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# Seismic structure of Precambrian lithosphere: New constraints from tomography and broadband surface-wave dispersion

J. Boonen (1), **S. Lebedev** (1), J. Trampert (1)
Utrecht Univ (sergei@geo.uu.nl)

Depth distributions of seismic velocities and their directional dependence (anisotropy) in the crust and mantle beneath cratons yield essential constraints on processes of formation and evolution of continental lithosphere. Despite recent progress in mapping the lateral extent of cratonic roots, profiles of seismic velocities within them remain uncertain. We employ a novel combination of waveform analysis techniques and measure interstation Rayleigh- and Love-wave phase velocities in broad period ranges. The data yield resolution from the upper crust to deep upper mantle. Sampling a selection of 10 Archean and Proterozoic locations, we derive new constraints on the isotropic and radially anisotropic seismic structure of Precambrian lithosphere.

S velocity Vs is consistently higher (and, thus, temperature is lower) in the lithosphere of cratons than in the lithosphere of Proterozoic foldbelts, even though temperature in the asthenosphere beneath the units does not appear to correlate with their age. This confirms that the stable, buoyant lithosphere beneath cratons is substantially thicker than beneath younger continental blocks. An increase in Vs between the Moho and a 100-150 km depth is consistently preferred by the data and is likely to be due to the transition from spinel peridotite to garnet peridotite, as proposed earlier. Seismic and mineralogical data available at present are consistent with both a sharp and a gradual increase in Vs: a Hales discontinuity or a 'Hales gradient'.

Radial anisotropy in the upper crust is observed repeatedly and indicates vertically oriented anisotropic fabric (Vsh $<$ Vsv); this may provide a clue on how cratons grew, lending support to the view that distributed crustal shortening with sub-vertical flow

patterns occurred over large scales in ancient orogens. In the lower crust and upper lithospheric mantle, radial anisotropy consistently reveals horizontal fabric (Vsh > Vsv); the fabric can be interpreted as a record of (sub-)horizontal ductile flow at the time of the formation and stabilization of the cratons. We also find indications for radial anisotropy in the 200-400 km depth range, corroborating recent evidence for the occurrence of seismic anisotropy due to current and recent flow in the asthenosphere beneath cratons.