Mapping upper mantle structure and mantle flows beneath Anatolia by adjoint tomography

Omer Bodur[1], Hejun Zhu[1,2], Xueyan Li[1]

[1]Department of Geosciences, The University of Texas at Dallas, Richardson, TX, USA

[2]Department of Physics, The University of Texas at Dallas, Richardson, TX, USA

The Anatolian Plate is a suitable study domain to investigate the dynamics of continental collision and subduction that modify the lithosphere and its underlying asthenosphere. However, existing tomography models for this area are still controversial and lacking information about mantle flow circulations. Here, we develop a new tomographic model for the Anatolian Plate by simultaneously fitting three-component, frequency-dependent phase anomalies of body and surface waveforms. An iterative inversion strategy involving adjoint methods is used to constrain 3-D variations in seismic velocities, azimuthal anisotropy, and shear attenuation. Our 3D starting model, EU60 updated with 60 preconditioned conjugate gradient iterations using crustal model EPcrust23 in combination with transversely isotropic mantle model S362ANI. We use data from 112 earthquakes recorded by over 1,200 seismographic stations, resulting in 29,475 useable three-component seismograms. Frequency-dependent travel-time differences between recorded and simulated waveforms are used to characterize the misfit in the inversion. The nondimensional total misfit function consists of two contributions: body waves with periods between 20 s and 60 s, and surface waves with initial periods between 60 s and 150 s. As the inversion progresses, the surface-wave corner period is gradually reduced for steadily resolving smaller-scale structures. We follow the pattern of the misfit on all three components; the total misfit function is the sum of these six contributions. By jointly interpreting velocities and azimuthal anisotropy, we are aiming to resolve several scientific questions: (1) the lower crustal channel flows beneath the area (especially at the western part); (2) the role of active mantle processes beneath the Eastern-Eurasian plate convergence zone and the pattern of volcanism; (3) the possible drip mechanism underneath the central Anatolia; (4) the poloidal- and toroidal-mode mantle flows near the Hellenic subduction zone. Answering these scientific questions will improve our knowledge of how continental collision and subduction modify the Anatolian lithosphere and asthenosphere.