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Imaging crustal roots in the Europe-Mediterranean region: a surface wave perspective

Antonio Villaseñor
CSIC, Institute of Earth Sciences Jaume Almera, Barcelona, Spain (antonio@ictja.csic.es)

The thickness of crustal roots is a fundamental constrain to understand the geodynamic evolution of mountain ranges. Crustal thickness can be inferred from a variety of geophysical observables (e.g. gravity anomalies, active and passive seismic methods, etc). Deep seismic sounding (DSS) using controlled sources usually provides the most accurate images of the crustal structure and thickness. However it is an expensive method, and often only used for 2D profiles. On the other hand, passive seismology experiments based on earthquakes or ambient noise have generally lower resolution, but are cheaper to conduct and can provide 3D images.

As a result of the success of USArray, experiments consisting of dense deployments of broadband seismometers have become the modern standard approach for imaging continental regions. This, in combination with the densification of permanent regional monitoring networks and the use of seismic ambient noise, has allowed to use surface waves to image with increased resolution regions such as Europe and the Mediterranean basin. Surface waves are not very sensitive to the location of discontinuities such as the Moho, but can provide good constraints on the lateral variation of crustal thickness.

Here, by combining continuous recordings of array experiments and permanent networks, I present a new tomographic model of surface wave velocities in the Europe-Mediterranean region that can be used as a proxy for crustal thickness. Large low velocity anomalies corresponding to thick crust are observed as expected in mountain ranges such as the Atlas, Pyrenees and Alps where crustal thickening has occurred as a result of continental collision. In addition, similarly large low velocity anomalies are observed in regions where slab roll-back/break-off has occurred (Betic-Rif, NW and SE Carpathians, Apennines, western Balkan peninsula). While these anomalies might not all be originated by thick crust, in some cases such as the Rif-western Betics previously unknown thick crust (without topographic nor gravimetric signature) has been confirmed by recent DSS studies, suggesting different a mechanism for crustal thickening than simply continental collision. This research has been funded by projects MISTERIOS (CGL2013-48601-C2-1-R) and VeTools.