EGU21-7231, updated on 07 Dec 2021
https://doi.org/10.5194/egusphere-egu21-7231
EGU General Assembly 2021

Permo-Triassic Oceanic and Adjacent Continental Lithosphere in the Eastern Mediterranean, from surface-wave and wide-angle imaging

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The Earth's oldest oceanic lithosphere preserved in-situ is in the eastern Mediterranean Sea. It can offer essential information on the oceanic plate evolution. Yet, its thickness and other properties have been difficult to determine by means of seismic imaging due to the high heterogeneity of the region. Here, we combine a large, new surface wave dataset with published wide-angle data in order to map the properties and lateral variability of the oceanic lithosphere, as well as the ocean-continent transition in the easternmost Mediterranean beneath the Levant Basin. We use stochastic joint inversion of broad band, phase-velocity dispersion measurements and seismic refraction P-wave velocity models to obtain 1-D, shear wave velocity models down to 300 km depth and compare the structure beneath the Ionian Sea and the Levant Basin. The thickness of the crust is about 16.4 ± 3 km and 22.3 ± 2 km beneath the chosen locations within the Ionian Sea and the Levant Basin, respectively. The Poisson's ratio of about 0.32 and Vp/Vs of about 1.93 in the crystalline crust, yielded by the inversion, confirm the presence of oceanic crust beneath the Ionian Sea. The thickness of the Ionian oceanic lithosphere is around 180 km, whereas the continental lithosphere beneath the eastern Levant Basin is ~70 km thick, with low crustal Vp/Vs (~1.7) and Poisson's (~0.24) ratios. According to 3-D shear wave velocity tomography using the surface wave data, the thickness of the oceanic lithosphere increases from the Triassic Ionian Sea towards the Permian-Carboniferous Libyan Sea and Herodotus Basin. Thicknesses of the Permo-Triassic oceanic lithosphere considerably larger than 100 km indicate that oceanic lithosphere can thicken by cooling substantially beyond the limits suggested by the plate cooling model. The transition from oceanic to continental lithosphere occurs at about 31°E in the crust, as indicated by magnetic and gravity measurements. The continental mantle lithosphere further to the east of this boundary is ~150 km thick beneath the westernmost Levant Basin, as indicated by shear wave velocity tomography and long wavelength gravity anomalies, and strongly thins eastward towards the area of the Levantine Coast and the Dead Sea Fault. The localization of the lithospheric deformation and crustal seismicity along the Dead Sea Fault correlates spatially with the thinning of the underlying continental lithosphere.

Key words: surface wave tomography, wide angle seismic imaging, joint inversion, Vp/Vs and Poisson’s ratios, eastern Mediterranean, Oceanic Lithosphere, Continental Lithosphere, Dead Sea Fault.