# A new look at crust-mantle differentiation

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Most current assessments of crust-mantle differentiation start with a chondritic bulk silicate Earth, and treat the continental crust and the MORB-source mantle as complementary reservoirs with correspondingly contrasting $\varepsilon_{Nd}$ and Sm/Nd values. All these models yield a highly depleted upper mantle occupying 30 to 50% of the mantle by mass. However, Pb-isotopic variations in MORB and OIB are inconsistent with formation of their sources by continent extraction alone. Moreover, none of the radiogenic isotope tracers are capable of separating the effects of continental and oceanic crust extractions. Unlike all of the radiogenic isotopes, the canonical ratios Nb/U and Ta/U are specific tracers of continental extraction only. By simple mass balance using global datasets for MORBs, we calculate the mass fraction of the mantle residual to the continental crust, $X_r$, at 60 to 80%, depending on the estimated U concentration of the continental crust. The trace element composition of this residual mantle is only moderately depleted in Th and U at about half of the primitive-mantle values. The analogous mass balance using Nd isotopes requires an $\varepsilon_{Nd} \leq 4$ for a residual mantle mass fraction of $X_r \geq 0.6$. This low epsilon value contrasts with a much higher average of global MORBs ($\varepsilon_{Nd} = 8.5$) and a marginally higher average OIB value of $\varepsilon_{Nd} \geq 4$. The combined MORB and OIB source reservoirs appear to be incapable of balancing the continental crust ($-20 \leq \varepsilon_{Nd} \leq -10$). This requires an additional, hidden, enriched reservoir with MORB-OIB-like (Nb, Ta)/U ratios and $\varepsilon_{Nd} \ll 4$. This might be an early-enriched reservoir now located within the two LLSVPs (Large Low Shear Velocity Provinces).