Geophysical Research Abstracts,
Vol. 11, EGU2009-8385, 2009
EGU General Assembly 2009
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Relationships between seismicity and tectonic in northern Sicily and southern Tyrrhenian: some important open problems.

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The widespread seismic activity which characterizes the Northern Sicily and its Tyrrhenian off-shore, is related to a very complex geodynamic context. The different tectonic structures are associated, first, to the collision between African and European Plate, and then to the evolution of Tyrrhenian Basin.
Sicily represents the easternmost sector of Maghrebian Chain, built since Oligocene, by the foreland migration of foredeep-deformation front couple. The recent deformation pattern of Sicilian Maghrebides is interpreted as a result of brittle and brittle-ductile neotectonic structures with strike-slip kinematics developed since Middle-Late Miocene in the internal zones of thrust belt. This structures are related to recent Tyrrhenian opening.
In particular, we tried to make a comparison among recent structure and seismicity in the hinge zone between northern Sicily and southern Tyrrhenian, corresponding to both emerged and submerged northern portion of the Maghrebian chain.
This hinge zone is part of a wider W–E trending right-lateral shear zone, mainly characterized by both a synthetic NW-SE/W–E oriented, and antithetic left-lateral N–S/NE-SW fault systems, which has been affecting the tectonic edifice, since the Pliocene.
The seismicity in the sicilian Maghrebides is mainly located in the hinge zone, either crustal or deeper, and limited in two main hypocentral sectors (Giunta et al., 2002b;Gueguen et al., 2002; Giunta et al., 2004; 2008). Deep seismicity, concentrated in north-eastern Sicily, is associated with the subduction of the Ionian lithospheric slab beneath the Calabrian arc, while the shallow seismicity results as expression of the brittle strain crossing the whole orogen (Neri et al., 1996).
The seismogenic process complexity requires that descriptive models are based on a large amount of experimental information about both a huge number of earthquakes and the structural features of the main seismogenic volumes in the investigated area.
At the moment, it is possible to describe in detail the source of single events if these are recorded by sufficiently dense arrays, while much still remains clear about the seismicity and the relationships between seismicity and recognized faults.
In this context, where possible, we describe the relationships between the structures that were observed inland and interpreted offshore and clusters of seismic events, carefully relocated. The hypocentral distribution, the typical focal mechanisms and the principal deviatoric stresses have been related to the geometrical features of the seismogenic volumes, their mechanical heterogeneity, and the tectonic stress, following in part the Caputo and Sato (1996), and Audemard (2004) methodology.
We defined firstly the neotectonic pattern of the study area using both aerial photos and field measurements. The geometrical relationships and/or the relative chronology of the identified tectonic structures were estimated by mesoscopic field analysis. In the second time, numerous volumes characterized by seismogenic homogeneity (clusters) have been obtained by the analysis of the seismological data. This analysis consisted in a preliminary location of the events, in their assignment to specific clusters or to the background seismicity (independent events) using statistical methods and in a subsequent relocation of the events of each cluster using a relative location technique. Moreover, the seismogenic processes, relative to the most numerous clusters, were characterized in the space, time and magnitude domains with statistical techniques.
Some informations on the regional deviatoric stress field can be inferred from fault orientation and slip direction, assuming a mechanical homogeneity of the cluster-relate volume. The heterogeneity of seismogenic volumes of the crust and the mantle makes the kinematics of dislocations rather complex and a non-unique relation between

faults geometry and the stress acting on these faults (Albarello, 2000).
In order to constrain the stress field acting in a seismogenic volume by a set of focal mechanisms, and furthermore assess the uniformity assumption, several techniques can be used (Mercier and Carey- Gailhardis, 1989; Bragato and Bressan, 2006), based on the reliable determination of the fault plane solution, calculated for several earthquakes generated by the same seismogenic volume.
The occurrence of a simple-shear deformational style, related to NW-SE trending maximum compressional stress axis producing a non-coaxial strain, was shown by the geometric characters of the cluster volumes, while the dispersion of several fault planes seems to be constrained by the mechanical heterogeneity of the rock volumes (Neri et al., 2003, 2005).
In fact, the rupture surfaces could represent the second or third order of the major recognized faults system affecting the study area, also producing positive or negative flower structures, and sometimes re-activating inherited flat and ramp thrust faults.