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Evidence for lithospheric and sublithospheric anisotropy of the eastern Canadian Shield and its margins

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The eastern Canadian Shield and its margins represent an excellent natural laboratory to study the formation and evolution of continental lithosphere, as the rocks and structures preserve approximately 4 billion years of geological history. The core of the continent is made up of several large Archean cratonic blocks and continental fragments, welded together by Paleoproterozoic mobile belts. Subsequent Proterozoic orogenesis added to the southern and eastern margins, building the Laurentian landmass, and a series of Wilson cycles established the form of the continent we see today. Laurentian lithosphere is characterized in seismic tomography by a thick, seismically fast continental keel, representing cold temperatures and a depleted composition, whereas the Phanerozoic margins have slower seismic wavespeeds and a thinner lithosphere.

Over the last several decades, numerous seismic anisotropy measurements have been used to investigate lithospheric and sublithospheric fabrics beneath the region. Shear wave splitting shows strong lateral variability in both the strength and fast-polarisation orientation of the anisotropy, and measurements at closely-spaced stations suggest a significant lithospheric component as well as a likely sublithospheric contribution. Recent regional and continental-scale surface wave tomography studies allow for some depth constraint on the azimuthal anisotropy, which appears pervasive, but varying, for different depth ranges within the lithosphere and asthenosphere.

We compare the measurements from shear wave splitting and surface wave tomography with several geological and geophysical observations that could relate to anisotropic fabric, such as surface tectonic boundaries, magnetic anomalies, absolute plate-motion directions and mantle flow patterns from global geodynamic models. We use these comparisons to investigate the relative contributions to the seismic anisotropy observed across the region from lithospheric deformation, basal shear of the North American plate, and active mantle convection.