The eclogite engine; Top-down geochemistry

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Properties of Bullen's Region C (400-1000 km) are used to test mantle stratification models (whole-mantle, two-layer, superplume, marble-cake, hole-in-the-floor, water-filter). Top-down models involving eclogite and continent recycling plus irreversible deep subduction [1, 2] are favored. Density-velocity correlations, transition zone (TZ) thickness and petrology imply radial and lateral changes in lithology and homologous temperature. Injection of warm lower crust into the mantle [3] explains the volume, and compositions, of hotspot magmatism. Massive crustal delamination has previously been ignored in favor of plume injections of ancient MORB.

Phase changes (basalt-eclogite-magma) are more effective in creating buoyancy than thermal expansion and drive the eclogite engine. Sinkers from over-thickened crust use mantle heat to melt and regain buoyancy. This style of heat exchange [2, 3] introduces a subterranean cycle that operates parallel to deep subduction.

Region C has the largest radial variations and lateral variations in density that exist anywhere in the mantle and negative correlations between density and velocity variations [5]. These are unaccounted for in standard models–and global tomography. Properties of C are uncorrelated with hotspots [4] and 'superplumes' and require lithologic heterogeneity.These observations alone rule out standard models. Observations favor a laterally inhomogenous stratified mantle and top-down fertilization. The asthenosphere and **C** are replenished from above. [Google; eclogite engine].

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Crustal and mantle cycles

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As Earth cooled through the eclogite transition thick-crust tectonics was replaced by delamination, plate tectonics and deep irreversible subduction. Oceanic crust (OC) is not a conveyor belt; it is replaced by material displaced out of the transition zone (TZ) by slabs. Delaminated crust is hotter and may be part of a short, shallow "subterranean" cycle ("eclogite engine"). Deep subduction is intermittent and started late in Earth history; the amount of subducted OC has therefore been overestimated. It can easily be stored in the TZ. MORB is colder and denser at depth than LCC eclogite. Today the mantle is digesting OC–irreversible plate tectonics–but is regurgitating former lower continental crust (LCC) and restites, which are buoyant at ambient temperatures.

New seismic data and TZ geothermometry do not support a deep or thermal origin for hotspots. New sources of heat and material are required. Loss of LCC is a non-negligible element in mantle geochemistry; the volume exceeds estimates of plume flux from the lower mantle. I suggest that crustal sloping provides much of the material and mantle heat is the energy source. LCC additions and losses occur at rates much higher than previously thought; orogenies are major sinks and sources for the mantle. If foundered CC is circulating in the upper mantle, most of the LIL and heat sources are in the current and former crusts. Mass balance can be achieved if the TZ is eclogitic and CC resides part time in the mantle. If more than ~50 % of the continental mass is continuously recycled between the crust and the mantle, the lower mantle must be barren.