Rayleigh Wave Dispersion and Anisotropy in the Tyrrhenian Sea
- Preliminary Results -

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Background

Subduction in the Mediterranean has a long and complex history of eastwards migration across the western Mediterranean Sea. At present, the Ionian slab subducts actively under southern Tyrrhenian Sea (Figure 1), as indicated by a deep, narrow Benioff zone and calcalkaline volcanism of the Aeolian Islands (Figure 2). Further north, the Calabrian slab is proposed to be disrupted by large windows (Figure 3). Such complex geometry of the Tyrrhenian–Apennine system will cause changes in mantle flow, such as inflow of subslab material. Geochemical evidence for such unusual flow mantle flow pattern exists in the complicated magmatism observed on some Italian volcanoes.

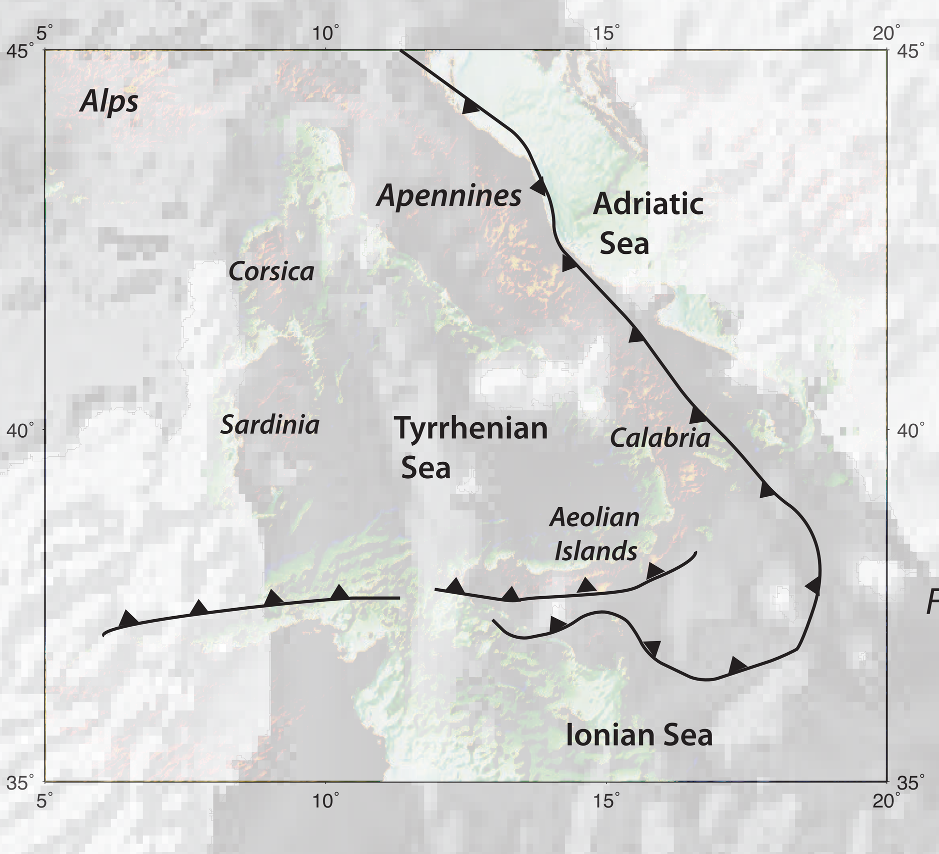

Figure 1

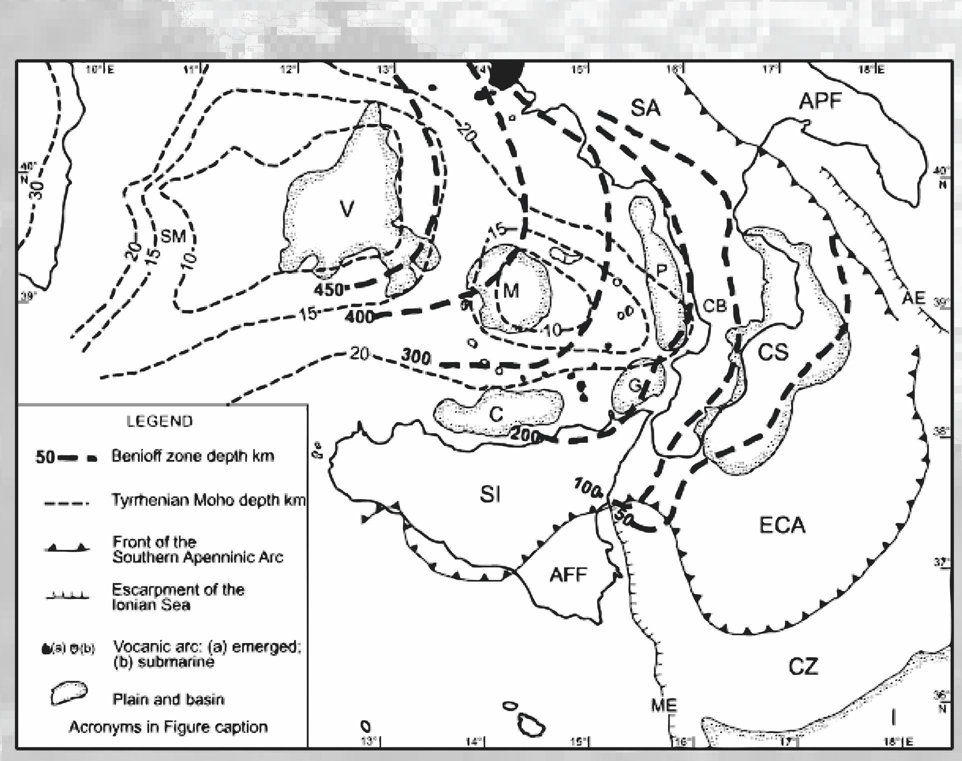

Figure 2 (from Sartori, 2003)

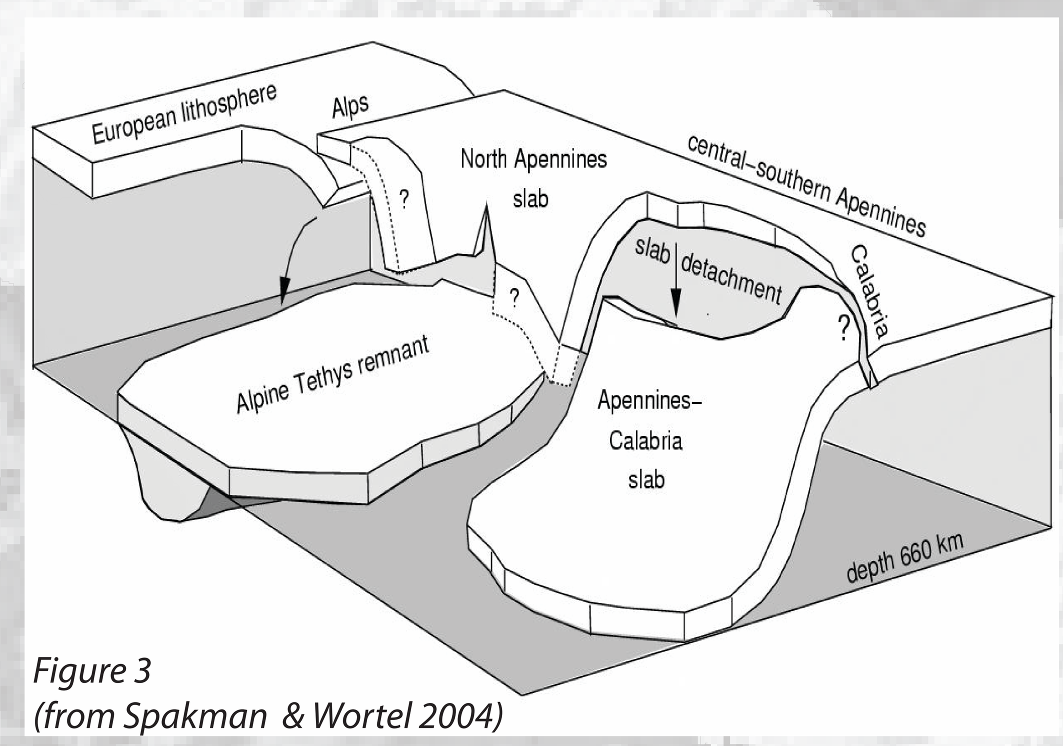

Figure 3
(from Spakman & Wortel 2004)

Aims

Geophysical evidence for mantle flow dynamics comes from seismic anisotropy and has already been measured by teleseismic shear wave splitting. This projects aims to extend our knowledge of the shear wave velocity structure and seismic anisotropy into the Tyrrhenian Sea by measuring interstation Rayleigh wave dispersion. These measurent have the advantage of providing a depth dependence of anisotropy, and therefore complements splitting measurements.

Phase Velocity Measurements

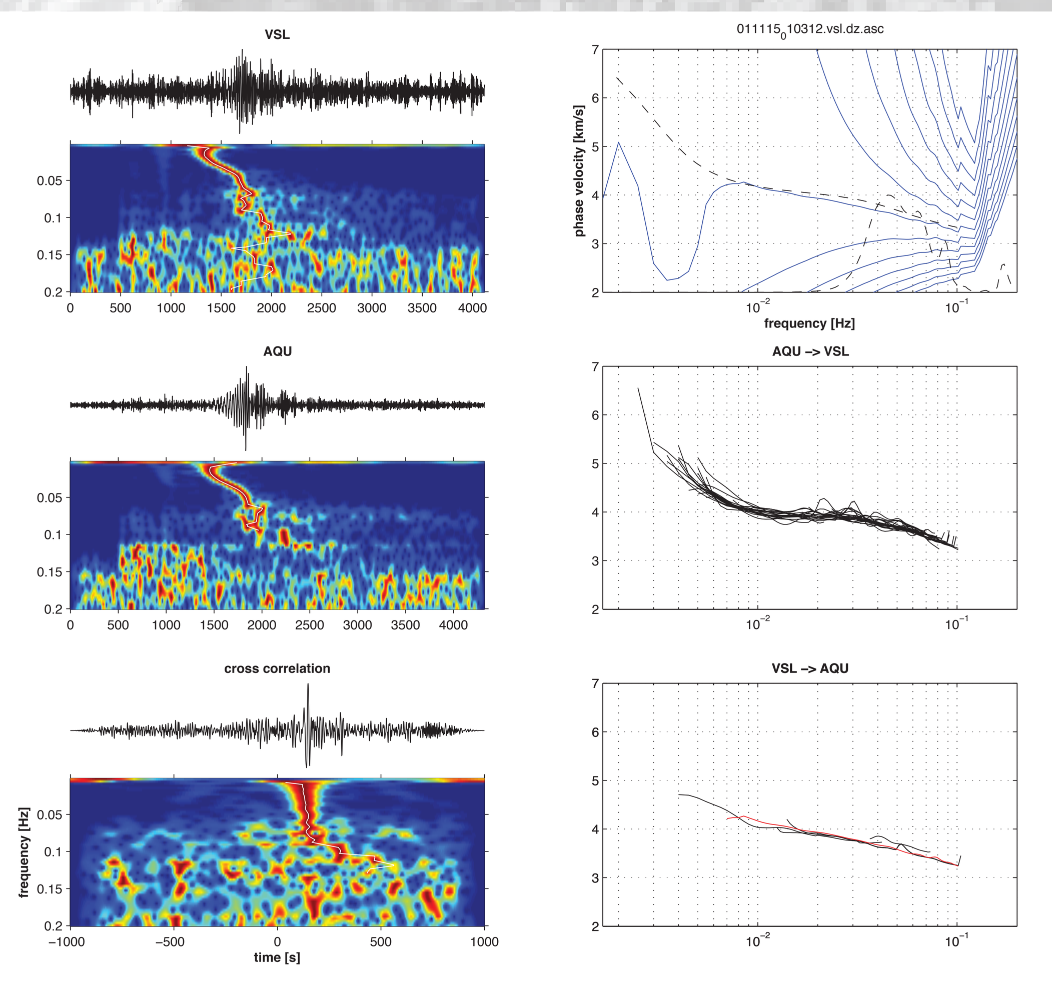

Figure 4

An example for interstation measurements of the fundamental mode Rayleigh wave phase velocity (Figure 4) shows traces from an event approximately aligned with the two recording stations (left panel, top and middle) and their cross correlation (bottom), together with the frequency sprectra. Phase velocities are picked interactively from all possible solutions (top right panel). The middle and bottom panels gives all the picked phase velocity curves for the station pair in the two opposite arrival directions.

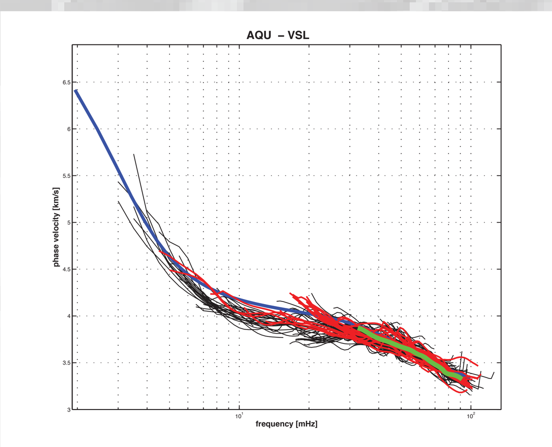

Figure 5a

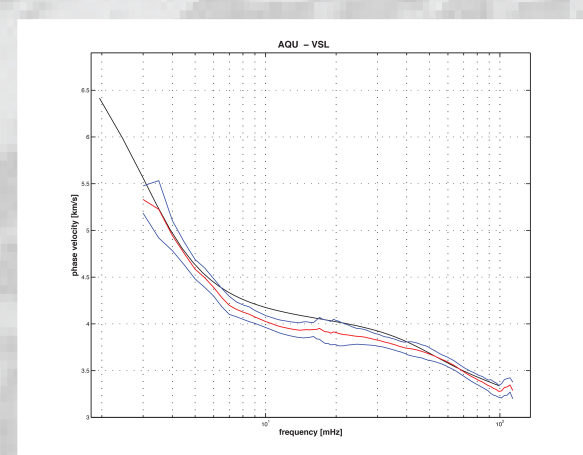

Figure 5b

All measurements are quality assessed to ensure robust results (Figure 5a). Then a mean (red curve, Figure 5b) and the standard deviation (blue lines, Figure 5b) for the interstation phase velocity curves are calculated. The inversion of the average phase velocity curves for all station pairs leads to the phase velocity maps (Figure 6).

Phase Velocity Maps - Preliminary Results

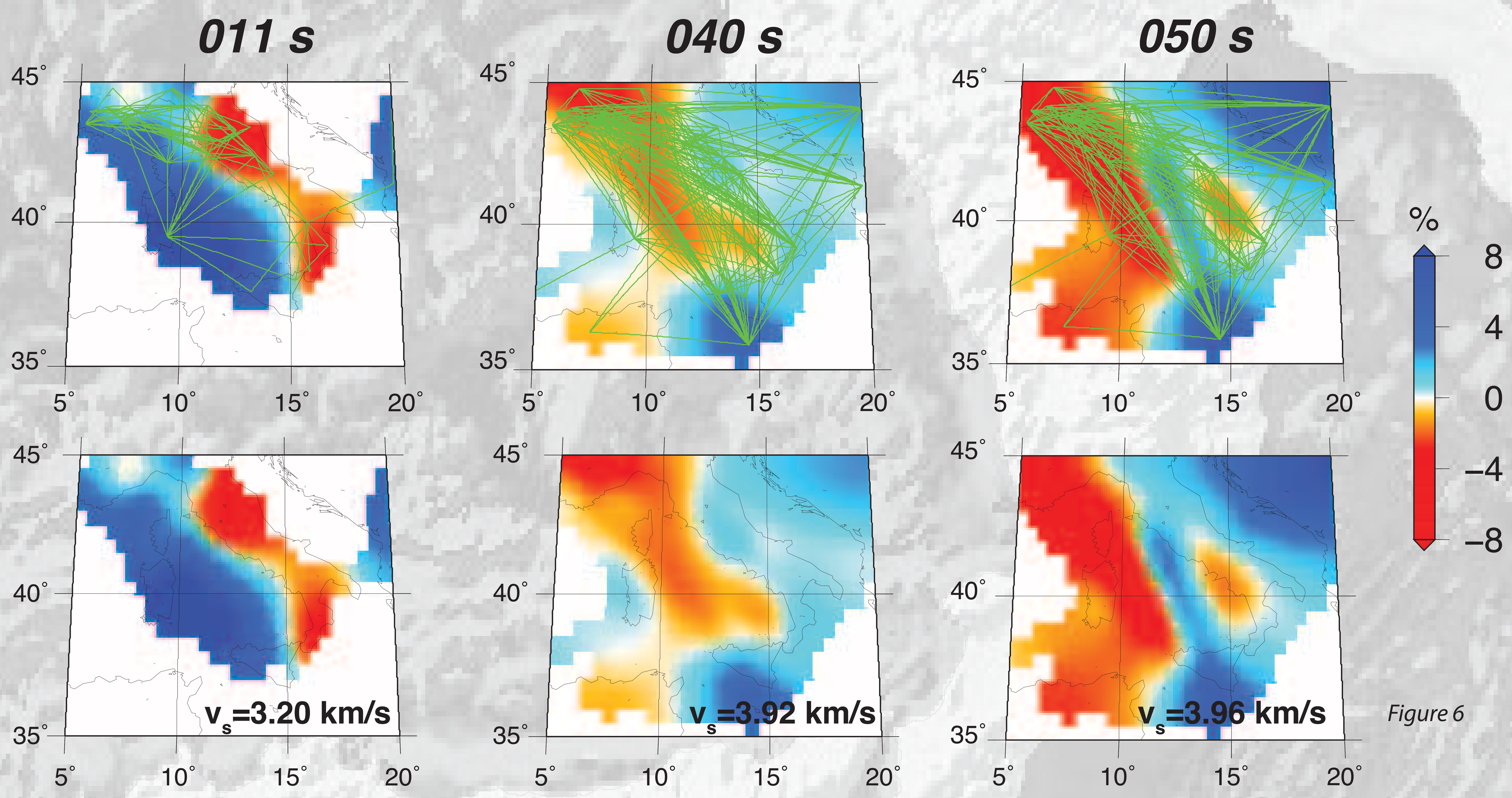

Figure 6

The first results (Figure 6) incooperate 286 station pairs with up to 233 interstation paths per inversion. We applied conservative smoothing and damping in order not to over-interpret non-stable results. Consistent patterns appear for periods of 11s in form of higher velocities in the oceanic compared to the continental region. This points to the differences in crustal thickness. The pattern changes for periods of 40 s, where the oceanic region appears slower than the continent.
One intriguing, stable pattern appears for periods of 45-55 s as a low velocity zone in the south-western Tyrrhenian Sea. It is located in the area where active subduction and volcanism take place.

Anisotropy from Shear Wave Splitting

A large amount of teleseismic shear wave splitting measurements from various studies and deployments exists for mainland Italy (Figure 7). Interpretation for locally observed anisotropy invoke toroidal mantle flow around slab edges or induced by rollback and backarc extension, mantle wedge anisotropy and contributions from the slab. However, separating the different contributions is difficult, as depth resolution is poor for teleseismic splitting measurements. Moreover, the lack of measurements in the oceanic area reduces interpretation to a narrow section of the subduction zone.

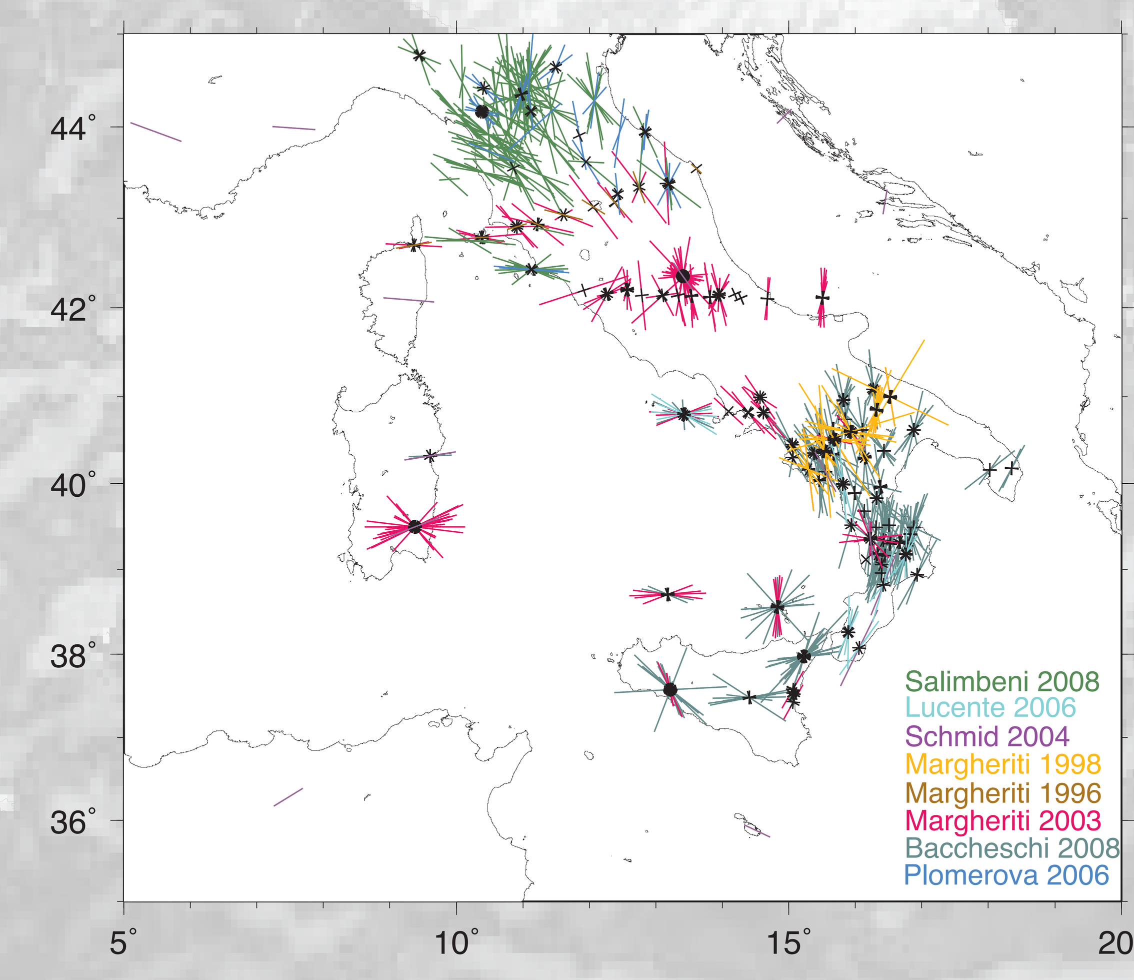

Figure 7

Outlook

We are currently picking more phase velocities for additional stations. We will then also include anisotropy into the phase velocity inversions. Then the inversion for shear wave velocity is planned.
Finally, we will attempt a combined interpretationfor the depth distribution of seismic anisotropy from shear wave splitting and surface waves in the tectonic context.

Acknowledgements

We use publicly available data from the following networks: Geofon, Midsea, Retreat, Mednet. Thanks to Bill Fry, Laslo Evers and Gert-Jan van der Hazel for help with retrieving data. Processing is largely based on codes developed by Sergei Lebedev and Thomas Meier. The research leading to these results has received funding from Crystal2Plate, an FP7-funded Marie Curie Action under grant agreement number PITN-GA-2008-215353