# Imaging the Alpine crust with ambient-noise tomography: Linking surface observations to deep structures

Emanuel D. Kästle[1]

1. Institut für geologische Wissenschaften, Freie Universität Berlin, Germany

DOI: http://dx.doi.org/10.17169/refubium-41042

By making use of the data coverage from the AlpArray and Swath D networks, a dense set of ambient-noise measurements of Rayleigh and Love waves is extracted. This data is used to investigate the Alpine crustal and uppermost mantle structure using different approaches:

(1) Azimuthal anisotropy from Eikonal tomography for the AlpArray network. We show how Eikonal tomography can be used to extract azimuthal anisotropy from surface-wave data. The methodological advantages and difficulties are discussed in detail. It is found that strong velocity heterogeneities can be the source of a major bias by causing strongly deformed wavefronts. By averaging contributions from many azimuthal directions and careful data correction, most of this bias can be removed. The results indicate a mostly orogen parallel upper and orogen perpendicular lower layer of anisotropies. In the forelands, we find good agreement with SKS studies from which we infer that lithospheric and asthenospheric anisotropies are mostly parallel.

(2) Azimuthally anisotropic 3D shear velocity structure of the eastern Alps from rjMcMC tomography. With this innovative approach, we go beyond what is is shown in (1) and are able resolve the depth structure of the azimuthal anisotropy and estimate the model uncertainties. It is shown that under the orogen, a two layer anisotropic structure exists that separates the upper crust which is dominated by arc-parallel anisotropy from the lower crust and uppermost mantle which mostly show arc-perpendicular fast axis. We find that the anisotropy in the upper crust is largely controlled by major fault structures. The isotropic velocity distribution indicates a fast anomaly in the Giudicarie zone that may be related to Permian magmatism and causes a small offset in the Moho proxy. The estimated Moho structure closely resembles the positions of the underlying subudction slabs with a lateral offset between Central and Eastern Alps.

(3) 3D joint inversion of surface and body wave data. To better image the crust-mantle transition zone under the Alps, we apply a 3D rjMcMC imaging approach that combines different datasets and resolves the Vp and Vs structure from the surface to 600 km depth. With this approach there is no need for crustal corrections applied to the body wave travel times since the crustal structure is constrained by ambient noise data. Preliminary results of this model indicate that the slabs are more vertical and vertically more continuous as compared to a pure P-traveltime inversion.

The Python scripts used to obtain the results are already or will be published on the author's github page (github.com/ekaestle).

Kästle, E. D., Molinari, I., Boschi, L., Kissling, E., & AlpArray Working Group. (2022). Azimuthal anisotropy from Eikonal tomography: example from ambient-noise measurements in the AlpArray network. Geophysical Journal International, 229(1), 151-170.

Kästle, E. D., Tilmann, F., & AlpArray Working Group. (submitted). Anisotropic reversible-jump McMC shear-velocity tomography of the eastern Alpine crust. Submitted to G3.

Kästle, E. D., Paffrath, M., El-Sharkawy, A., Meier, T., & AlpArray Working Group. (in prep). Direct 3D rjMcMC inversion of body and surface wave traveltimes in the Alps.