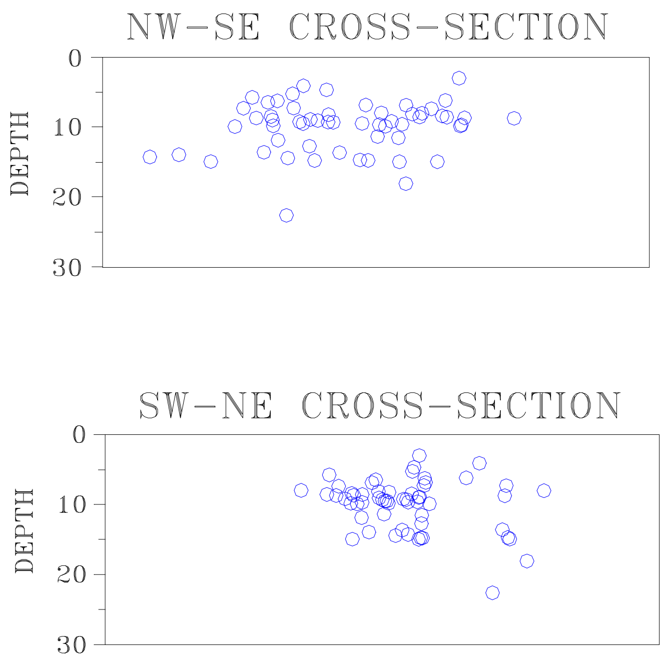

Figure 3: Hypocentral distribution.

FAULT PLANE SOLUTIONS

Fault plane solutions of events for which at least 9 P-polarities were readable have been computed by means of the FPFIT algorithm (Reasenberg and Oppenheimer, 1985). The average errors on the maximun likelihood solutions were also computed by FPFIT and are less than 10 degree for strike, slip and rake, respectively. In Fig. 4 the focal mechanisms are reported (lower hemisphere equal area projection). For each mechanism the date (year, month, day), the origin time (hour and minute), the focal depth in km (z) and the magnitude (M) are reported.

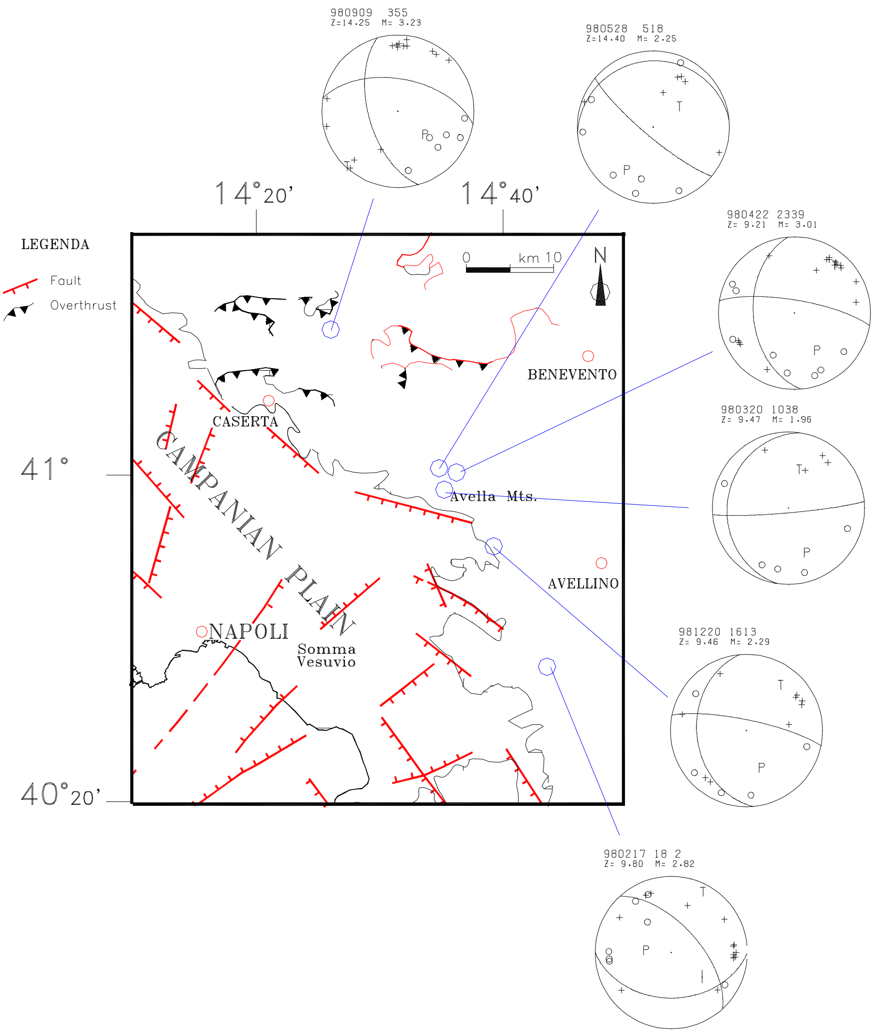

Figure 4: Fault plane solutions.

The computed focal mechanisms show the same polarities distribution on the focal sphere; however, they can be grouped in: strike-slip solutions with a dip-slip component and normal dip-slip solutions with a strike component. Strike-slip solutions show fault planes about W-E and N-S directions whereas normal dip-slip solutions show nodal planes in Apenninic direction (NW-SE).

The state of stress cannot be determined directly from earthquake observations; however, directions of the principal components of the stress field can be inferred from the directions of P- and T- axes of fault plane solutions. The spatial distribution of the T- and P-axes of the computed focal mechanisms are shown in figure 5. The length of the axes is proportional to the cosine of the plunge. T-axes are aligned along NE-SW direction whereas P-axes are prevalently aligned along NNW-SSE direction. The T-axes distribution suggests a NE-SW oriented σ3 in agreement with the extensional stress regime active along the Apennine Chain.

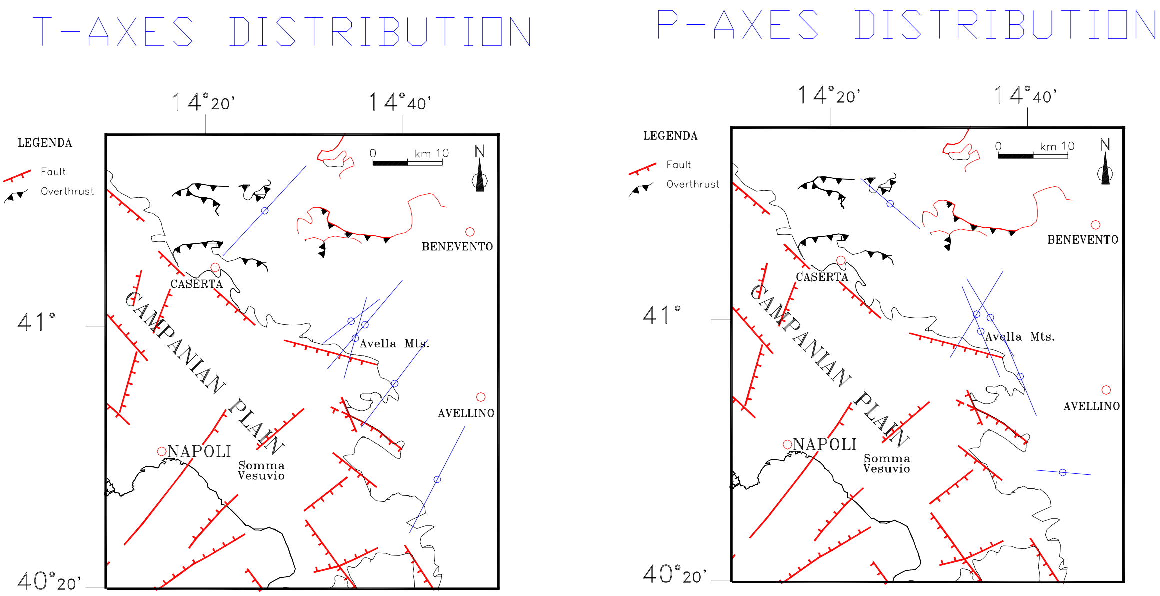

Figure 5: Distribution of T-axes (left) and P-axes (right) from focal mechanisms.

CONCLUDING REMARKS

In this report the seismicity occurring between 1992-99 in the circular area with radius of 40 km centred on Napoli has been analyzed. The detected seismicity is characterized by isolated events of low energy (magnitude less than 2.5) that only occasionally reach magnitude 3.0. No events have been located in the Campanian Plain and, in particular, between the two active volcanic areas (Vesuvius and the Flegraean Fields) and the first outcrop of the Apennine Chain. The seismicity is located on the first outcrop of the Apennine Chain with a concentration of the events in the Avella Mountains; the depth of the events is prevalently between 5 and 12 km. Focal mechanisms show both normal than strike-slip solutions with strike planes along the Apenninic and about W-E directions, rispectively. The T-axes distribution suggests a NE-SW oriented σ3 in agreement with the extensional stress regime active along the Apennine Chain.

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