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High-velocity lower crust and upper mantle metasomatism in the Archean Slave carton revealed by the receiver function inversion

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From the global perspective cratons are believed to remain coherent for billions of years, have cold, depleted, seismically fast and featureless underlying mantle. We present a unique geophysical view of the seismic structure within the Archean Slave craton that shows clear vertical stratification of the crust sub-continental lithospheric mantle (SCLM). P- and S-wave velocity profiles (Vp and Vs) and Vp/Vs ratio from the Earth's surface down to 300 km depth are obtained by simultaneous inversion of P- and S-receiver functions for the stations of POLARIS array in the Central Slave craton and permanent YKW3 station in the southwestern part. Present study is the first application of the joint P- and S-receiver function inversion for the characterization of SCLM of the Slave craton. Crustal thickness varies from 30 to 38 km. Beneath the Central Slave we observe high-velocity (Vp > 7.0 km/s) lower crustal layer that makes up to 50% of the bulk crust. Vp/Vs ratio changes sharply with depth: ∼1.7 in the upper crust and ∼1.9 in the lower crust. High Vp and Vp/Vs values suggest mafic composition and we propose this layer to be a result of mantle underplating. McDonald fault is expressed in by high Vp/Vs (∼1.9). Obtained for the upper mantle Vs profiles clearly form two distinct groups corresponding to the central and peripheral parts of the craton. Upper mantle beneath the Central has a low S-velocity zone (Vs∼4.5 km/s) of ∼100 km thickness. The S-velocity reduction in this zone is ∼7.5% relative to the typical values for cratonic values. The velocity drop correlates in depth with the change in the depletion degree reported by Eocene and top of the Central Slave mantle conductor. Stations of the second group express low S-velocity (∼4.55 km/s) layer (∼50-100 km thickness) under the Moho. This layer is not expressed in the xenoliths data and we suggest that its formation occurred later that the kimberlite eruption. We speculate on the recent (Tertiary?) various degree metasomatic alteration of the upper mantle, variations in Opx and Fe content and possible presence of water to explain the seismic structure of the SCLM beneath the Slave craton. No robust seismic indication of lithosphere-asthenosphere boundary (LAB) is observed.