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Traces of subduction and their relation to seismic anisotropy beneath Greece and Turkey: new evidences and questions from seismic tomography

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The Aegean-Anatolia region is the most strongly deforming zone of the Euro-Mediterranean area. Although the part played by the retreat of the Hellenic trench in the Aegean extension is rather well understood, the driving mechanism of the westward motion of Anatolia is debated. Faccenna & Becker (2010) show that buoyancy-driven and plate motion induced mantle flow account for much of the observed dynamic topography and surface motion in the Mediterranean. Further refinements of this type of model require higher resolution data on mantle structure and anisotropy provided by dense regional seismic networks. Using records of ∼150 broadband permanent and temporary seismic stations compiled in the database of the SIMBAAD project, we computed a new 3-D shear wave velocity model of the crust and upper mantle to 300 km depth in the area from western Greece to central Anatolia. The lateral and vertical resolutions are ∼100 km at mantle depth. The overall mantle structure is characterized by a low-velocity zone (80-200 km depth) reflecting a slow and warm asthenosphere underlying a thin lithosphere. The south-westernmost termination of the low velocity anomaly corresponds to the northward dipping Hellenic slab while its northwestern and northern terminations correspond to the transition to areas with a thicker lithosphere. The detailed shear-velocity structure of the upper mantle beneath Anatolia appears to be far more geometrically complex than revealed in previous tomographic studies of the area. Shear wave velocities beneath Anatolia are higher at 200-300 km depth than in the reference Earth model ak135. The high-velocity bodies have slab-like geometries. When it is extrapolated to the surface, the top surface of the southernmost high Vs body outcrops in the vicinity of the Cyprus trench. We therefore favor the hypothesis of these mantle high velocity bodies being traces of subducted slabs. The westernmost anomaly is separated from the Hellenic slab by a low velocity anomaly which we interpret as a vertical slab tear beneath southwest Anatolia. We also measured azimuthal anisotropy from SKS splitting at ∼200 stations of our database, complementing previously published data. From western Greece to western Anatolia the anisotropy pattern has the expected characteristics of mantle flow in the vicinity of a retreating slab, including trench-normal flow in the mantle wedge and toroidal flow around the slab edges. The very stable NE-SW oriented fast split directions observed from the Aegean to eastern Anatolia could all be due to trench-normal flow induced by the retreat of the Hellenic slab. This observation however contradicts the west-directed flow in the Anatolian mantle of the Faccenna & Becker's model. The westward displacement of Anatolia and the possible associated asthenospheric flow either have not yet imprinted the mantle anisotropy, or there is no E-W mantle flow and basal drag beneath Anatolia.