Basal differentiation of the mantle.

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Signals from the top and the bottom of the mantle

Mantle differentiation is clearly evident at the Earth's surface taking place by melting at ridges, hydrothermal alteration and weathering of oceanic crust, followed by the subduction "factory". A widely held point of view in mantle geochemistry is that these observed processes are entirely sufficient to account for all the chemical heterogeneity observed in mantle-derived samples. The presence of radiogenic $^{186}Os/^{188}Os$ in some plumes indicates the possible contribution of an isotopic signal derived from the outer core, by core-mantle interaction. Mantle geophysics requires the presence of about 10% iron-enrichment in the lower mantle. Precise Fe/Mn measurements have provided evidence for excess FeO ~15% in the mantle source of lavas from the major shield-building stage of Hawaii, relative to MORB and Iceland [1]. These Hawaiian lavas are also characterized by higher Ni, lower Sc, but similar Si, compared with lavas from Iceland at the same MgO content. The higher Fe/Mn can be partially explained by having a mantle source enriched in SiO_2, resulting in a shift of the mineral mode from olivine-dominated to pyroxene-dominated. Since the Si-content of lavas is controlled by the olivine/pyroxene ratio of the source, the absence of a ubiquitous enrichment of SiO_2 in lavas having high Fe/Mn requires a different explanation.

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The geochemical implications of seismic evidence for the presence of partial melt at the base of the mantle, particularly below ascending mantle plumes including Hawaii, have not been explored. Mg-Perovskite has a high partition coefficient for Si, Sc and Mn, but FeO and NiO are concentrated in ferropericlase. As an alternative hypothesis to core-mantle interaction [1], I consider the implications of melting at the CMB, with Mg-Pv as the restite phase. Segregation of the denser Mg-Pv provides the phase separation needed to drive mantle heterogeneity. Percolation of such melt could provide metasomatism of the mantle source that imparts a higher Fe and Ni to the plume source, without imparting higher SiO_2. Further, the higher Fe/Mn and Ni/Mg can be obtained without the need for entrainment of material from the core. The new model of mantle heterogeneity driven from both boundary layers fits the Fe/Mn evidence better. Effects of partitioning of Fe and Mn in the post-perovskite phase is still unknown.

References

[1] Humayun M., Qin L. and Norman M. D. (2004) *Science* **306,** 91-94.