THE CALABRO-IONIAN SLAB NARROWING AS IMAGED BY HIGH RESOLUTION SEISMIC TOMOGRAPHY

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The dynamics of the subduction processes have a great influence on the tectonic evolution and the geologic structure of a region, as well as on its seismicity and magmatism. Their understanding is still today a major subject in the geological research. This is the case of the western-central Mediterranean region whose current tectonic framework is the result of long–lasting geodynamic processes, mostly driven by the subduction towards the NW of the Ionian oceanic lithosphere and by a more recent southeastward slab retreat and its progressive detachment (e.g., Carminati and Doglioni, 2005). At present, in central Mediterranean active subduction is recognized beneath the Calabro-Peloritan Arc (e.g., Calò *et al*., 2009).

Many efforts have been made by investigators to understand the evolutionary phases and to describe the deformation mechanisms that characterize the Calabro-Ionian subduction system. There is a general agreement that subduction is at a final stage, indicated by the narrowing of the slab; however, detailed outline of the processes currently occurring and how they influence the tectonic and magmatic regimes of the region are still elements not well constrained and matter of discussion.

In this study we focus on improving the image of such subduction system and surrounding zones, by means of a local earthquake tomography (LET). For this goal we considered a large dataset, encompassing both shallow and deep events, which was exploited to carry out a reliable 3D velocity structure and accurate hypocentre locations.

From the national and local catalogues managed by the Istituto Nazionale di Geofisica e Vulcanologia (http://csi.rm.ingv.it/;http://bollettinosismico.rm.ingv.it/index.php;http://www.ct.ingv.it/ufs/analisti/catalogolist.php) we selected earthquakes recorded between 1981 and 2014, with at least 7 observations (minimum 5 P and 1 S readings) and maximum azimuthal GAP of 270°. The final dataset includes about 20,100 events whose hypocentral distribution provides initial evidence of a good ray-coverage of the earth volume beneath Calabria and Sicily. The seismic velocity modeling (Vp, Vs, and Vp/Vs) was carried out by the software LOTOS (Koulakov, 2009), which automatically sets up the inversion mesh according to the distribution of the seismic rays. Specifically, the software is able to not install any node in case of absence of seismic rays, whereas in areas of higher ray number it can increase the grid density up to a maximum value (in our case, 8 and 3 km for the horizontal and vertical direction, respectively). Moreover, final earthquake locations were further enhanced by the tomoDDPS algorithm (Zhang *et al*., 2009), which has the additional advantage of using a combination of both absolute and differential arrival time readings. In practice, in case of clustered events, additional information are used to improve the relative locations: since the uncertainty of the velocity model along the station-hypocenter path is the same for all the rays, the travel-time differences can be attributed to the spatial offset between the events. This procedure produces better clustering and further reduces the residuals (RMS).

Tomographic images and earthquakes distribution reveal the current structure of the subduction zone, which is characterized by an in-depth continuous slab only below the southern Calabria, between Milazzo and S. Eufemia Gulf (Fig.1; section BB'). In particular, the slab is very steep (~70°), at least down to 200 km of depth, and exhibits a progressive necking being affected at its edges (NE and SW) by large tears propagating horizontally in a scissor-type mode. To the NE horizontal breakoff can be inferred by the earthquake gap at 130 km of depth around the S. Eufemia Gulf, enlarging to the north, and by the high-velocity anomaly, the signature of the slab, that appears fragmented in north Calabria and absent in the shallow layers (Fig.1; section AA').

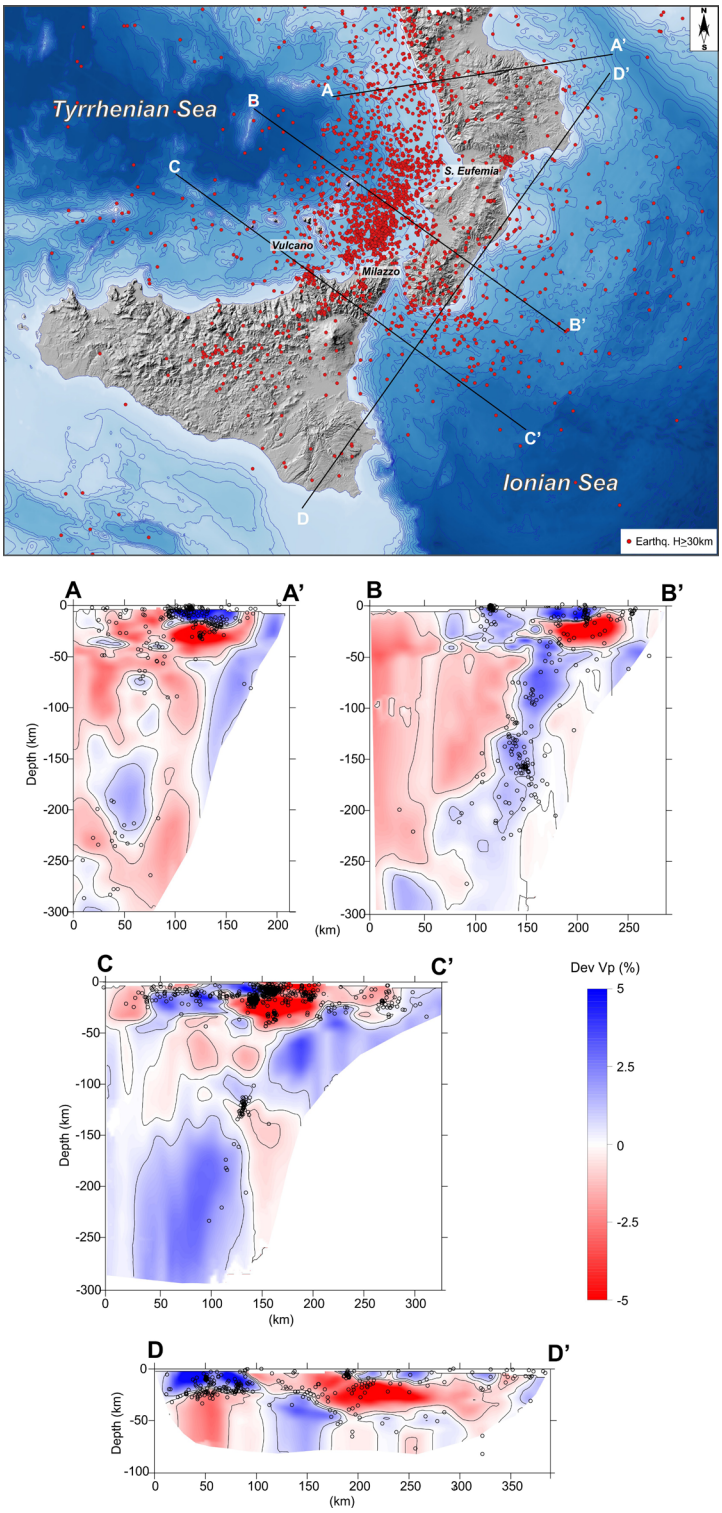

Fig. 1 - Top: epicentral map of the seismic events with depth >30 km. Center and bottom: vertical sections through the VP model, as perturbations (%) of the initial velocity model. Relocated earthquakes, within ±5 km from the section lines, are plotted as black circles. The traces of the sections (AA', …, and DD') are reported in the map.

To the SW, although the slab seismicity shows an incipient narrowing at about 70-100 km of depth, the boundary is sharper and emphasized by lateral velocity discontinuities and by earthquake lineaments. These features take place in a narrow sector, perpendicular to the slab hinge, extending between Vulcano and the Ionian Sea. There, the hypocentre distribution suggests an array of NE-dipping seismogenic structures, deep down to 70 km (Fig.1; section DD'). Moreover, other seismic, geological and geodetic evidences indicate right-transtensional tectonics. All these features could be framed within a large deformation zone delimiting laterally the Sicilian (continental) and the subducting Ionian (oceanic) lithospheres.

References

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