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Sulfur content of the Earth and its core

WILLIAM F MCDONOUGH[1] AND TAKASHI YOSHIZAKI[2]

[1]University of Maryland

[2]Earth Sciences, Tohoku University

Presenting Author: mcdonoug@umd.edu

Compositional models of the Earth are built on physical and chemical data for the planet, compositional systematics in chondritic meteorites, and experimental studies that mimic early Earth's formation and differentiation. Chondrites, the building blocks of the terrestrial planets, do not, however, match the Earth's bulk composition. To determine the core's composition we must combine cosmochemical observations with geophysical and geochemical data for the Earth. By defining the composition of the Earth and its layers, we are better equipped to understand its origin and evolution.

The Earth's metallic liquid core convects and creates a protective magnetosphere through dynamo action. The core's density does not matching that of an Fe,Ni alloy at core conditions and thus has a density deficit; it contains lighter element(s) to account for its ~10% lower density. Debate continues regarding the composition and proportion(s) of light element(s) in the Earth's core. It is commonly concluded that the core contains only ≤2 wt% S, plus other elements. This prediction for its S content was based upon the Earth's depletion in moderately volatile, lithophile elements, those not partitioned into the core.

Here, we characterized systematic differences between lithophile and non-lithophile (siderophile and chalcophile) elements in chondrites and predict the bulk Earth and its core contains 2.1±0.3 and 6.5±0.8 wt% sulfur, respectively. We propose a 3.3×increase in the core's S content relative to traditional estimates, which consequently lowers the core's contents of other light elements (e.g., H, O, Si) to compensate for its density deficit. The mean atomic weight for our proposed core composition (24.2) is consistent with that recommended by Birch (1968). The systematics of siderophile and chalcophile elements in chondrites can also be used to constrain the sulfur contents of other terrestrial planets. Changes to the abundance estimates of other moderately volatile and volatile siderophile/chalcophile elements include the core's Pb abundance and its implications for the lead paradox of the BSE. From this study, we estimate that the bulk Earth and core contains 0.46±0.13 and 1.1±0.36 µg/g Pb, respectively, assuming 0.15±0.01 µg/g in the BSE.