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# Multi-scale full waveform inversion for the the crust and upper mantle beneath Europe and western Asia

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We present the first-generation seismic model of the crust and upper mantle beneath Europe and western Asia, constrained by the full waveform inversion of complete teleseismic and regional seismograms in a broad period range (8-200 s).

Our method combines the spectral-element modelling of seismic wave propagation, adjoint techniques and the quantification of waveform differences via time-frequency phase misfits. To resolve both crustal and mantle structure, we simultaneously solve multiple regional- and continental-scale inverse problems. The inverse problems on different scales are coupled via 3D non-periodic homogenisation which induces apparent anisotropy that is accounted for in the forward modelling.

We assess tomographic resolution using curvature information obtained via second-order adjoints. Regions where resolution is particularly high compared to previous studies include the North Atlantic, the western Mediterranean and Anatolia, where lateral resolution length drops below 30 km within the lithosphere.

The multitude of geologically interpretable features include the Iceland plume which extends into the lower mantle. Furthermore, we observe two low-velocity fingers that extend from the Iceland plume into the North Atlantic asthenosphere, where they correlate with regions of Neogene uplift. Western Anatolia is characterised by the extension-related updoming of lower-crustal material. The deep expressions of volcanic provinces in central Anatolia and the North Anatolian Fault Zone are clearly imaged.

Future refinements of our model include the incorporation of (1) high-frequency body wave data, (2) additional data from local and regional arrays, especially in Northern Europe, (3) more complete amplitude information, and (4) data from noise correlations.