METEORITES, COMPOSITION OF THE EARTH AND EARLY ACCRETING MATERIAL IN THE INNER SOLAR SYSTEM. D. C. Rubie[1], D. J. Frost[1], and H. Palme[2], [1]Bayerisches Geoinstitut, University of Bayreuth, D-95440 Bayreuth, Germany, dave.rubie@uni-bayreuth.de, [2]Forschungsinstitut und Naturmuseum Senckenberg, Senckenberganlage 25, D-60325 Frankfurt am Main, Germany.

Introduction: The composition of the Earth's mantle as deduced form upper mantle rocks is basically chondritic, but differs in detail from existing chondrite compositions.

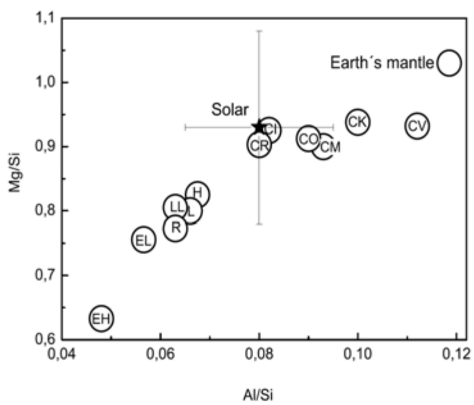

Fig. 1. Major element compositions of the Earth's mantle and chondritic meteorites (adapted from [1]).

The Earth's mantle is higher in Mg/Si and Al/Si than carbonaceous chondrites. Assuming 10% of a light element in the core and the observed FeO content of the Earth's mantle yields a Fe/Mg ratio of bulk Earth about 10% above the CI-ratio. The extent of depletion of volatile elements in the Earth exceeds that of CV chondrites, but the depletion sequence follows a similar trend. Bulk Earth is thus compositionally different from any type of chondritic meteorite [2].

A comparison of the composition of the bulk Earth with chondrite compositions requires, however, to consider the effects of (1) core formation, (2) heterogeneous accretion and (3) fractionation during accretion.

Core Formation: The early differentiation of the Earth involved the segregation of metal from silicate to form the mantle and core. We have recently formulated a new model of core formation that is based on a simplified accretion scenario [3]. The Earth accretes through collisions with differentiated bodies that are approximately 0.1 × Earth's mass at the time of impact. After each collision, the impactor's core partially or completely equilibrates in a magma ocean before merging with the Earth's proto-core. The resulting core composition in our model is: ~5 wt.% Ni, ~8 wt.% Si, ~2 wt.% S and ~0.5 wt.% O. With 8 % Si in the core the bulk Earth Mg/Si and Al/Si ratios would be within the range of CV-meteorites (Fig. 1).

Homogeneous or Heterogeneous accretion? The multistage core formation model gives poor results when the bulk composition of accreting material remains constant (homogeneous accretion). A single composition for all accreting embryos cannot reproduce the current mantle composition of the Earth. In contrast, heterogeneous accretion produces excellent results for all the non-volatile elements. The best fit is obtained when the initial 60-70% of Earth's mass accretes from material that was highly reduced (>99% of Fe initially present as metal) and the final 30-40% from material that was more oxidized (~60% of Fe initially present as metal). The reduced composition is considered to represent the average composition of material that originated early in the inner regions of the solar nebula where temperatures were high, whereas the more oxidized material originates further out. The model is thus consistent with radial mixing in the solar system. However, enstatite chondrites do not provide a good fit for the reduced component because they are high in volatile elements. A volatile poor E-chondrite composition would require a comparatively volatile element enriched oxidized component, which would still be within the range of existing chondrite compositions, i.e. volatile elements would still be depleted in this component. However, a volatile free enstatite composition with very low Mg/Si and Al/Si ratios (Fig. 1) would also require an oxidized component with much higher Mg/Si and Al/Si ratios than are known from chondritic meteorites to compensate for the low Mg/Si and Al/Si of the reduced component.

The excess Fe in the bulk Earth can be explained by collisional erosion which removes early formed crusts from embryos by collisions [4].

Conclusions: The major part of the Earth cannot be made of material represented in the meteorite record. This is in agreement with stable isotope systematics (i.e. [5]). Meteorites formed in separated, local areas unrelated to the major planetary formation regions.

References: [1] O'Neill H.St.C and Palme H. (1998) in: *The Earth's Mantle: Structure, Composition and Evolution* pp. 3-126, Cambridge University Press. [2] Palme H. and O'Neill H.St.C. (2003) in: *Treatise on Geochemistry, Volume 2-The Mantle and Core*, ed: Carlson, R.W., Elsevier-Pergamon, Oxford, pp. 1-38. [3] Rubie D.C. et al. (2010) *EPSL 301*, 31-42. [4] O'Neill H.St.C. and Palme H. (2008) *Phil. Trans. R. Soc. A 366*, 4205-4238. [5] Trinquier, A. et al. (2007) *Astrophys. J. 655*, 1179-1185.