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The missing craton edge: crustal structure of the East European Craton edge beneath the Carpathian Orogen as revealed by double-difference tomography

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The Trans-European Suture Zone (TESZ) is the most important and extensive continental suture in Europe, marking the edge of the East European Craton (EEC), from the North Sea to the Black Sea. It corresponds to significant changes in surface geology and deep crustal structure, evident in seismic, gravitational and magnetic studies. However, the TESZ disappears beneath the Eastern Carpathians accretionary nappes and Neothethys ophiolites, thrusted over the subducted EEC passive margin in Romania. Hypothetical north-to-south slab break-off also gave rise to Neogene volcanism and an anomalous cluster of intense seismicity beneath the SE Carpathians (the Vrancea region), thought to express the last stage of slab break-off.
To illuminate the missing TESZ section and investigate the change in crustal properties from the Precambrian EEC across the collisional orogen and the impact of related volcanism, we constructed a 3D seismic model of P and S wave velocities of the Eastern Carpathians in Romania. With the advent of new permanent broadband and short-period seismic stations of the Romanian National Seismic Network, maintained by the National Institute for Earth Physics, we were able to detect lower magnitude crustal earthquakes in the area and construct seismic images of the crust across the Carpathians. Using the classical double-difference tomography method and waveform-derived cross-correlation differential times, we relocated local crustal earthquakes which occurred between 2005 and 2017 and simultaneously inverted for the 3D P and S wave velocity structure down to the Moho discontinuity.
This study provides the highest resolution of 3D crustal seismic models of this area up to date and emphasizes the manifestation of surface tectonic boundaries at lower crustal depths. Most previous passive and 2D active seismic studies focused on the southern sections of the SE Carpathians partially overlap the study area. We observed strong seismic anomalies especially in the lower crust and correlations between seismicity patterns and Vp and Vs variations, revealing complex seismotectonic features. Additional analysis of the estimated Vp/Vs ratio, an excellent petrological discriminant, in conjunction with maps of gravity and magnetic fields, provided important insights into the change of crustal composition across the missing edge of the Eastern European Craton.