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3D isotropic shear wave velocity structure of the lithosphere-asthenosphere system underneath the Alpine-Mediterranean Mobile belt

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The Alpine-Mediterranean mobile belt is, tectonically, one of the most complicated and active regions in the world. Since the Mesozoic, collisions between Gondwana-derived continental blocks and Eurasia, due to the closure of a number of rather small ocean basins, have shaped the Mediterranean geology. During the late Mesozoic, it was dominated by subduction zones (e.g., in Anatolia, the Dinarides, the Carpathians, the Alps, the Apennines, and the Betics), which inverted the extensional regime, consuming the previously formed oceanic lithosphere, the adjacent passive continental margins and presumably partly also continental lithosphere. The location, distribution, and evolution of these subduction zones were mainly controlled by the continental or oceanic nature, density, and thickness of the lithosphere inherited from the Mesozoic rift after the European Variscan Orogeny. Despite the numerous studies that have attempted to characterize the lithosphere-asthenosphere structure in that area, details of the lithospheric structure and dynamics, as well as flow in the asthenosphere are, however, poorly known. A 3D shear-wave velocity structure of the lithosphere-asthenosphere system in the Mediterranean is investigated using new tomographic images obtained from surface wave tomography. An automated algorithm for inter-station phase velocity measurements is applied here to obtain both Rayleigh and Love fundamental mode phase velocities. We utilize a database consisting of more than 4000 seismic events recorded by more than 2000 broadband seismic stations within the area, provided by the European Integrated Data Archive (WebDc/EIDA) and IRIS. Moreover, for the first time, data from the Egyptian National Seismological Network (ENSN), recorded by up to 25 broad band seismic stations, are also included in the analysis. For each station pair, approximately located on the same great circle path, the recorded waveforms are cross correlated and the dispersion curves of fundamental modes are calculated from the phase of the cross correlation functions weighted in the time-frequency plane. Path average dispersion curves are obtained by averaging the smooth parts of single-event dispersion curves. A careful quality control of the resulting phase velocities is performed. We calculate maps of Love and Rayleigh phase velocity at more than 100 different periods. The phase-velocity maps provide the local phase-velocity dispersion curve for each geographical grid node of the map. Each of these local dispersion curves is inverted individually for 1D shear wave velocity model using a newly implemented Particle Swarm Optimization (PSO) algorithm. The resulted 1D velocity models are then combined to construct the 3D shear-velocity model. Horizontal and vertical cross sections through the 3D isotropic model reveal significant variations in shear wave velocity with depth, and lateral changes in the crust and upper mantle structure emphasizing the processes associated with the convergence of the Eurasian and African plates.

Key words: seismic tomography, Mediterranean, surface waves, particle swarm optimization.