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Crustal structure of the Carpathian orogen from receiver function analysis: how craton subduction and active delamination affect the crust

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The Carpathian arc is an uncommon curved collisional system, involving the subduction of the Eastern European craton and the Proterozoic Moesian platform beneath younger European microplates. The Cenozoic collision led to the closure of the Tethys Oceanic basin, portions of which are actively breaking off or delaminating beneath the orogen, generating deep mantle earthquakes. Neogene volcanism, possibly related to subduction slab roll-back, also formed a band of presently extinct volcanoes in the back-arc region. The Carpathian embayment is thus an ideal laboratory to investigate crustal processes related to subduction of cratonic material, multiple plate junctions and active delamination.

To better understand how the crustal structure changes from the Eastern European cratonic foreland, across the curved subduction zone, to the younger European microplates, we analyse teleseismic earthquakes recorded at broadband seismic stations located across eastern and southern Carpathians, in Romania and Moldova. We processed data from permanent seismic networks (The Romanian National Seismic Network) as well as data from temporary deployments such as CALIXTO (Carpathian Arc Lithosphere X-Tomography) and SCP (South Carpathian Project). Using extended multi-taper spectral division, we compute and analyse radial and transverse receiver functions. Energy on the transverse component may be an indicator of crustal anisotropy or the existence of intracrustal dipping interfaces. Using phase-weighted H-k stacking of receiver functions, we estimate the crustal thickness and the bulk crustal Poisson's ratio as well as the seismic sharpness of the Moho discontinuity. Furthermore, we invert receiver functions to obtain the S-wave velocity structure of the crust and upper mantle beneath individual stations, which provide concurrent information on the Moho nature.

Our results provide a better understanding of crustal structure across complex collisional systems involving the subduction of multiple Precambrian domains beneath Phanerozoic microplates and the seismic signature of an active late-stage Wilson cycle on the overlying crust.