The geological record of southeast Canada spans more than 2.5 Ga of the Earth's geological history, making it a natural laboratory for the study of crustal formation and evolution over time. We constrain bulk crustal properties (Vp/Vs ratio and Moho depth) from teleseismic earthquakes recorded by a new network of seismograph stations that spans the Archean Superior craton, the Proterozoic Grenville province, and the Phanerozoic Appalachian terranes. Probabilistic inversion of receiver functions is also performed to constrain crustal shear wavespeed structure.

The Proterozoic Grenville province shows a thicker crust and higher Vp/Vs ratios (average ~41 km, ~1.76 respectively) than either the Archean domains ~36 km, ~1.73) or Phanerozoic terranes ~37 km, ~1.75). Proterozoic crust appears significantly more mafic on average than adjacent Archean domains. We also note significant differences in the probabilistic seismic wavespeed structure; Proterozoic and Phanerozoic terranes are both seismically faster and more heterogenous than the Archean domains.

A ~20 km thick, high velocity (Vs=3.8-4 km/s) lower crustal layer beneath the Grenville and Appalachian terranes supports the theory that Proterozoic crustal growth was characterized by mafic underplating. The lack of correlation between elevation, Moho depth, and gravity anomalies in Proterozoic terranes suggests Moho topography of ~10 km is better explained by buoyant mantle support than by compositional variations driven by lower crustal metamorphic reactions. However, Grenvillian geology is characterized by massive felsic anorthosite intrusions, inferred to have differeniated from Paleoproterozoic magmatism. Mafic underplating may have promoted their formation, stimulating crustal growth within the mobile belts, increasing its overall mafic content.