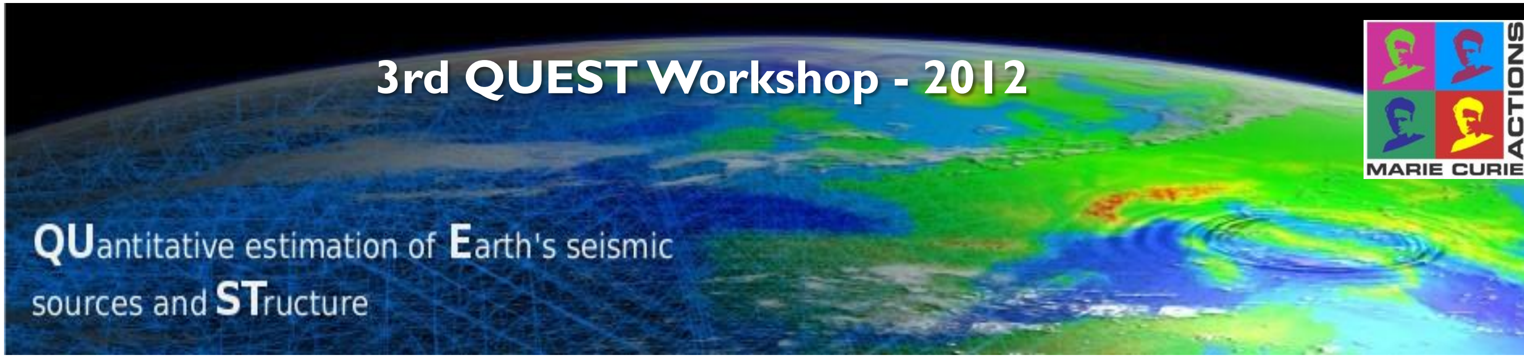


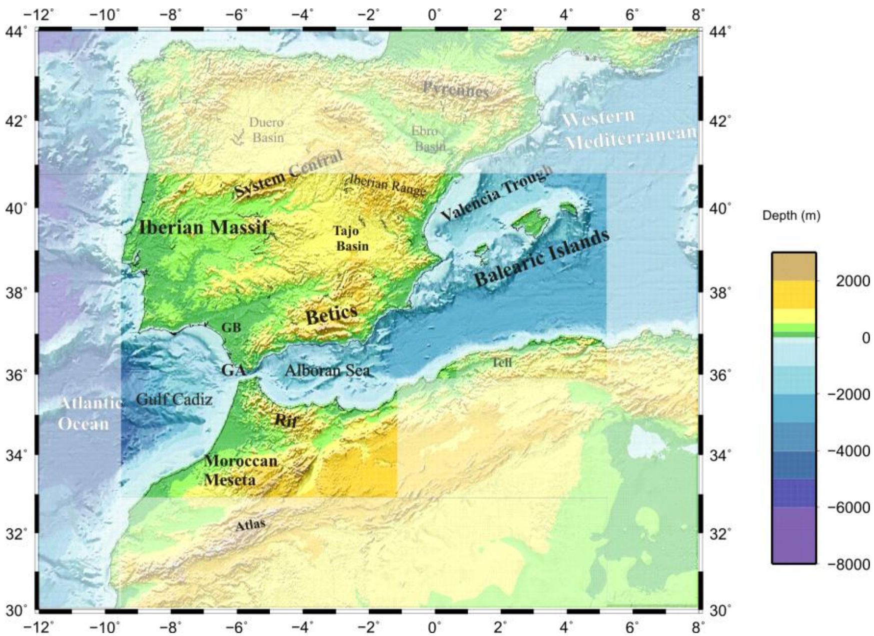

# Deep structure of crust and mantle beneath Iberia and western Mediterranean from P and S receiver functions and SKS waveforms

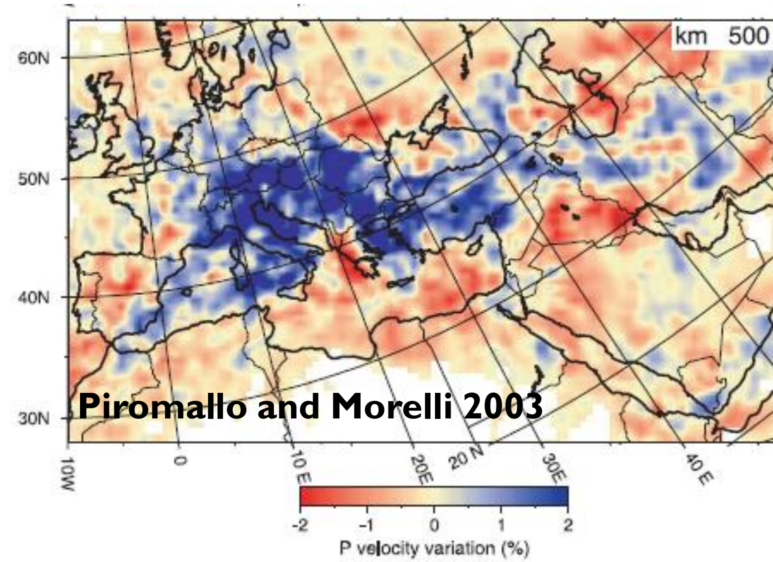
**I. Morais,** L.Vinnik, G.Silveira, L.Matias, S.Kiselev

INGV IPE ISEL IDL

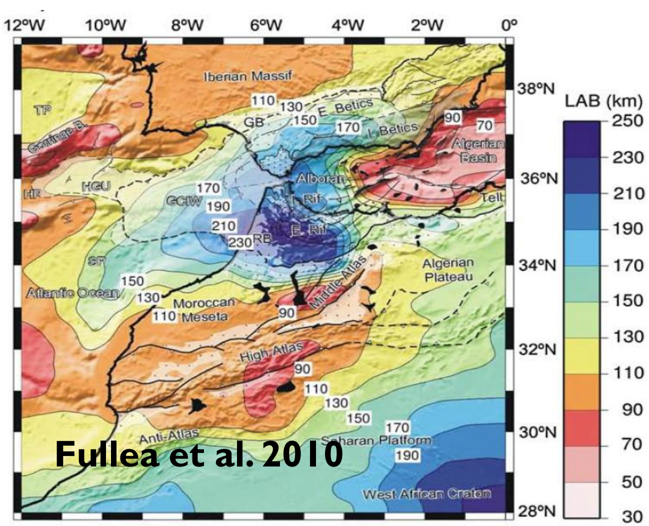
TopoMed Plate re-organization in the western Mediterranean: Lithospheric causes and topographic consequences

# Motivation



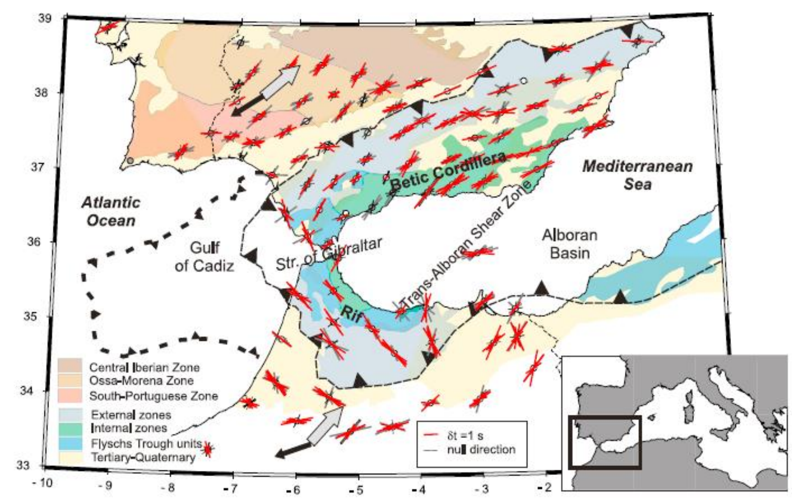




Piromallo and Morelli 2003



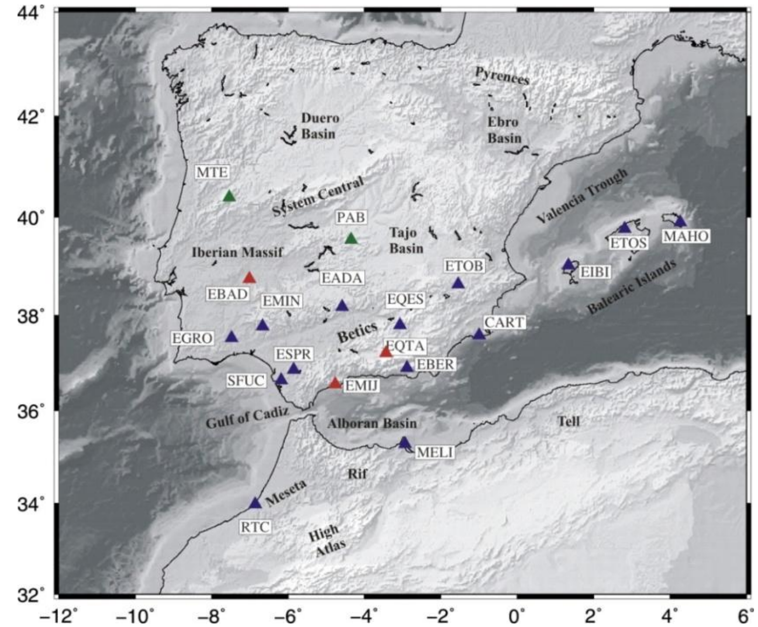

Fullea et al. 2010

Diaz et al., 2010



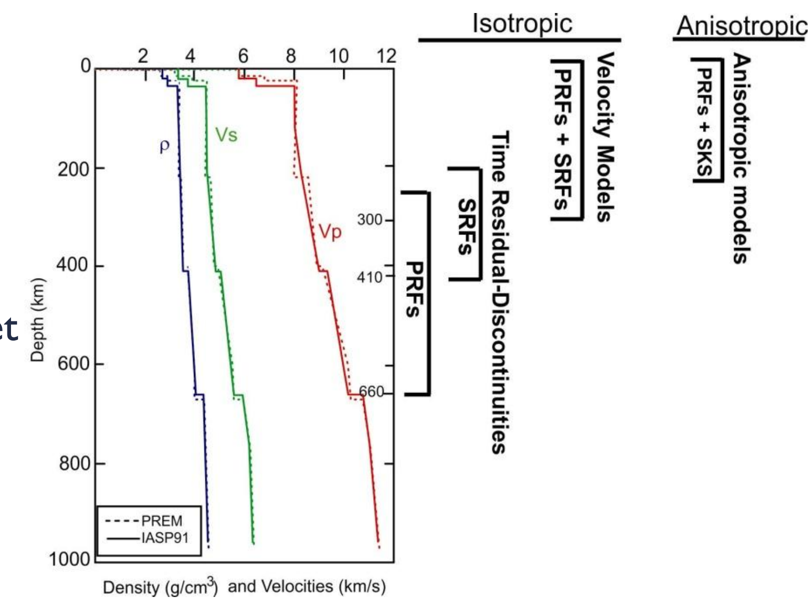
# Objectives

- To map the topography of the main inner discontinuities, particularly in the mantle Transition Zone;
- To understand the structure of the lithosphere-asthenosphere;
- To improve our understanding of the anisotropy and heterogeneity in the Iberia and western Mediterranean region;

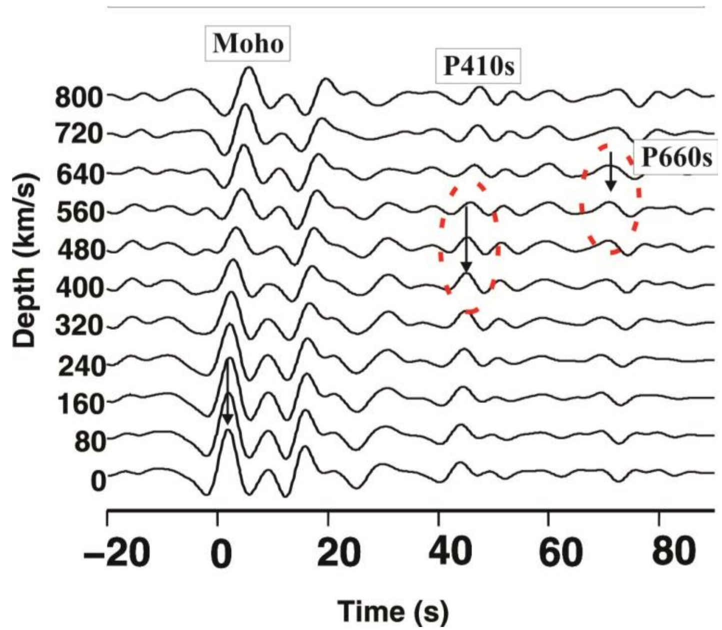


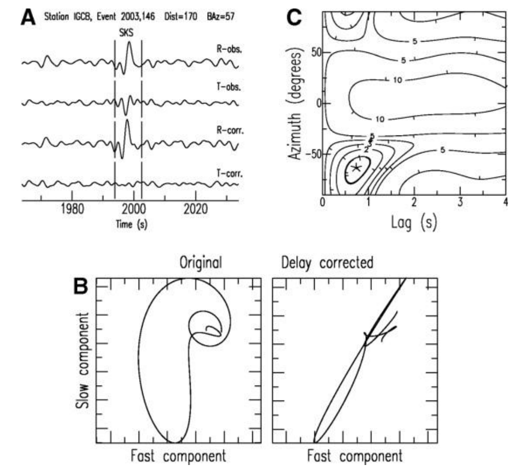

# Methods

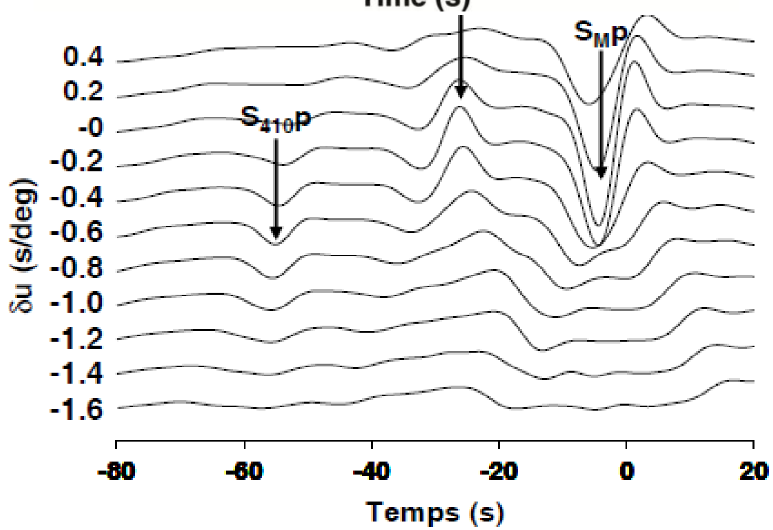
- P Receiver Functions (Vinnik, 1977)
- S Receiver Functions(Farra and Vinnik, 2000)
- Joint inversion of PRFs and SRFs (e.g. Kiselev et al., 2008)
- SKS Splitting (e.g.Vinnik et al., 1989)
- Joint inversion of PRFs and SKS (e.g. Vinnik et al., 2002)

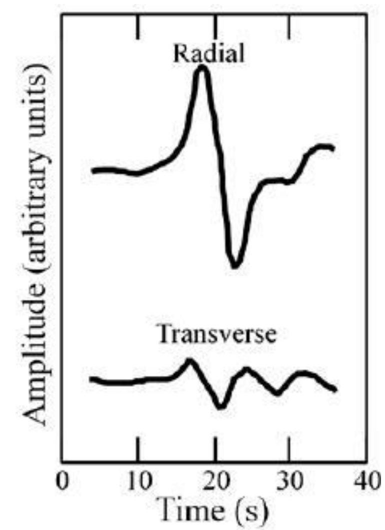


# Data Processing

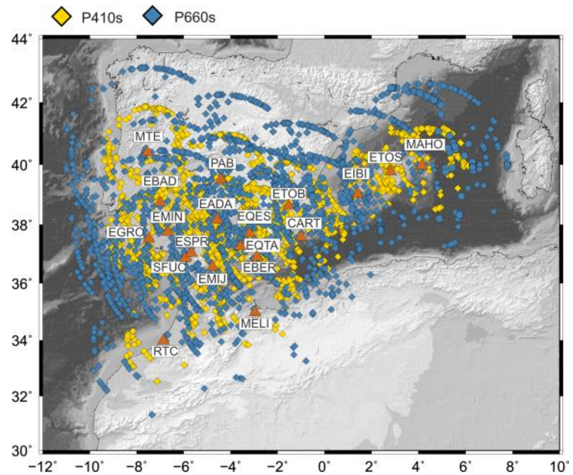


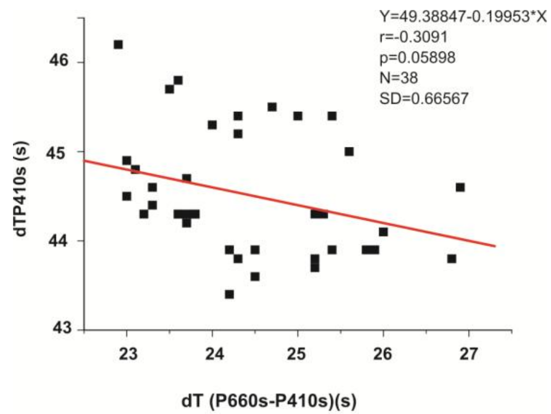



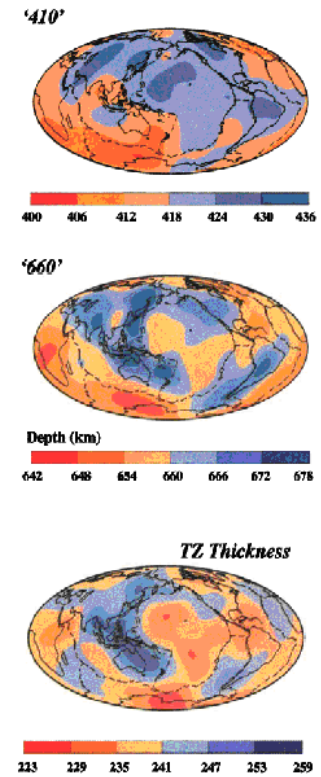



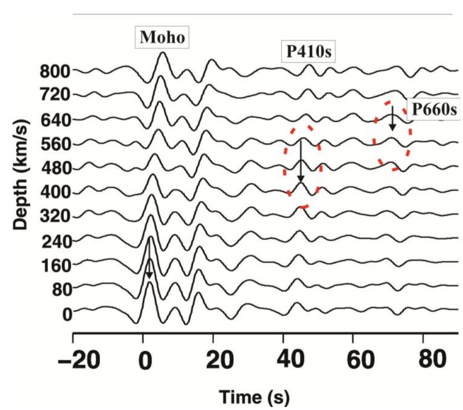



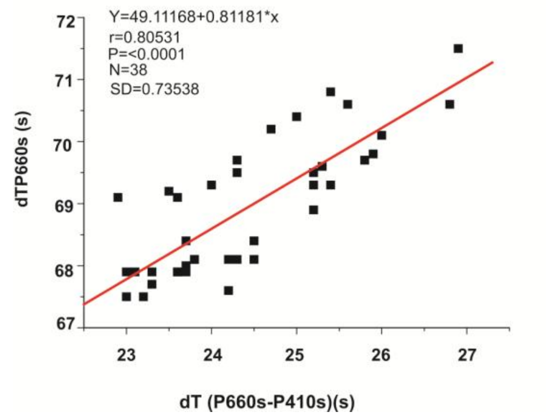
# Results of the Transition Zone



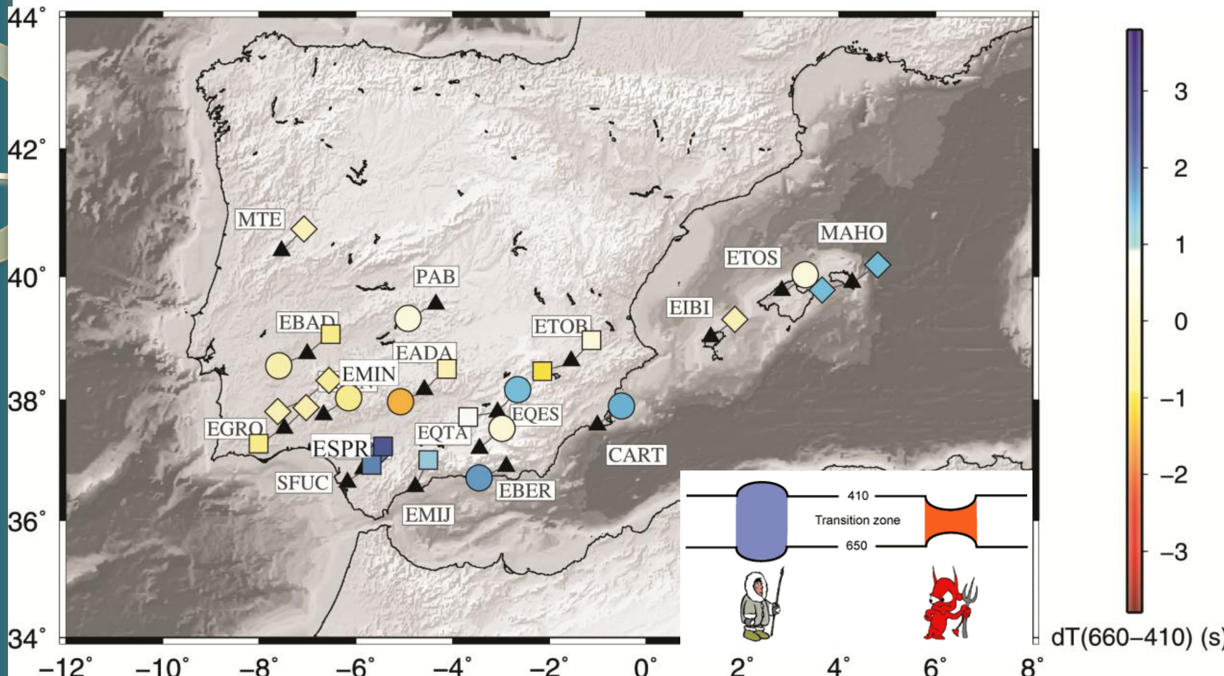




Flanagan and Shearer, 1998

- The dependence of P410s on the differential time is a few times weaker than of P660s;
- This correlation means that the thickness of the TZ is controlled by topography on the
- 660-km;
- This is in line with what is seen on the global scale.

Differential time between P660s-P410s. The time residual relative to the standard time of 24 s is shown by color code.



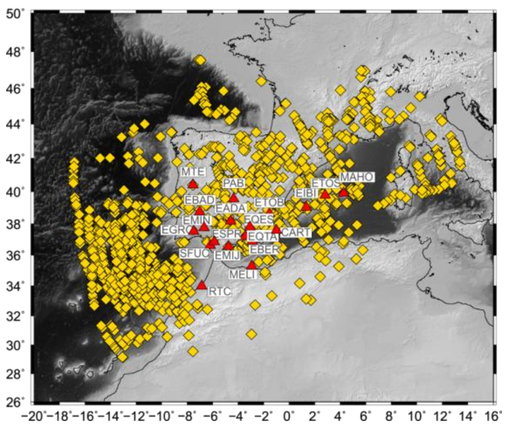

•The largest residuals (of ~+1.5 s) are observed in the coastal region of Spain and at Balearic islands. Accordingly the thickness of the TZ is by ~15 km larger than the standard 250 km. At most stations the residuals are close top 0 s.

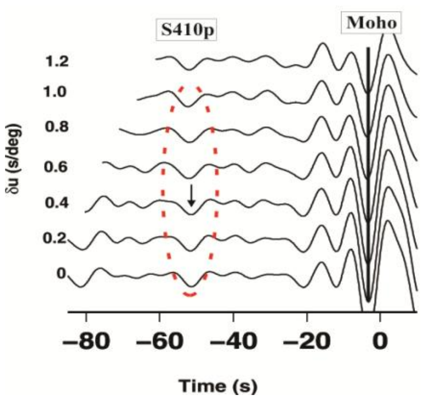
| Discontinuity | | Clapeyron |
|---|---|---|
| 410 km | exothermic | > 0 |
| 660 km | endothermic | < 0 |

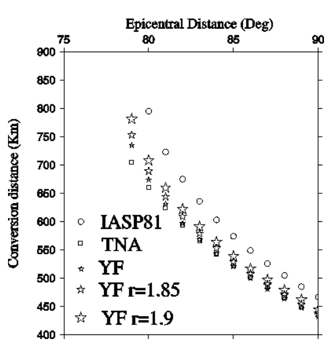
• Over the anomalous TZ our analysis reveals a zone of reduced velocity in the upper mantle

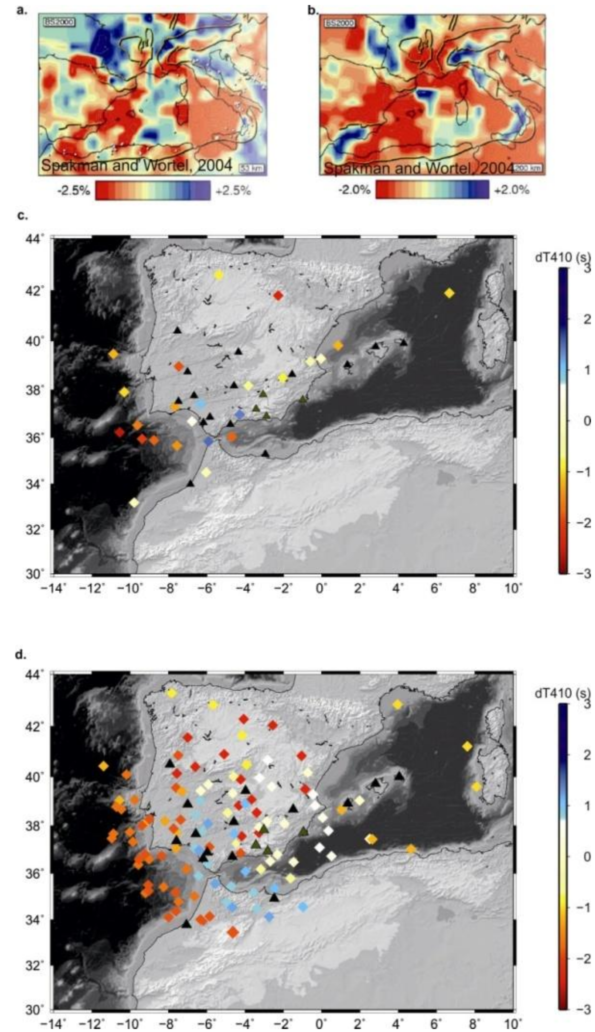
- We interpret the variable depth of the 660-km discontinuity as an effect of subduction;

# Residual time of S410p



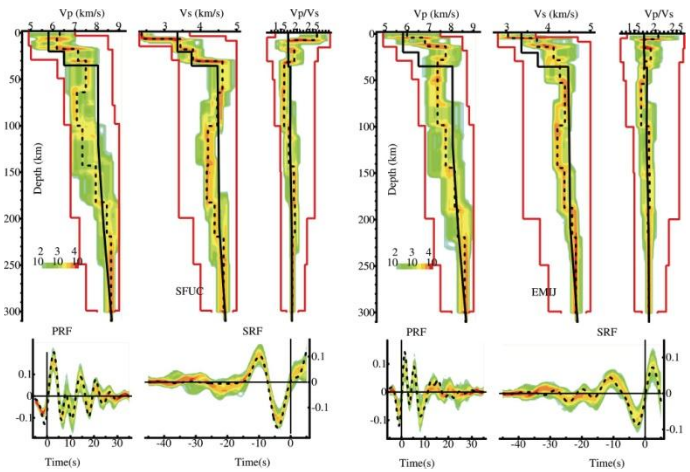



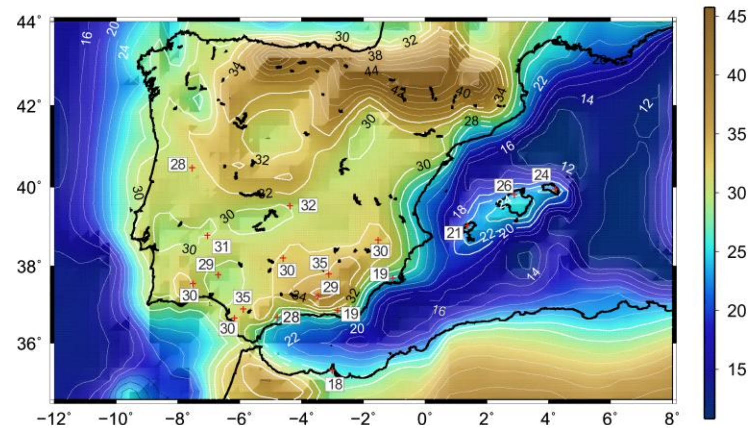

Most of the residuals times of S410p, excluding few data points, are negative with the average near 1.5 s. The reasons are:

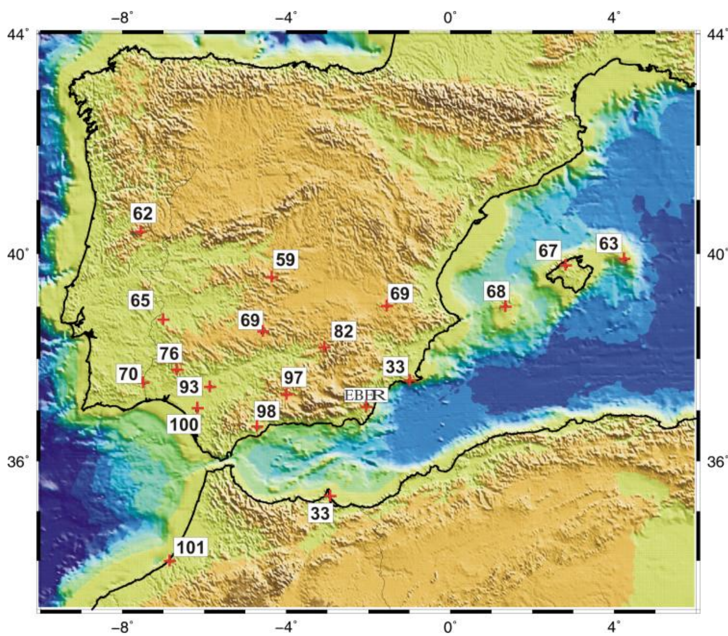
- high Vp/Vs ratio in the crust and upper mantle (0.05 higher than the normal in a layer 115 km thick)
- depression on the 410-km discontinuity of ~11.5 km

# Joint inversion P and S receiver functions




Moho depth (km)



Lithosphere depth (km)

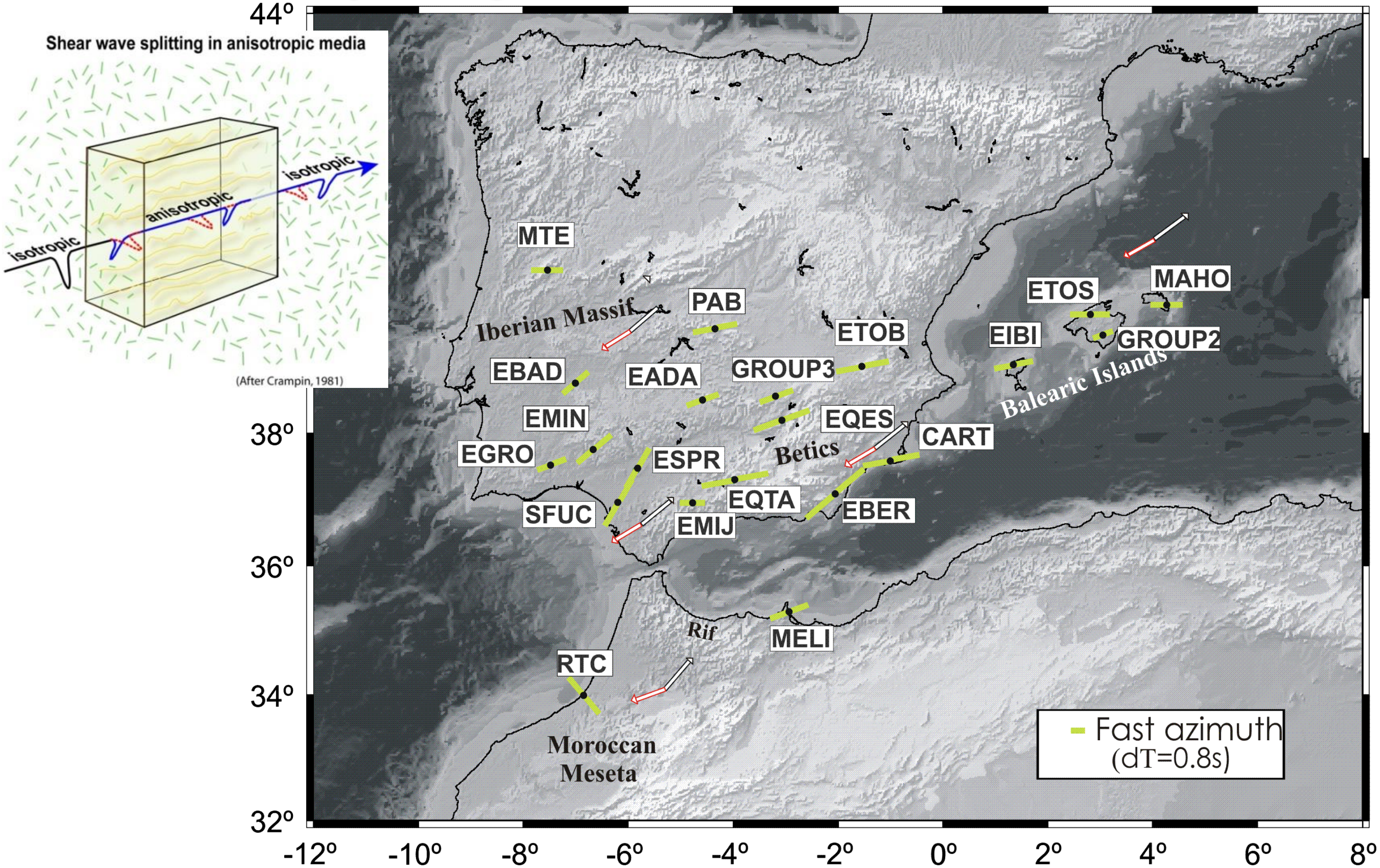
✓All velocity models contain a high velocity mantle lid, which is underlain by a low S velocity layer.

✓The depth of the boundary between the lid and the LVZ at most stations is 65±5 km

✓At several stations sampling the upper mantle of the Mediterranean we observe evidence of destruction of the lid, where it is either not observed or its lower boundary is at a depth of ~30 km.

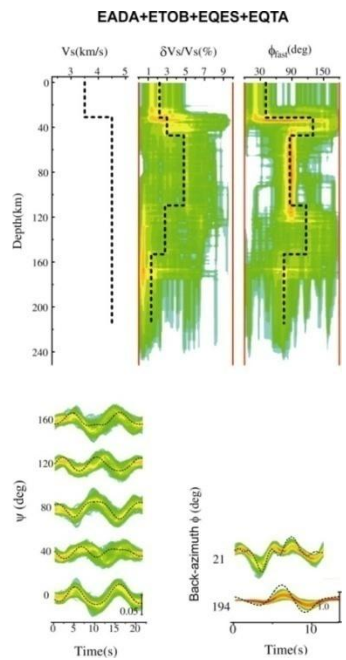
✓At a few stations (Gibraltar, North Africa) the depth of this boundary is around 100 km.

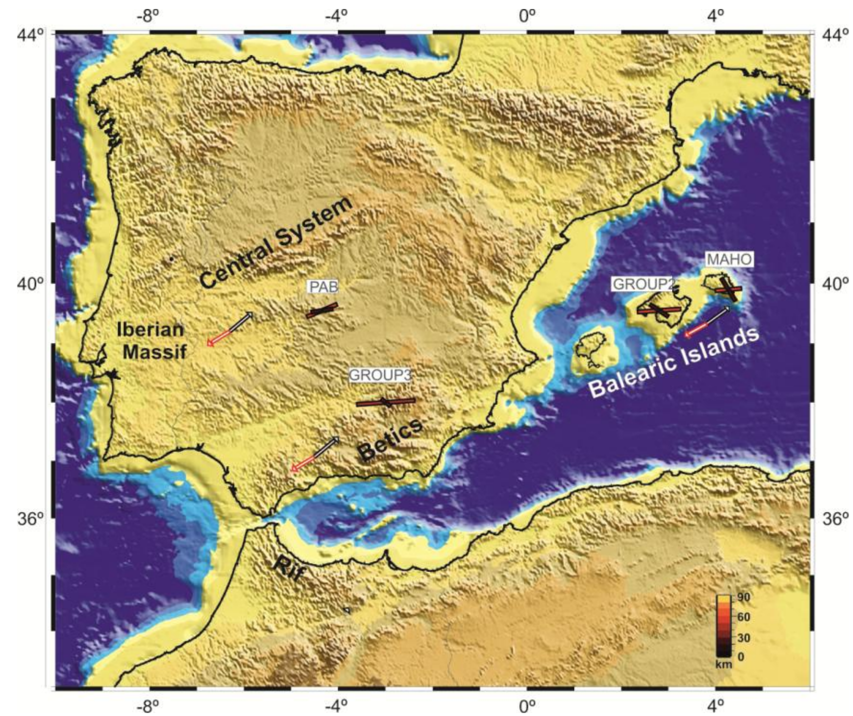
# SKS + SKKS splitting




Splitting SKS/SKKS results shown at the seismic stations used in the present study. The white arrows indicate the local direction of local absolute plate motion from no net rotation model NUVEL-1 [black contour] and HS3-NUVEL-1A [red contour].

# Joint inversion of PRFs and SKS waveforms




- The  firts results of this analysis indicate that a strong anisotropy (~5%) is localized in a depth range from ~50 km to ~120 km. Most of this range corresponds to the LVZ (asthenosphere).

- The fast direction of anisotropy (90 deg) in the asthenosphere corresponds to present-day or recent mantle flow. In the upper mantle can be interpreted as frozen in the lithosphere;

- The effect of the asthenosphere in the SKS splitting is much larger than the effect of the subcrustal lithisphere;

# Conclusions

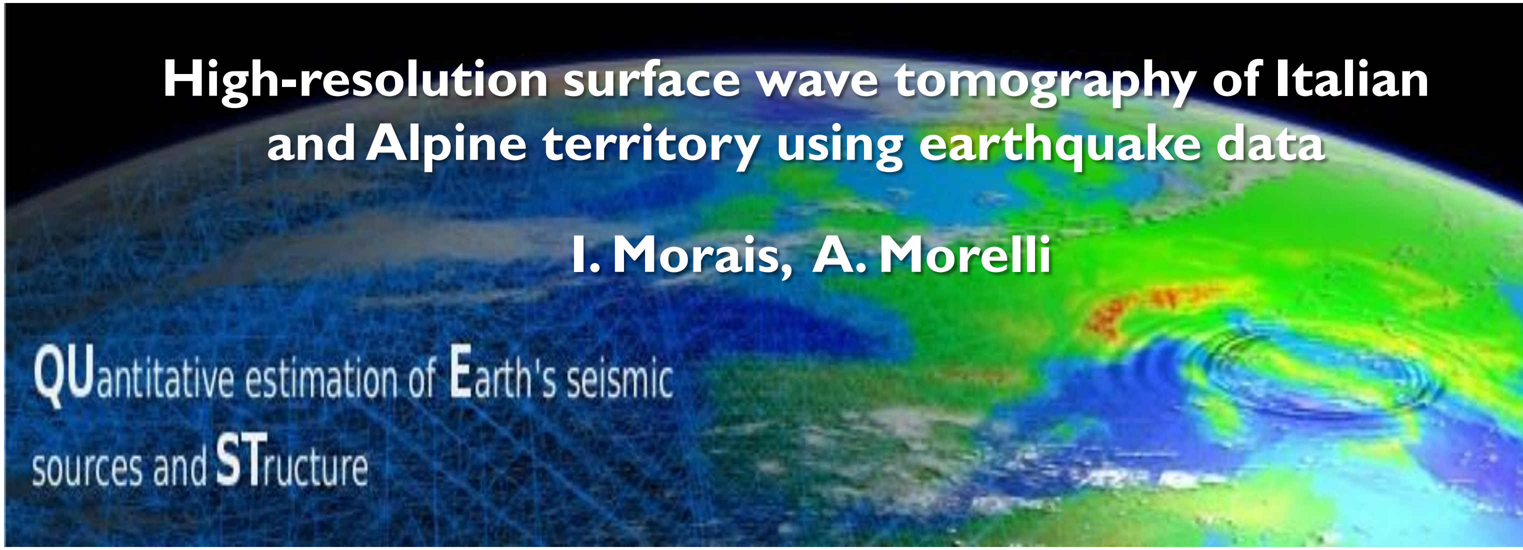
- The compilation of a dataset of nearly 2600 P receiver functions and nearly 2200 S receiver functions allows us to obtain a reliable and stable image of the seismic structure in Iberia and western Mediterranean.

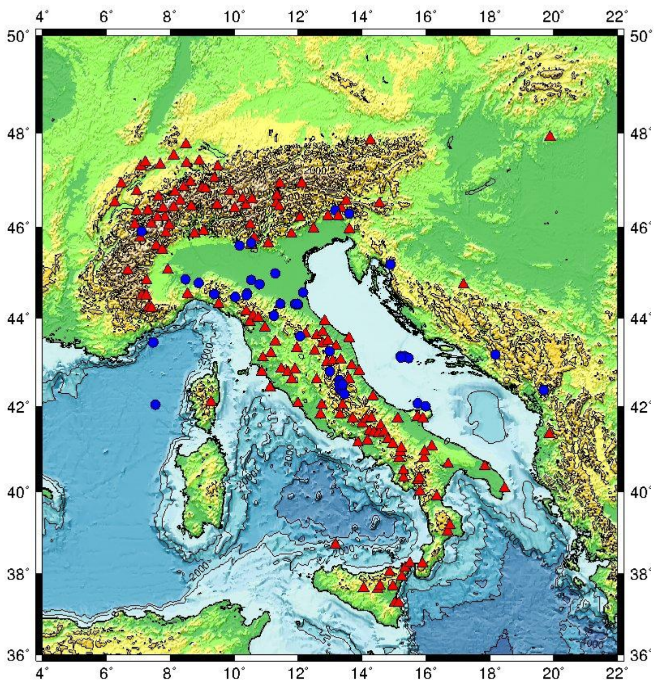
- The joint inversion of PRFs and SKS waveforms, which we only could apply for a restricted number of stations, is a very promising methodology. It offers the possibility of not only constraining the anisotropy with depth but also to discriminate the presence of different anisotropic layers.

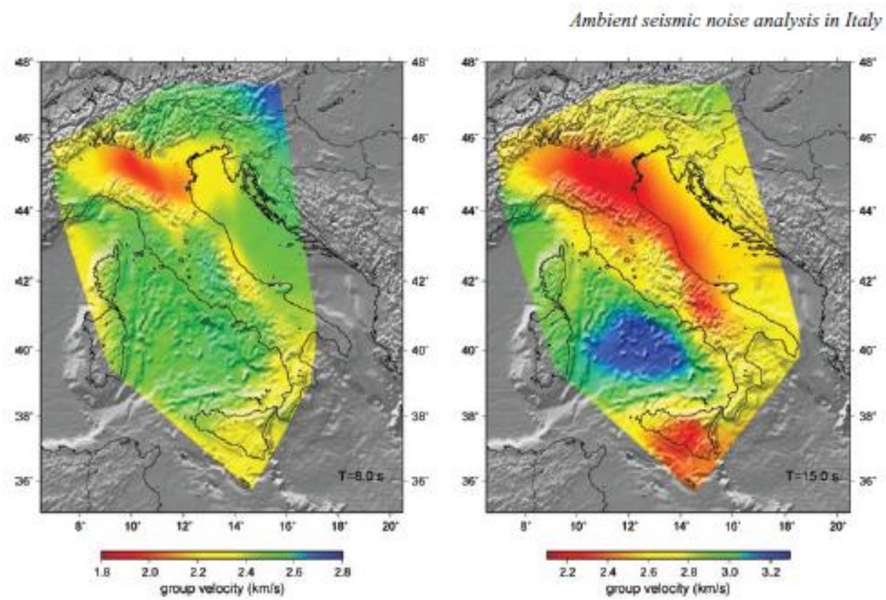
Nevertheless, t he knowledge about the structure in this complex region is far from being finished. A better understanding of the seismic anisotropy pattern beneath Iberia and western Mediterranean may provide important keys to understand who has the main role on the structure of the upper mantle: **heterogeneity or anisotropy**.

# High-resolution surface wave tomography of Italian and Alpine territory using earthquake data

I. Morais, A. Morelli




Li et al., 2010