SEISMIC ANISOTROPY AND ATTENUATION BENEATH THE SOUTHERN ITALY SUBDUCTION ZONE

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Subduction zones represent a tectonic region where intense deformations and complex dynamic processes are expected. Although several progress have been made in understanding the structure and the geodynamic evolution of the subduction zones, the active interaction among the subducting slab and the surrounding mantle material remains still debated. The Southern Italy Subduction System is part of the complex tectonic boundary between the Africa-Eurasia macroplates and has been inherited from several phases of fragmentation of the Western Mediterranean subduction zone. It is widely accept that the geodynamic setting of the Southern Italy Subduction System results from the southeast retrograde motion of the northwestward subducting Western Mediterranean slab (i.e., Gueguen et al., 1998; Carminati et al., 1998; Faccenna et al., 2005 and refrences therein). The retrograde motion of the slab was responsible for the creation of the backarc extensional Tyrrhenian Sea and the building of the Southern Apennines and Calabrian arcuate orogenic belts. At present, only the portion of subduction beneath the Calabrian Arc, in the Ionian area, may be active, while a young slab window develops at the Southern Apennines (Lucente et al., 2006).

The purpose of this study is to characterize the seismic structure beneath the Southern Italy in order to better define the geometry of the Ionian slab and of the surrounding mantle flows. We therefore analyzed the anisotropic and attenuation properties beneath the study region.

Seismic anisotropy is found to be a ubiquitous properties of the Earth due to the mantle deformation and, thus, it is represent a powerful tool to constrain the anisotropic behavior of the upper mantle and of the subducting plate. In particular, the observed anisotropy can help to understand the mantle and the slab deformation and the dynamic processes occurring in the upper-mantle wedge above the sinking oceanic slab and in the mantle below the slab. In this study we present a large collection of shear wave splitting measurements in the Calabrian Arc - Tyrrhenian basin Subduction System. The data analyzed consist of several teleseisms and subduction zone local deep earthquakes (Baccheschi et al., 2007, 2008). We used the method described by Silver and Chan (1991), assuming that shear waves pass through a medium with homogeneous anisotropy and with an horizontal fast axis. We analyzed SKS phases from earthquakes with magnitude greater than 6.0 and epicentral distance $\Delta°$ ranging from 87° to 112°. In addition, to obtain the best signal to noise ratio, all teleseisms are band-pass filtered between 0.03-0.3 Hz. The pattern of SKS fast directions, with delay times up to 3.0 s, reveals the existence of a strong seismic anisotropy in the sub-slab mantle region. We observe both trench-parallel and trench-perpendicular fast directions. Fast axes are oriented NE-SW along the Calabrian Arc, parallel to the strike of the subduction. To the N they rotate to NNW-SSE following the curvature of the slab. Fast directions are almost perpendicular to the strike of subduction in front of the slab (Aeolian Islands) and behind the slab (Straits of Messina). In the Apulian domain we observe trench-perpendicular fast directions, oriented N-S and ENE-WSW. The pattern of SKS splitting measurements parallel to the strike of the slab suggests that the anisotropy is closely controlled by subduction and by the rollback motion of the slab. These two processes would be responsible for activating mantle flow below and around the slab itself. The pattern of SKS splitting in the Apulian domain seems to be not a direct results of the rollback motion of the slab and may be explained as frozen-in lithospheric anisotropy or as asthenospheric flow deflected by the structure of the Adriatic microplate.

In order to obtain a detailed image of the anisotropic structure beneath the Southern Italy Subduction System we also used the direct S waves from earthquake located within the descending Ionian plate. The particular geometry of the Tyrrhenian subduction zone relative to the distribution of the land areas and, consequently, locations of the seismic stations provide an opportunity to collect unique data. In fact, the main massif Calabria is an uplifted fore-arc that lies well trenchward of the volcanic arc. In addition, the slab dips at high angle (about 70°) below Calabria and the lateral extension of the slab is limited and bounded at its edges by the Southern Apennines and Sicily. Seismic stations are distributed in Calabria, in the Southern Apennines and in Sicily and only few are in the Aeolian volcanic arc. This allows most recorded rays to travel through and along the subducted slab. This is not frequently observed worldwide since in most subduction zones, as in Japan, land corresponds to the volcanic arc and trenchward of this the forearc is submerged. This enabled us to sample rays that propagate up the slab and allowed us to separate the different sources of the anisotropy: the subducting lithosphere, the mantle wedge above it and the overriding plate. We analyzed several deep earthquakes, with depth greater tha 150 km, that occurred within the descending slab; S splitting parameters show a complex pattern of anisotropy with variable fast directions across the subduction zone and delay times ranging from 0.1 sec to 2.2 sec. Measurements at single stations are quite variable excluding the overriding plate as main source of anisotropy. The S wave splitting parameters also show frequency-dependent behaviour that we attribute to the presence of small-scale anisotropic heterogeneities. Comparison of the S splitting measurements to the P-wave velocity anomaly at 100-200 km depth shows that where the rays primarily sample the slab the delay times are small. In contrast, where the S rays sample the mantle wedge, the delay times are quite high. This dt pattern depicts the slab as a weakly anisotropic region and suggests that the main source of anisotropy in the subduction zone is the surrounding asthenosphere (Baccheschi et al., submitted to JGR). We also determined the attenuation structure of the slab and of the surrounding regions by the inversion of high quality S-waves t^* from slab earthquakes. We obtained high-resolution Qs model down to 300 km depth. The results indicate low values of Qs (Qs values down to 200) corresponding to crustal layers (down to 25 km depth), while the slab is characterized by higher but heterogeneous Qs structure (Qs values up to 1100). At 100 km depth the high Qs body is well reconstructed beneath the Calabrian arc and at 200 km depth it is extended offshore the Southern Tyrrhenian Basin beneath the Aeolian Islands. These preliminary attenuation results allowed us to better define the geometry and the boundary of the Ionian slab and distinguish between anisotropy in the slab and in the mantle wedge .

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