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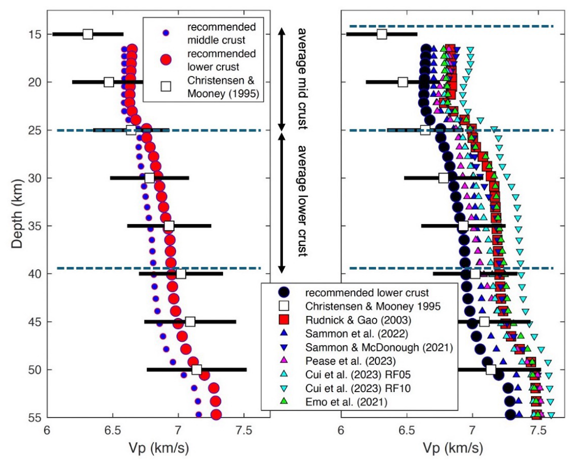

Average composition of lower continental crust is andesitic, not mafic

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In this invited presentation and a recently published paper (Kelemen et al., Treatise on Geochemistry, 3rd Edition, "Average Composition & Genesis of the Lower Continental Crust") we constrain compositions using seismic wave speeds and the physical properties of thermodynamically-constrained, equilibrium mineral assemblages in granulite and amphibolite suites. Focusing on stable crust with steady state geotherms, we find that average lower continental crust has an andesitic composition with 57-58 wt% SiO_2, 3 tons/m^3, 0.53-0.65 μW/m^3, P-wave speed, Vp, 6.9 km/s, 0.92 GPa, 410 to 510°C. Similarly, middle continental crust has 61-62 wt% SiO_2, 2.8 tons/m^3, 0.68-0.65 μW/m^3, Vp 6.6-6.7 km/s, 0.54 GPa, 280 to 300°C. Combining layer thicknesses modified from CRUST1.0 with the well-constrained composition of upper crust yields bulk continental crust with 62 wt% SiO_2. Adding heat flow from the mantle into the crust (11-18 mW/m^2) yields surface heat flow of 47-55 mW/m^2, consistent with heat flow in stable regions (60% of continental area) and in 46% of tectonically active regions. Active regions with high heat flow have advective heat transport, so lower crustal temperatures cannot be estimated using combinations of thermal conduction and heat production.

Thus, average lower crust is intermediate in composition, not mafic as is commonly stated. It is similar in major and trace element composition to upper crust, bulk crust, and intermediate arc lavas and plutons. Though the lower crust may record partial melting and melt extraction, complementary to a melt component in the upper crust, it does not have the composition of cumulates or residues of crystal fractionation from primitive, mantle-derived melts. Average continental lower crust is significantly more enriched in incompatible trace elements than arc lower crust, even at depths at which arc lower crust is buoyant with respect to the underlying mantle. Although continental genesis has involved a variety of processes, it is likely that the average composition is primarily the result of density sorting of subducting, arc-derived material, either via thrusting of volcanoclastic sediments and forearc crust beneath arc lower crust, combined with density sorting at the arc Moho, or via ascent of buoyant, viscous, eclogite-facies lithologies in diapirs or subduction channels.