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Velocity-conductivity relationships for mantle mineral assemblages in Archean cratonic lithosphere based on extremal bounds

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Using multi-phase, extremal-bound theory we derive the likely shear and compressional velocities and electrical conductivity at three depths, 100 km, 150 km and 200 km, beneath the central part of the Slave craton and beneath the Kimberley region of the Kaapvaal craton based on known petrologically-observed mineral abundances and magnesium numbers, combined with estimated temperatures and pressures and laboratory single mineral data. We show that there are measurable differences between the physical properties of the two lithospheres for the upper depths, but that differences in velocity are negligibly small at 200 km. We also show that there is an advantage to combining seismic and electromagnetic data, given that conductivity is exponentially dependent on temperature whereas the shear and bulk moduli have only a linear dependence.

Focussing on a known discontinuity between harzburgite-dominated and lherzolitic mantle in the Slave craton at a depth of about 160 km, we demonstrate that the amplitude of P-S conversions would be very weak, and so explanations for the receiver-function observations must either appeal to effects we have not considered (perhaps anisotropy), or imply that the laboratory data require further refinement.