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Continental strike slip fault zones in geologically complex lithosphere: the North Anatolian Fault, Turkey.

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As part of the multi-disciplinary Faultlab project, we present new detailed images in a geologically complex region where the crust and upper mantle is bisected by a major continental strike-slip fault system. Our study region samples the north Anatolian fault zone (NAFZ) near the epicentres of two large earthquakes that occurred in 1999 at Izmit (M7.5) and Düzce (M7.2) and where estimates of present day slip rate are 20-25 mm/yr. Using recordings of teleseismic earthquakes from a rectangular seismometer array spanning the NAFZ with 66 stations at a nominal inter-station spacing of 7 km and 7 additional stations further afield, we build a detailed 3-D image of structure and anisotropy using receiver functions, tomography and shear wave splitting and illuminate major changes in the architecture and properties of the upper crust, lower crust and upper mantle, both across and along the two branches of the NAFZ, at length scales of less than 20 km. We show that the northern NAFZ branch depth extent varies from the mid-crust to the upper mantle and it is likely to be less than 10 km wide. A high velocity lower crust and a region of crustal underthrusting appear to add strength to a heterogeneous crust and play a role in dictating the variation in faulting style and postseismic deformation. Sharp changes in lithospheric mantle velocity and anisotropy are constrained as the NAFZ is crossed, whereas crustal structure and anisotropy vary considerably both parallel and perpendicular to the faulting. We use our observations to test current models of the localisation of strike-slip deformation and develop new ideas to explain how narrow fault zones develop in extremely heterogeneous lithosphere.