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Seismic radial anisotropy in Central-Western Mediterranean and Italian peninsula from ambient noise recordings

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The dynamics of crustal extension and the crust-mantle interaction in the Central-Western Mediterranean and Italian peninsula (i.e. Liguro-Provençal and Tyrrhenian Basin), and plate convergence (i.e. Alpine and Apennines chains) are key for the understating of the current geodynamics setting and its evolution in the region. However, open questions such as the style, depth and extent of the deformation still exist despite the wealth of seismological and non-seismological data acquired in the past decades. In this context, it is necessary to provide improved subsurface models in terms of seismic velocities, from which better constraints on the geodynamic models can be derived.

We use seismic ambient noise for retrieving phase velocities of Rayleigh and Love waves in the 4-35 s period range, using private (LiSard network in Sardinia island) and publicly available continuous recordings from more than 500 seismic stations. Considering the excellent coverage and the short period of recovered phase velocities, our study aims to provide an unprecedented, high-resolution image of the shallow crust and uppermost mantle.

We employ a Bayesian trans-dimensional, Monte Carlo Markov chain inversion approach that requires no a-priori model nor a fixed parametrization. In addition to the (isotropic) shear wave velocity structure, we also recover the values of radial anisotropy ($\xi=(V_{SH}/V_{SV})^2$) as a function of depth, thanks to the joint inversion of both Rayleigh and Love phase velocities.

Focusing on radial anisotropy, this appears clearly uncoupled with respect to the shear wave velocity structure. The largest negative anisotropy anomalies ($V_{SH}<V_{SV}$, $\xi<0.9$) are found in the Liguro-Provençal and western Tyrrhenian basins in the top 10-15 km, suggesting a common structural imprint inherited during the extensional phases of such basins. Conversely, the eastern Tyrrhenian basin shows positive radial anisotropy ($V_{SH}>V_{SV}$, $\xi>1.1$) within the same depth range. This evidence, combined with the observed shear wave velocities typical of the uppermost mantle, corroborates the presence of a sub-horizontal asthenospheric flow driving the current extension and oceanization of the eastern Tyrrhenian basins.

Moving towards the Italian mainland, a strong anomaly of negative anisotropy appears in the eastern portion of the Apennines chain. We relate such an anisotropic signal with the ongoing compressive regime affecting the area. Here, the high-angle thrust faults and folds, that

accommodates the horizontal shortening, obliterate the horizontal layering of the sedimentary deposits, currently constituting the flanks of the fold system.

Our results suggest that the combination of radial anisotropy and shear wave velocities can unravel key characteristics of the crust and uppermost mantle, such as inherited or currently active structures resulting from past or ongoing geodynamic processes.