EGU2020-13779
https://doi.org/10.5194/egusphere-egu2020-13779
EGU General Assembly 2020

Teleseismic P-wave travel time tomography of the Alpine upper mantle using AlpArray seismic network data

Marcel Paffrath[1], Wolfgang Friederich[1], and the AlpArray Working Group[*]
[1]Institut für Geologie, Mineralogie und Geophysik, Ruhr-Universität Bochum, Bochum, Germany (marcel.paffrath@rub.de)
[*]A full list of authors appears at the end of the abstract

We perform a teleseismic P-wave travel time tomography to examine geometry and slab structure of the upper mantle beneath the Alpine orogen. Vertical component data of the extraordinary dense seismic network AlpArray are used which were recorded at over 600 temporary and permanent broadband stations deployed by 24 different European institutions in the greater Alpine region, reaching from the Massif Central to the Pannonian Basin and from the Po plain to the river Main. Mantle phases of 347 teleseismic events between 2015 and 2019 of magnitude 5.5 and higher are evaluated automatically for direct and core diffracted P arrivals using a combination of higher-order statistics picking algorithms and signal cross correlation. The resulting database contains over 170.000 highly accurate absolute P picks that were manually revised for each event. The travel time residuals exhibit very consistent and reproducible spatial patterns, already pointing at high velocity slabs in the mantle.

For predicting P-wave travel times, we consider a large computational box encompassing the Alpine region up to a depth of 600 km within which we allow 3D-variations of P-wave velocity. Outside this box we assume a spherically symmetric earth and apply the Tau-P method to calculate travel times and ray paths. These are injected at the boundaries of the regional box and continued using the fast marching method. We invert differences between observed and predicted travel times for P-wave velocities inside the box. Velocity is discretized on a regular grid with an average spacing of about 25 km. The misfit reduction reaches values of up to 75% depending on damping and smoothing parameters.

The resulting model shows several steeply dipping high velocity anomalies following the Alpine arc. The most prominent structure stretches from the western Alps into the Apennines mountain range reaching depths of over 500 km. Two further anomalies extending down to a depth of 300 km are located below the central and eastern Alps, separated by a clear gap below the western part of the Tauern window. Further to the east the model indicates a possible high-velocity connection between the eastern Alps and the Dinarides. Regarding the lateral position of the central and eastern Alpine slabs, our results confirm previous studies. However, there are differences regarding depth extent, dip angles and dip directions. Both structures dip very steeply with a tendency towards northward dipping. We perform various general, as well as purpose-built resolution tests, to verify the capabilities of our setup to resolve slab gaps as well as different

possible slab dipping directions.

AlpArray Working Group: The complete member list of the AlpArray Working Group can be found at http://www.alparray.ethz.ch