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Constraints on S-velocity, radial and azimuthal anisotropy in the Aegean region from surface wave dispersion

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The Aegean region is located at the boundary between the African and Eurasian plates and characterized by a complex tectonic development. Due to various episodes of continental collision, subduction and extension in its tectonic history, marked structural differences are expected to exist within the crust and upper mantle of this area. Installation of several digital broad-band seismic networks within this region during the last couple of years offers the opportunity to investigate for example differences in crustal thickness in detail.

We present a new study of fundamental mode surface wave dispersion in the Aegean region. Data from the network of the Greek National Observatory of Athens (NOA), GEOFON-stations on Crete and in the Cyclades as well as from CYCNET, a temporary network in the central volcanic arc, were used to measure Rayleigh wave phase velocities along 129 different ray paths with a two-station method. For the central volcanic arc, short-period CYCNET stations were used to extend the frequency range of the dispersion curves up to 300 mHz, which results in additional constraints on the S-velocity in the upper 10 km of the crust. Additionally, Love wave dispersion was measured along 12 selected paths. The resulting coverage is particularly good in the central forearc and volcanic arc and in continental western Greece.

The data were inverted for 1D S-velocity models along each ray path with the non-linear Neighbourhood Algorithm (NA). Dependent on the seismometer type used in this somewhat heterogeneous network, velocities could be constrained to at least 50 km and up to 250 km depth. The NA was used to investigate trade-offs and constrain the uncertainty of the resulting models. In a second stage, tomographic phase velocity maps were calculated including azimuthal anisotropy.

Results show marked contrasts in crustal thickness between the forearc and continental Greece (up to 50 km) on the one hand and the Aegean sea (20-25 km) on the other hand. The subducted African lithosphere is imaged as an arc-shaped high velocity region descending from 40 km depth in the forearc to 130 km depth beneath the volcanic arc. Above the slab, a low-velocity region is identified which extends from about 50 km depth below the Sea of Crete to approximately 70 km depth beneath the volcanic arc and is not resolved beneath the northern Aegean. This zone is interpreted as the asthenosphere of the Aegean plate, indicating a pronounced thinning of the lithosphere to about 40-50 km in this area. Besides, different lithospheric structures are detected in the western and eastern forearc, respectively: An Aegean Moho and mantle velocities above the slab are only found beneath the eastern forearc. Azimuthal anisotropy is most reliably imaged at crustal depth, where it is compared to the direction of plate motion.