Title: Reconciling geophysical and geochemical constraints on the temperature and composition of cratonic lithosphere by considering mantle discontinuities

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Much of Earth’s cratonic lithosphere has resisted deformation throughout geologic time. Cooler-than-average temperatures make cratonic lithosphere strong and thick, and its depleted composition provides a buoyancy force which resists entrainment in deeper mantle flow. Surface-wave dispersion measurements place constraints on the absolute velocities of the cratonic mantle lithosphere, but it is difficult to reconcile these geophysical observations with the steady-state geotherms inferred from mantle xenoliths if a simple peridotite composition is assumed.

The crux of the problem is that xenolith-derived geotherms predict shear velocities that are higher than observed in the shallow mantle lithosphere and slower than observed in the deeper cratonic lithosphere. One possible explanation is that a low-velocity layer pervades the shallow cratonic lithosphere, potentially a relict of metasomatic activity. Numerous studies of scattered body-waves have suggested the presence of a negative velocity discontinuity at depths ranging from 90 to 140 km; these have been interpreted as the top of such a low-velocity zone. At greater depths, converted waves occasionally reveal a velocity increase at a depth of 220 +/- 20 km—the so-called Lehmann discontinuity—which is detected more often beneath continents than beneath oceans.

Here we plan to present an integrative perspective on cratonic temperature and composition by jointly analyzing surface wave observations (both shear velocity and attenuation), receiver functions (both Ps and Sp), and underside reflected waves (SS precursors) across the North American continent. Given improved constraints on shear-velocity profiles and geotherm bounds inferred from xenoliths and attenuation, our ultimate goal is to infer cratonic composition as a function of depth.