A New Three-Dimensional Moho Model of the Central Mediterranean Area

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INTRODUCTION

The Central Mediterranean is a very complex geodynamic area resulting from the interaction between the African and European plates. This interaction is responsible for tectonics and geodynamic processes that are strongly related to the variable topography of the Moho surface present in the study area.

In this context, a Moho map is of great importance as it is a fundamental requirement to obtain detailed high resolution models of the structure of the upper mantle (Lippitsch et al., 2003) and to better understand the geodynamic of the area.

In this work we propose a new three-dimensional Moho map for the central Mediterranean, obtained from the interpolation of results of different methods.

STUDY AREA

The Central Mediterranean consists of a complex system of extensional, compressive and strike/slip structures resulting from the interaction between the African and European Plates. This process has caused continental collision, lithospheric subduction and opening of back-arc basins with strong lateral variation in lithospheric composition and thickness (Catalano et al., 2001; Di Stefano et al., 2009).

As a result, half of the 14 crustal types defined at global scale by Mooney et alii (1998) are present in the study area (Van der Maijde et al., 2003).

MATERIALS AND METHODS

In order to reconstruct the three-dimensional Moho model of the Central Mediterranean, different data were used.

Initially, Moho maps existing in literature were considered (Di Stefano et al., 2011; Finetti, 2005; Cassinis et al., 2005; Maesano et al., 2017; DISS Working Group, 2021). These were supplemented with data from 2D velocity models (Scarascia et al., 1994; Chironi et al., 2000; Nicolich et al., 2000; Cassinis et al., 2005; Dellong et al., 2018), gravimetric profiles (Chironi et al., 2000; Dellong et al., 2018) and seismic profiles interpreted (Finetti, 2005; Catalano et al., 2013; Tugend et al., 2019; Sulli et al., 2021). The location of these data is shown in Figure 1. These data were interpolated using the Delaunay triangulation method using the three-dimensional modelling software "Move 2017".

In order to optimize the geometry of the Ionian slab, the hypocenters of the seismic events extrapolated from the ISIDe database (2016) were used. In particular, the seismic events of the last 17 years (2005-2022) with a depth greater than 40 km and M>2 were collected.

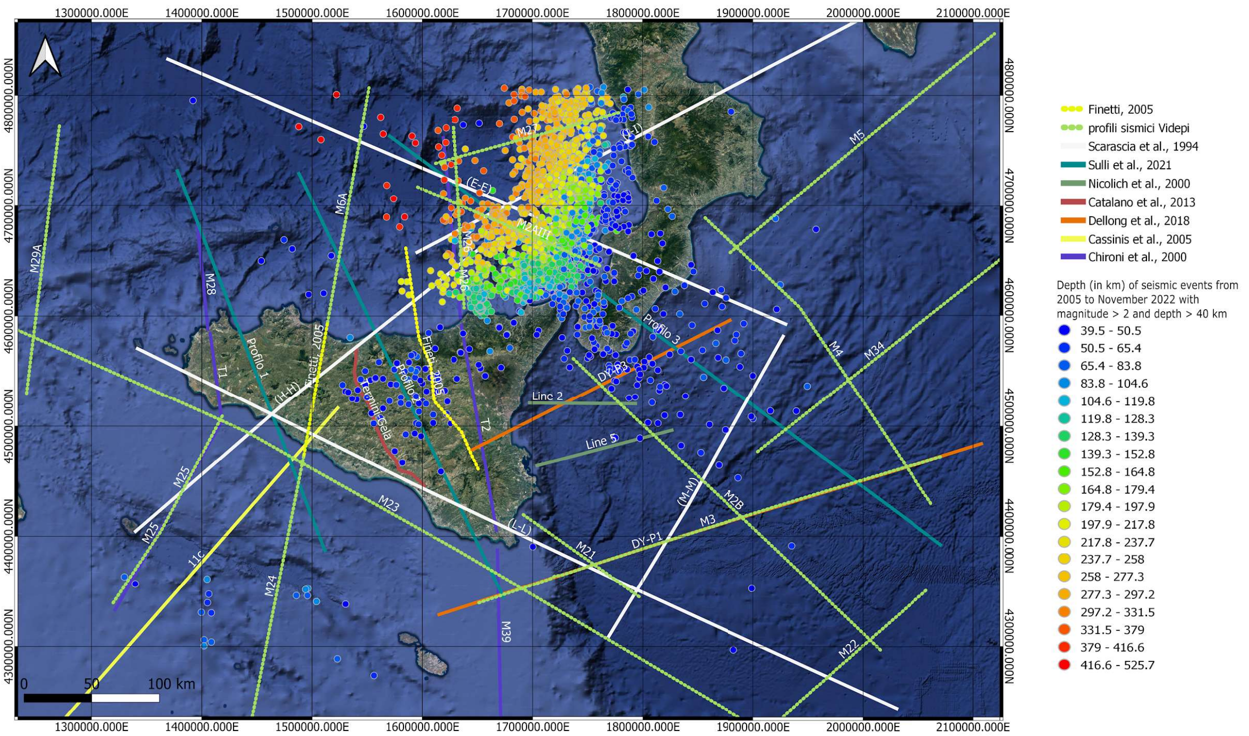

Fig. 1 - Location of hypocenters of the seismic events (from 2005 to 2022, M>4, depth >40 km), velocity models, gravimetric and seismic profiles.

RESULTS

The topography of the Moho in the Central Mediterranean presents a strong lateral variation (Fig. 2).

In the Sicily Channel the depth of the Moho is between 25 and 28 km deep with a mantle uplift up to 17 km at the graben of Pantelleria and Linosa.

Below the Calabrian Arc the depths are greater and reach 40 km. In the southern Tyrrhenian Sea depths are observed between 20 and 25 km that decrease at the basins of Vavilov and Marsili where the Moho reaches a depth of 10 km.

The Ionian Sea has a shallower Moho to the east that deepens westward toward the subduction of the Ionian slab below the Calabrian Arc, highlighted by the deep seismicity. In this work, the Ionian slab is modified with respect to the model proposed by DISS and its geometry has been adapted to the hypocenters of the deepest seismic events (>40 km deep). Therefore it was verticalized starting from about 200 km deep and between 65 km and 250 km deep was also extended laterally (Fig. 3).

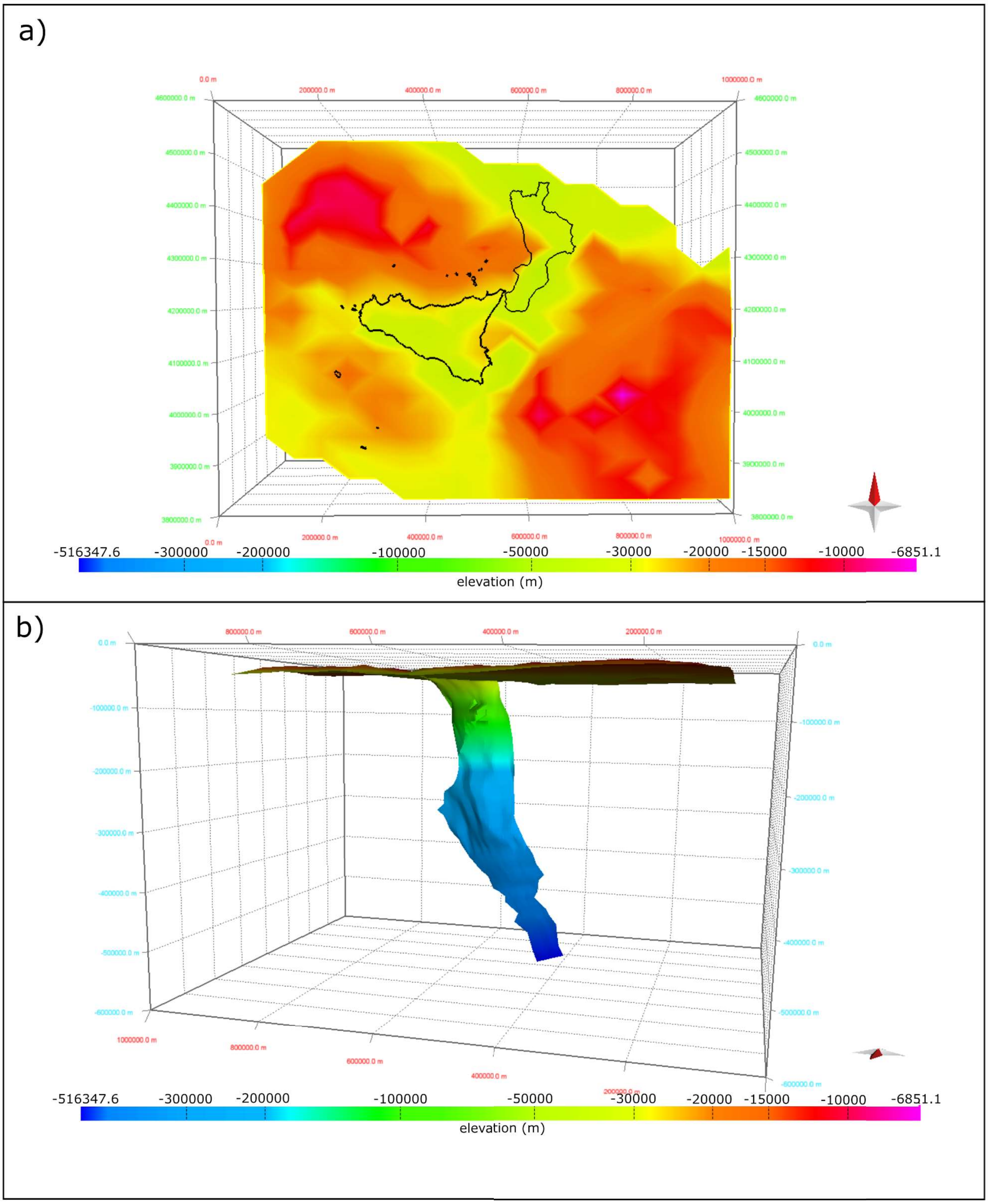

Fig. 2 – a) Three-dimensional model of the most superficial part of the Moho; b) Visualization of the three-dimensional Moho model of Central Mediterranean that allows to observe the Ionian slab.

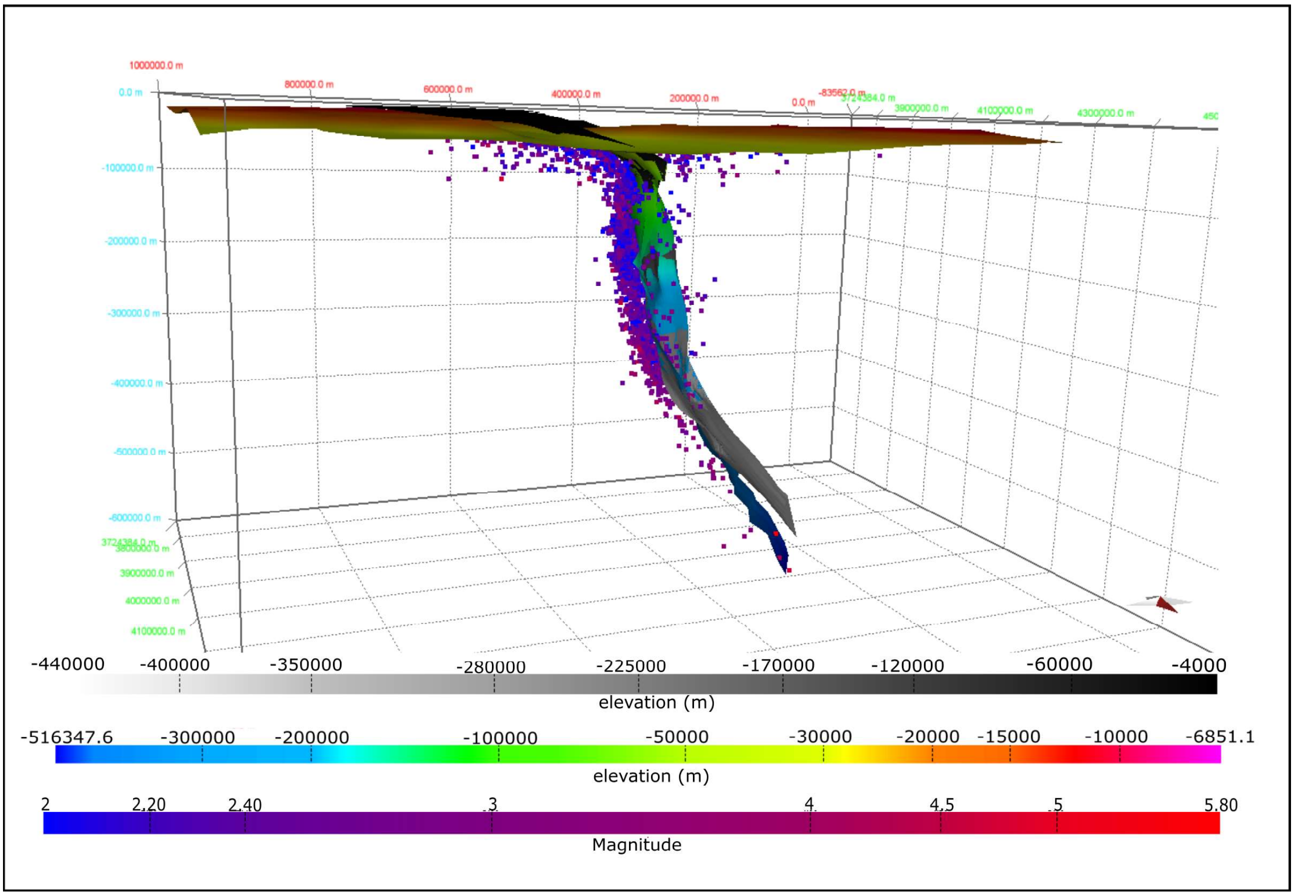

Fig. 3 – Comparison between the Ionian slab proposed by DISS (surface represented in grey scale) and that proposed by us (surface represented in color scale). The seismic events plotted are related to the period from 2005 to 2022, M>4 and depth > 40 km.

CONCLUSION

The joint use of one-dimensional and two-dimensional data of different kinds has allowed to obtain a detailed three-dimensional model of the topography of Moho in the Central Mediterranean area.

This model will allow a better understanding of the structure of the upper mantle and will contribute to the understanding of the complex geodynamics of the area.

In addition, the model can be easily updated: new data, such as tomography, seismic, gravity and velocity profiles, will be useful to perfect the model in its most superficial portion while new seismic events and a relocation of past ones will be of great help to perfect the model in its deepest portion.

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