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Layered deformation within the Aegean continental crust and mantle revealed by seismic anisotropy

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Relative measurements of Rayleigh wave phase velocities allow to reveal depth dependent azimuthal anisotropy of shear-wave propagation within the crust and the mantle lithosphere. In the Aegean, azimuthally anisotropic phase-velocity maps determined by tomographic inversions indicate preferred orientations of minerals (anisotropic fabric) within the extending lithosphere. In the south-central Aegean, deforming weakly at present, anisotropic fabric in the lower crust trends parallel to the direction of paleo-extension in the Miocene. This hints at frozen-in anisotropy related to Miocene extension that was accompanied by exhumation of metamorphic core complexes. Beneath the northern Aegean Sea, fast shear-wave propagation directions within the mantle lithosphere show a remarkable match with the directions of the extensional component of the current strain field obtained by GPS measurements at the Earth surface. This observation indicates that deformation of the northern Aegean Sea lithosphere is coherent in the sense that from the upper crust down to the lithospheric mantle it undergoes the same region-scale, North-South extension. The style of this deformation, however, is different in the brittle upper crust (slip on fault systems) and in the lithospheric mantle (viscous flow), with the ductile mid-lower crust accommodating the transition between the two. The close match of orientations of regional-scale anisotropic fabric and the directions of extension during the last major episodes of deformation implies that at least a large part of the extension in the Aegean has been taken up by distributed viscous flow in the lower crust and lithospheric mantle.