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Deep structure of the Tyrrhenian basin from 2-D joint refraction and reflection travel-time tomography of wide angle seismic data

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Located between Italy, Corsica, Sardinia and Sicily the Tyrrhenian Sea is a Neogene back-arc basin formed by continental extension related to the southeastward rollback of the subducting Ionian oceanic plate. This basin is an ideal place to study the evolution of extension process. The basin structure displays different amount of extension along its length, from the low-extension episodes of continental rifting in the northern areas to break up and exhumation of the mantle in the deepest part of the basin. Here there also seems to be evidence of extension-associated volcanism.

In order to study the nature of the crust and the 4D evolution of the Tyrrhenian basin, a survey to collect multichannel (MCS) and wide-angle seismic (WAS) data was carried out into the framework of the MEDOC project in 2010 with the coordination of 2 research vessels, the R/V Sarmiento de Gamboa and the R/V Urania. During the experiment a total of 17 MCS lines and 5 WAS lines were acquired, with 125 deployments of both Ocean Bottom Hydrophones and Seismometers (OBH/S) and simultaneous land recordings in Corsica, Sardinia and Italy.

In this work we present modeling results along two WAS lines that cross the central and deepest area of the basin. The models, which are obtained by joint refraction and reflection travel-time tomography, unveil the seismic structure of the crust and uppermost mantle and the geometry of the Moho boundary. The data selected for the inversion are arrival times of phases refracted through the crust and upper mantle (Pg and Pn phases), and those reflected at the Moho boundary (PmP phases). A statistical uncertainty analysis has been also performed to account for the inverted model parameters uncertainty (velocity values and Moho geometry).

The seismic structure of both models reveals a significant lateral variation of the velocity gradient that has allowed defining various different crustal domains. In the western side of the profiles, the models show a progressive transition between a 23 km-thick continental crust, and a thinned, and apparently magmatically-intruded crust with a well-defined Moho boundary. Thinning is more pronounced in the central, deepest part of the basin, where the abrupt thinning coincides with the absence of PmP reflections and, in turn, with that of a well-developed Moho boundary. In this area, the velocity model indicates that the basement is mainly made of exhumed upper mantle rocks such as those described in the ODP Leg 107 in 1990. Finally, in the central part of the basin where the exhumed mantle domain is larger we find three low-velocity anomalies attributed to the extension-related magmatism.