The Silicate Earth and the Core
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Many existing models for determining the composition of the bulk earth are overly complicated, and so developing a more simplistic model that fits data and observations is therefore a worthwhile endeavor. The bulk earth is a simple mass balance of its component reservoirs: continental crust, depleted mantle, primitive mantle and core. Assuming continental crust and depleted mantle were derived from the primitive mantle, we can reduce the equation for the bulk earth to a sum of the primitive mantle and the core. Further simplification is provided by the additional assumptions that 1) the bulk earth is related to meteorites, 2) the present mantle is homogeneous with respect to the major elements, and 3) the core is made of Fe-Ni alloy.

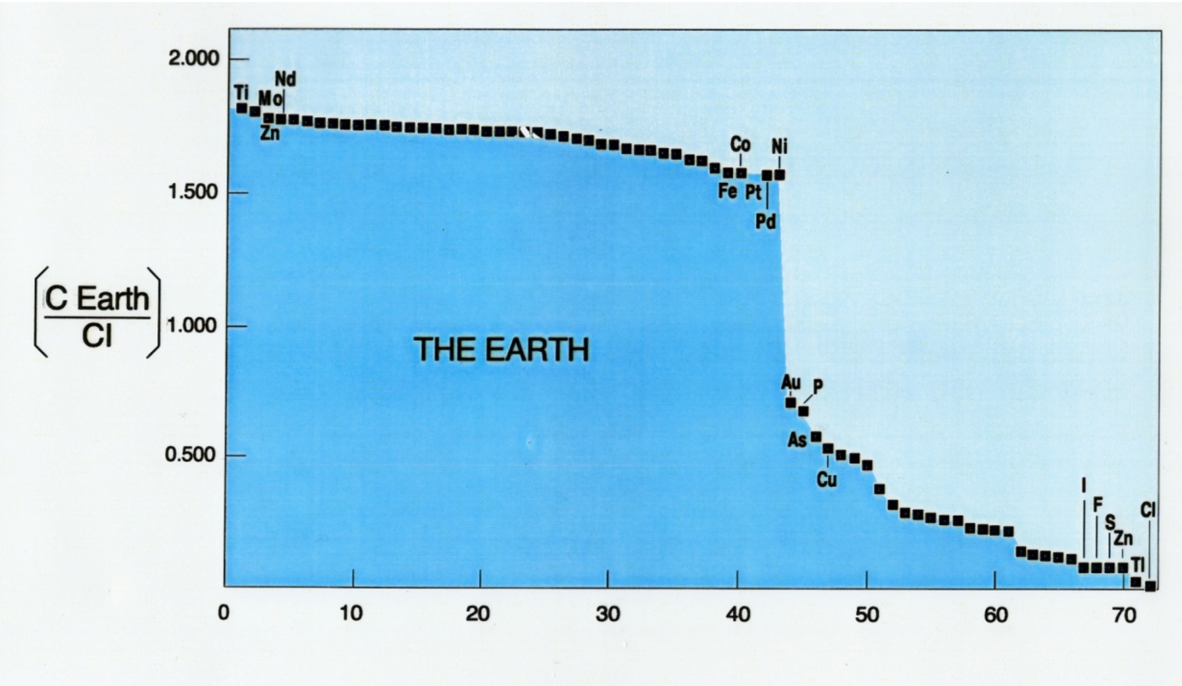

Figure 1. The composition of the earth normalized to chondrite plotted as a function of atomic number

Carbonaceous chondrites define straight-line arrays on ratio-ratio plots of refractory elements such as Si/Mg-Al/Mg. Since certain refractory elements (Mg, Ca, Al, etc.) do not partition into the earth's core, we can assume that their bulk earth ratios are equivalent to their ratios in the primitive mantle. The bulk earth falls along the carbonaceous chondrite lines for these elements. The position of the earth on these diagrams, however, varies systematically as a function of the volatility of the elements plotted. Bulk earth falls closer to CI for refractory elements, nearer CM for moderate refractories and beyond CV for volatile elements. Relationships between elemental ratios in chondrites probably reflect differences in condensation temperature, rather than mixing between end-members. These systematic variations permit a reasonable estimate of the bulk earth composition for all the elements (Figure 1). Combining these results with solar nebula condensation curves for the elements yields an estimate of the condensation temperature of the earth (1100-1200 K).

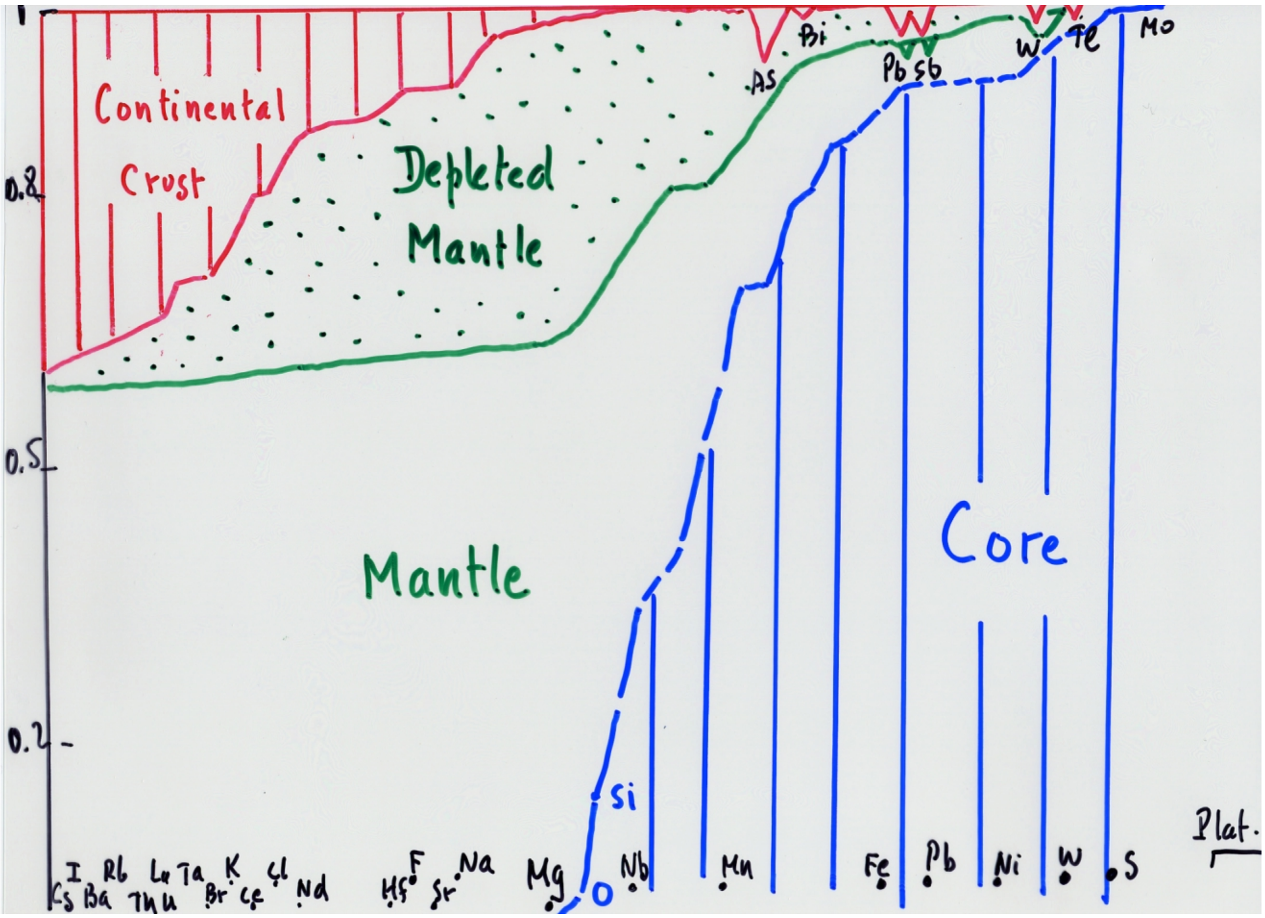

Figure 2. The composition of earth reservoirs (Cont. Crust, Depleted Mantle, Mantle and Core) plotted as a function of relative abundances in the earth

To compute the composition of the primitive mantle, another approach is employed. Operating on the assumption that the primitive mantle is composed of some combination of depleted mantle plus continental crust, isotope and element inversion describes how different element families (eg. siderophile, metalloid, etc.) are partitioned between mantle and crust. The composition of the core can then be calculated as a simple difference between the primitive mantle and the bulk earth (Figure 2).

Discussion and important points for the future:

• How does the moon relate to the bulk earth?
• Conditions in the mid-mantle during core segregation
    Highly reducing?
    Magma ocean?
• How well do OIBs represent the composition of the lower/primitive mantle? How well can we expect to know the composition of the primitive mantle?
• How much primitive mantle or OIB source actually exists within the earth?