Elaboration of active and passive seismic data along the CROP 04 line, Southern Apennines

Lucia Savastano (1) and Nicola Piana Agostinetti (2)

(1) University of Roma Tre, Department of Science, Italy (luc.savastano@stud.uniroma3.it); (2) University of Vienna, Department of Geodynamics and Sedimentology, Austria

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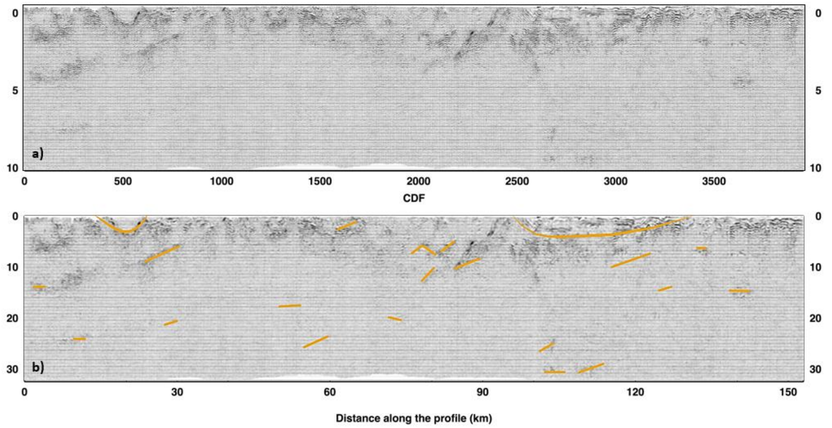
Abstract

The Southern Apennines collisional setting is characterized by deep structural complexities, which have been here investigated through the combination of different (active and passive) source seismic data. Several interpretations of the available seismic data and profiles have been already carried out in the last two decades in order to provide a consistent geological significance of the detected sub-structures: since these do not allow an univocal interpretation of the Apennine roots, strong disagreements exist among geologists about the tectonic style of the chain in that portion of the Italian peninsula. In this work, we have first combined five passive seismic datasets from the overall available literature; we have then projected them at relative depths on the active seismic profile (CROP 04) where our interpretation has finally been made. The general aim of the work is to shed light on the Southern Apennines structure at depths greater than 25 km where, through the adopted approach, an approximative shape of the lower crust and upper mantle structure can be delineated.



Tectonic setting and map of the data

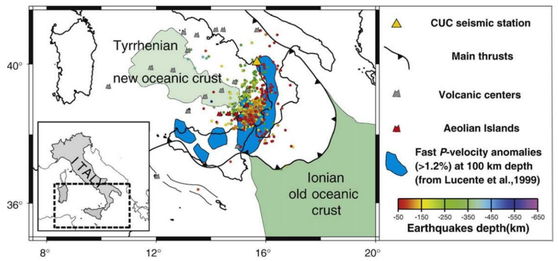


Fig. 1. Schematic tectonic map of southern Tyrrhenian subduction zone (modified from Civello and Margheriti, 2004; Piana Agostinetti et al., 2008). Circles indicate well located subcrustal earthquakes recorded in the period 1981–2002 by the Italian Permanent Seismic Network (RSNC) (Castello et al., 2006).

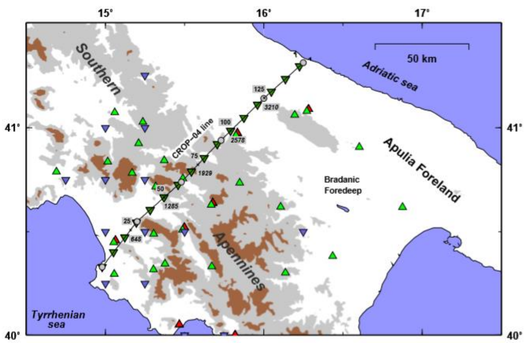


Fig. 2. Distribution of all the datasets considered for this work along and around the CROP 04 line. Red triangles: data from Steckler et al., 2008 and Piana Agostinetti et al., 2008; light green triangles: data from Piana Agostinetti and Amato 2009; dark green triangles: data from Tiberti et al., 2005; blue triangles: data from Molinari et al., 2015.

Methodology

Data were selected from a total of five previous works and projected along a 160 km long profile, according to their values of coordinates. An appropriate depth conversion of the active seismic line (from TWT to Kilometers) was then performed in order to make a correct comparison between the different data.

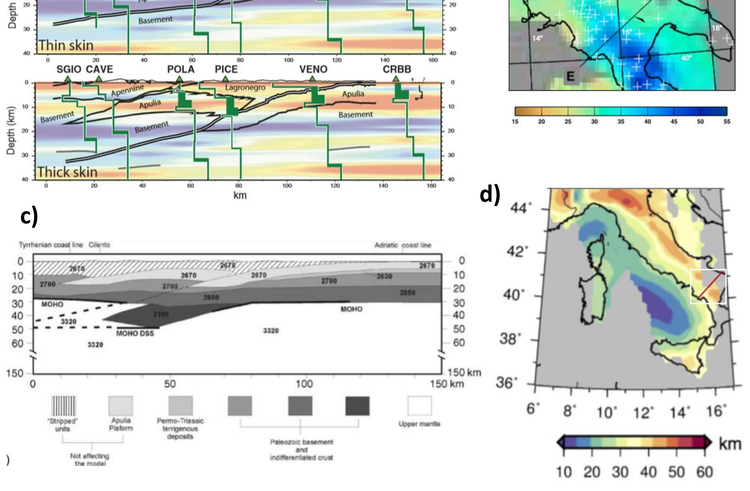


Fig. 3. Data representations around the CROP 04 area, extracted from previous works: a) Thin- and thick-skinned geological models with common conversion point (CCP) image and RF inversions (modified from Steckler et al., 2008); b) Map of Moho depth. Crosses indicate seismic stations (modified from Piana Agostinetti and Amato 2009); c) 2D gravity model along CROP 04 seismic line: numbers within the bodies indicate the density values in kg/m3 (modified from Tiberti et al., 2005); d) Moho depth values obtained from ambient noise data; CROP 04 line falls within the white box (modified from Molinari et al., 2015).

Fig. 4. a) CROP 04 active seismic profile; b) line drawing of the main reflectors recognized along the CROP 04 profile.

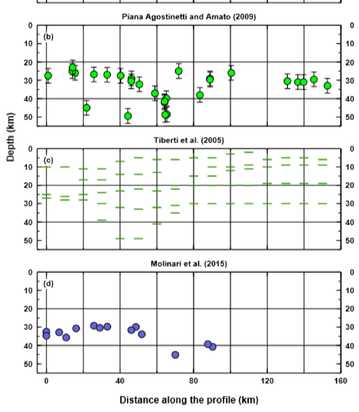


Fig. 5. Projection of geophysical data along the CROP 04 profile: a) Depths recorded by five stations extracted from the CAT-SCAN database (Steckler et al.. 2008); b) Receiver functions data of 37 stations, teleseismic records obtained between October 2004 and July 2007 (Piana Agostinetti and Amato 2009); c) depths obtained from data based on the regional component of gravity anomalies (Tiberti et al., 2005); d) Depths recorded through ambient-noise seismology (Molinari et al., 2015).

Geological interpretation

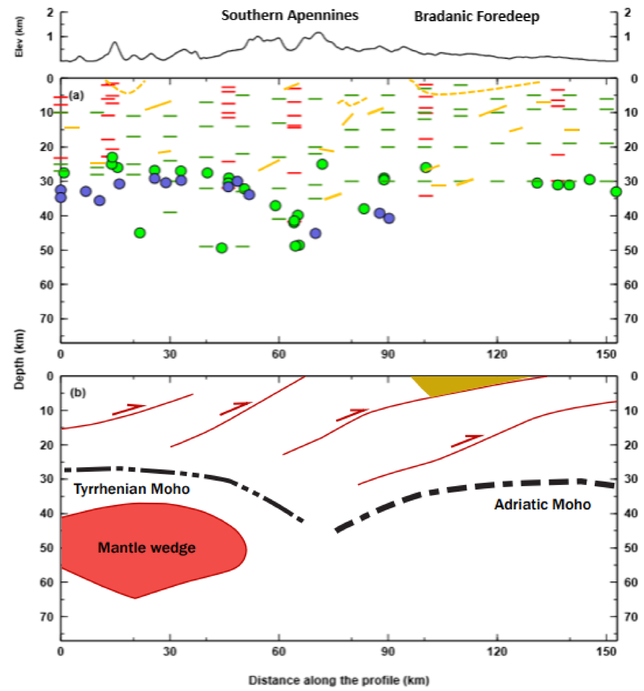


Fig. 6. a) Combination of all the datasets utilized for this study and topographic profile along the CROP 04 line; b) Geological interpretation of the data.

Conclusions

Our analysis of the combination of different source datasets along the CROP 04 seismic profile allows some hypotheses to be done:

1) In the studied area, during the Adriatic slab retreat, the Tyrrhenian margin was involved in a weaker process of thinning if compared with the Northern Apennines and Calabria cases. This may in turn be associated with a faster mechanism of extension.

2) Subduction has locally been stationary for a long time, leading to the complete eclogitization of the subducted crust and total regeneration of the Tyrrhenian Moho.

3) High velocities recorded at Moho depth in the Tyrrhenian region (observed nowhere else in the Apennine subduction setting) could be explained considering a complete fluid migration out of the mantle wedge.

4) At first, heat from the mantle wedge deformed the Moho surface in the westernmost sector, then the Adriatic slab promoted the creation of a close system beneath the Tyrrhenian crust, hindering the heat transfer from East.

Acknowledgments

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