The Light Element Content of the Earths Core: Constraints From a New Core Formation Model

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It was recognized many years ago that the density of the Earth's core is too low for it to consist of pure Ni-Fe alloy. Based on estimates of the density deficit, it is considered that the core contains up to 10-12 wt% light elements, with possible candidates being S, O, Si, C, N, and H. Previous studies have tried to constrain the light element content by considering the solubilities of the respective light elements under *P-T* conditions of the core. However, this approach may be problematic because the light element content must have been set during core formation and early differentiation of the Earth. In this case, the chemistry of the core is determined by metal-silicate element partitioning and is dependent on the conditions under which the core formed.

We have estimated the concentrations of oxygen and silicon in the core by developing a new model of core formation that is constrained by the concentrations of both siderophile and lithophile elements in the Earth's mantle. In order to be consistent with accretion models, the Earth accretes through a series of collisions with smaller planetary bodies that had already differentiated at low pressure (e.g. $<$1 GPa). Each impact results in a magma ocean in which the core of the impactor reequilibrates with silicate liquid at high pressure (that increases during the course of accretion, e.g. from 3 to 90 GPa) before merging with the Earth's protocore. The bulk compositions of the proto-Earth and impactors are chondritic with oxidation states (i.e. bulk oxygen contents) that can be varied during accretion. The compositions of coexisting liquid metal and liquid silicate in the magma ocean are determined through a novel mass balance approach combined with new formulations for the metal-silicate partitioning of FeO and Si, together with a range of trace elements including Ni, Co, V, Cr, Ta and Nb.

Models that are currently most successful in reproducing mantle geochemistry involve heterogeneous accretion in which oxygen fugacity increases significantly as the Earth grows. In addition, the final large impacts involve only partial reequilibration of metal and silicate at high *P* (due to incomplete emulsification of the impactor cores). These models predict that both O and Si are present in the core in sub-equal concentrations. Together with 2 wt% S, the concentrations are sufficient to satisfy recent estimates of the density deficit. Based on the likely oxygen content, the very base of the mantle must be strongly depleted in the FeO component.

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Abs. No. **276**
Meeting: **DMG 2008**
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email: **dave.rubie@uni-bayreuth.de**
date: **0000-00-00**
Req. presentation: **Vortrag**
Req. session: **S04**