

Crustal multiscale teleseismic tomography: building a high-resolution velocity structure beneath the Tan-Lu fault zone using a short-term seismic array in eastern China

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The 1000-km-long Tan-Lu fault zone is among the largest continental strike-slip faults in the world. In its geological history the Tan-Lu fault has experienced an extensional process and split into four major branches in Shandong Province. Evidence from previous geochemistry and receiver function studies suggest that there may be upwellings of mantle material beneath the Shandong section of the Tan-Lu fault zone, though no seismologic evidence has yet been found due to low resolution in the deep crust.

To study the detailed crustal structure beneath the fault zone, we have deployed a dense seismic array across the Tan-Lu fault zone in the summer of 2015 and developed a multiscale teleseismic tomography method to achieve higher resolution than conventional teleseismic tomography. Numerical tests suggest that our new array can map crustal anomalies at the resolution of 5 km in the shallow crust, and 10 km in lower crustal depth, which are higher than the resolution of previous studies using a 40-km grid spacing.

Using teleseismic data recorded over a period of one month and multiscale teleseismic tomography we have obtained a 2D P-wave crustal velocity model across the Tan-Lu fault zone. The imaged velocity anomalies in the shallow crust correlates well with the surface geology, and the deep crust shows strong vertical and lateral variations in the new tomographic model that have similar patterns with previous geophysical surveys. A low velocity zone at 20-km depth of the deep crust matches well with the velocity interface, and its position correlates with an uplift of the Moho as revealed by previous receiver function studies. This anomalous feature extends upwards and connects with the upper crustal areas where the volcanic rocks are found. The evidence suggests that the low-velocity zone may be a partial melting area beneath the Tan-Lu fault zone, and it may be the source of surface basalts near the fault zone.