Session: Earthquake swarm and associated process #2928

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SEISMIC SWARM vs MAINSHOCK-AFTERSHOCKS SEQUENCE:

REFINED HYPOCENTERS LOCATIONS AT THE APENNINES-CALABRIAN ARC BOUNDARY (SOUTHERN ITALY)

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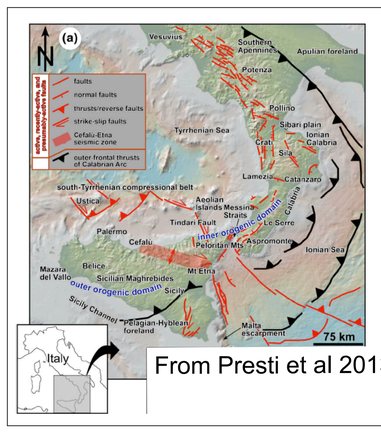
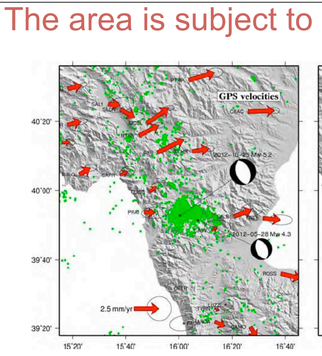
The main goal of this study is to increase the understanding of the physical mechanisms behind the ongoing seismic swarm and its influence on the seismic hazard of the Apennines-Calabrian arc boundary region.



From Presti et al 2013

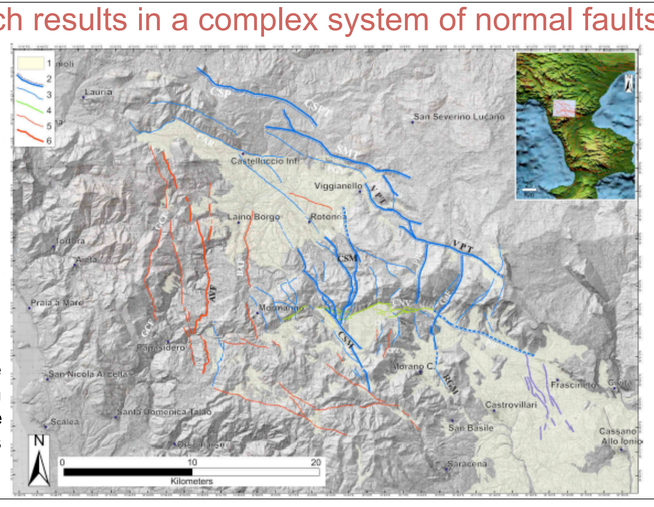
The study area, near the Pollino massif, is located at the northernmost edge of the Calabrian Arc, the last remnant of subduction along the Africa- Eurasian boundary.

The area is subject to NE-SW extension, which results in a complex system of normal faults striking NW-SE.



From D'Agostino et al 2013

GPS velocity field relative to the station CETR and PRAI on the Tyrrhenian coast with 2010-2012 seismicity (green circles) from ISIDe.rm.ingv.it. In the right panel the principal axis of the strain rate tensor are shown together with the focal mechanisms of the main events (Mw 4.3 and 5.2) of the 2010-2014 seismic sequence.

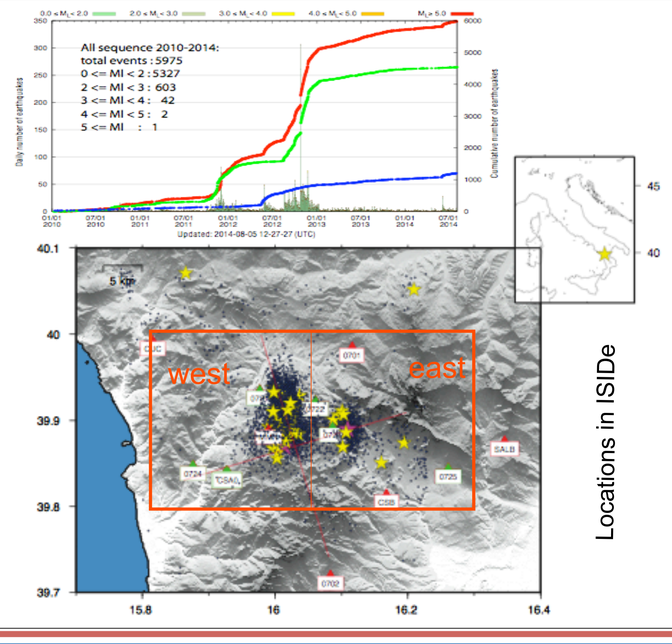


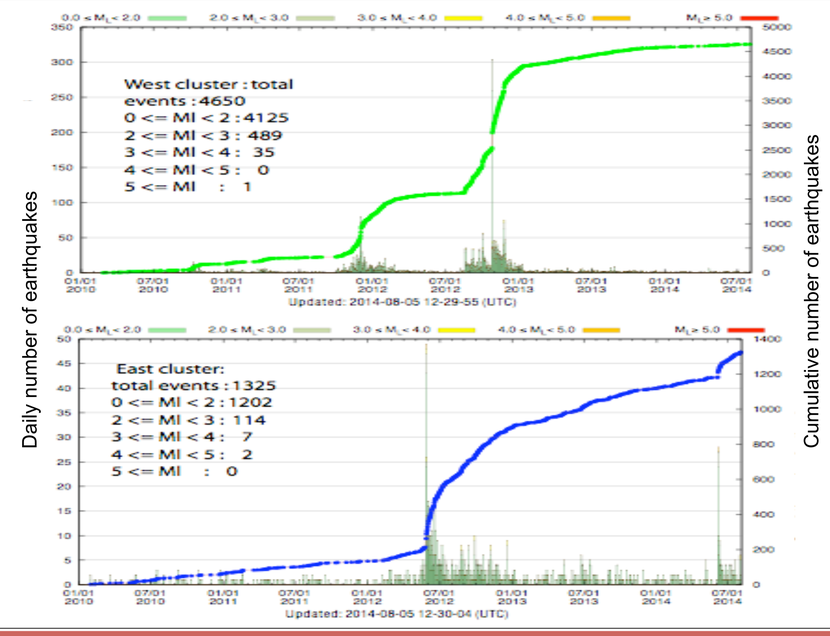
From Brozzetti et al 2013

Structural Map of Active Faults in the Calabro-Lucania Region: 1) Quaternary deposits; 2) trace of west dipping active fault; 3) Quaternary W- to SW-dipping fault (no data available on present activity); 4) Cerviero-Cozzo Nisco-Timpone Viggianello boundary fault, which represents the western continuation of the Pollino Fault (Middle Pleistocene activity); 5) Quaternary NE-dipping fault (no data on the possible present activity); 6) E-dipping Quaternary fault tentatively classified as active.

Between 2010 and 2014 the Italian Seismic Network detected about 6000 earthquakes in the study area (Italian Seismological Instrumental and Parametric Data-Base; ISIDe.rm.ingv.it).

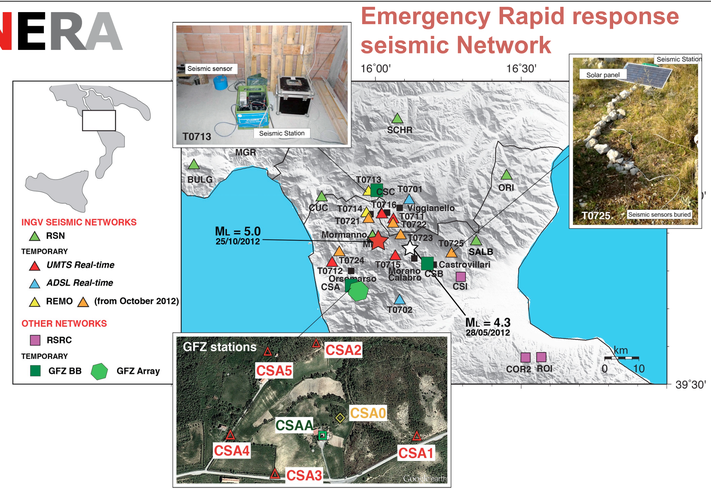
In 2011 the earthquake rate has been variable, with increasing and decreasing phases and maximum magnitudes below M=4.0. On May 28th 2012, a shallow event with local magnitude of 4.3 struck, about 5 km east of the previous swarm. The seismic activity remained concentrated in the M=4.3 source region until early August. At that time seismicity jumped back westward to the previous area, with several earthquakes of magnitude larger than 3.0, culminating with a M=5.0 earthquake on October 25th 2012. The seismic rate remained high for some months, but magnitudes did not exceed 3.7. The seismic rate then suddenly decreased at the beginning of 2013 and stayed quite low for the rest of the year up to June 2014 when a magnitude 4 occurred in the eastern cluster.





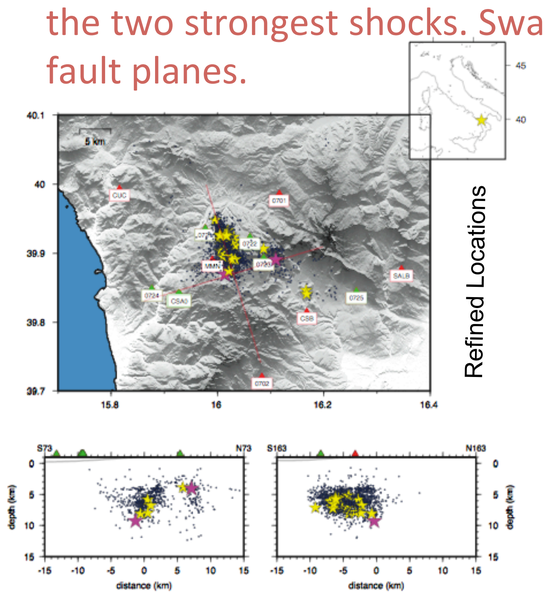
NERA

Emergency Rapid response seismic Network



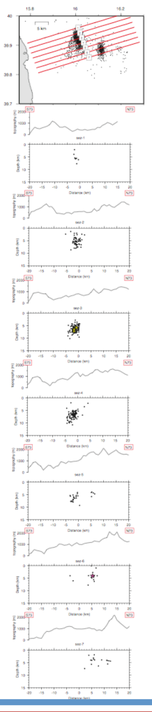
During these years several temporary seismic stations were deployed in the area (Govoni et al. 2013, EOS), improving the detecting threshold of the Italian Seismic Network there and giving us the opportunity to refine the location of the earthquakes hypocenters. A combined dataset, including three-component seismic waveforms recorded by both permanent and temporary stations, has been analyzed in order to obtain an appropriate 1-D and 3-D velocity model for earthquakes location in the study area.

Refined earthquakes locations allowed us to infer the geometry of the fault system responsible for the two strongest shocks. Swarm activity seems to occur on a diffuse crustal volume more than on fault planes.

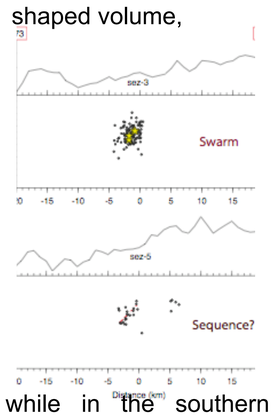


We produced refined locations for events between October 2011 March 2013 using waveforms of temporary stations installed during the seismic sequence; we plot only events with small location errors.

Period 1: Oct2011-Aug2012

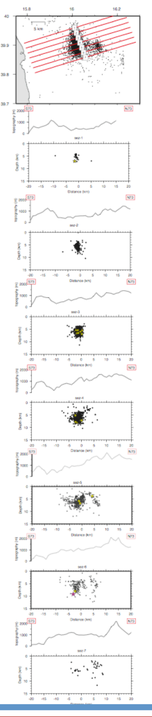


In the Period 1 the western cluster is active: in the northern portion hypocenters are localized in a ball-shaped volume,

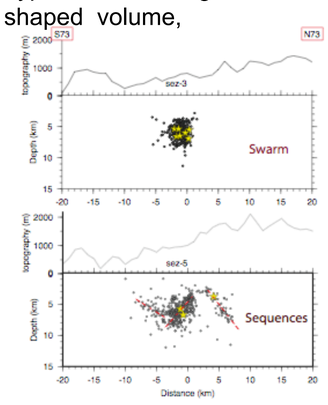


while in the southern part hypocenters define a SW dipping fault plane. The eastern cluster has few well located events.

Period 2: Aug2012- Mar2013



In the Period 2 the western cluster is very active: in the northern portion hypocenters are again localized in a ball-shaped volume,

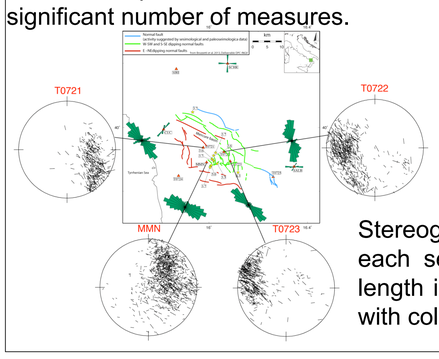


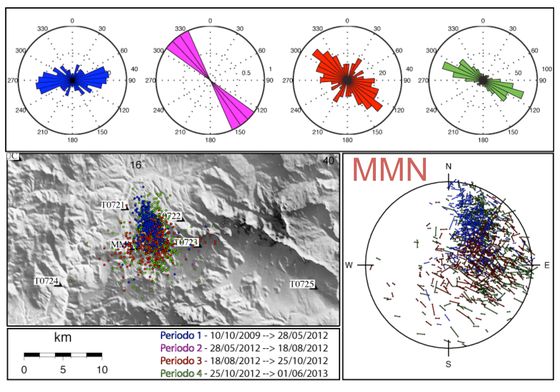
while in the southern part the M>5 earthquake occurred on the SW dipping plane, already visible in Period 1.Now it is also noticeable an antithetic plane to the west. The eastern cluster defines a NE dipping plane, probably related to the occurrence of the M4.3 event of May 2012.

To yield a better understanding of the origin of the ongoing seismic activity in the Pollino area, using thousand of seismograms, we are analyzing:

Anisotropic parameters, by means of Anisomat code (Piccinini et al. 2013, Computers & Geosciences)

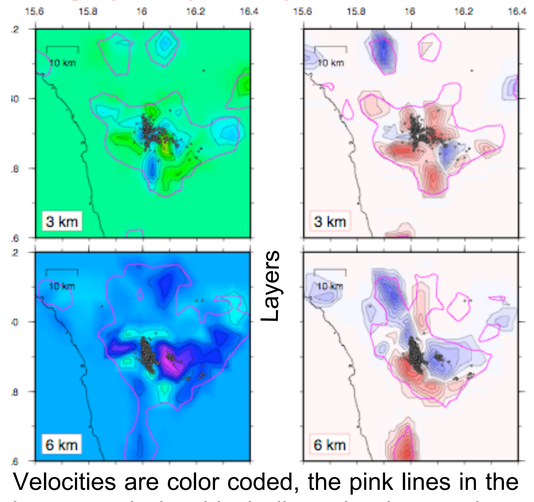
The average values of Δt range from 0.05 s at MMN to 0.08 s at T0723 station. Fast directions range from 108°N at MMN to 156°N at T0722. The Green rose diagrams on the map are frequency plots representing how fast directions trending NW-SE are prevalent at all stations with a significant number of measures.



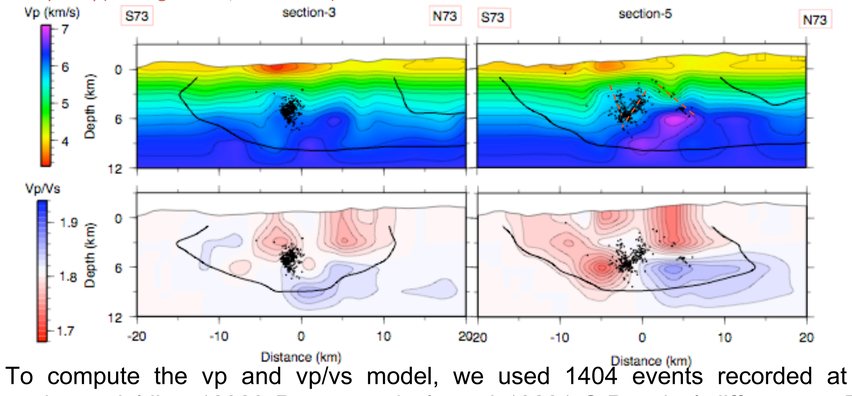


Stereographic projections of the anisotropic parameters: each segment is oriented along the fast direction and its length is proportional to the delay time. MMN is shown also with colours coded with time.

Tomographic vp and vp/vs models, by means of Simulps14q (Haslinger 1998, PhD at ETH)



Velocities are color coded, the pink lines in the layers and the black lines in the sections identify the well resolved volume.



To compute the vp and vp/vs model, we used 1404 events recorded at 22 stations, yielding 18989 P-wave arrivals and 13281 S-P arrival differences. The model is parameterized by a 3-D grid of nodes spaced 4 and 3 km in the horizontal and vertical directions respectively. Starting model is the one used for 1-D locations. Sections 3 and 5 are the same of 1-D locations. The velocity structure reflects the geometry of the fault system identified by hypocenters.