Goldschmidt 2024 Abstract
https://doi.org/10.46247/gold2024.23711

Mantle Water–Iron Coevolution

JUNJIE DONG[1], LARS STIXRUDE[2] AND PAUL D. ASIMOW[1]

[1]California Institute of Technology
[2]University of California Los Angeles
Presenting Author: junjiedong@g.harvard.edu

We present a new view on how water and iron co-evolve in the Earth's interior, influencing both the oxidation state of the mantle and the size of the surface oceans. We first quantify the iron disproportionation reaction ($3\ Fe^{2+} = 2\ Fe^{3+} + Fe^{0}$) occurring in the cooling mantle using the latest version of the thermodynamic code HeFESTo, which for the first time self-consistently describes iron in multiple valence states. [1]. We then calculate the extent to which precipitated metallic iron in the mantle has reacted with subducted water since the Archean. We find that about 3.1×10^{21} kg of metallic iron in the mantle, derived from the iron disproportionation reaction, could have reacted with subducted water to account for the mantle redox evolution recorded in the rock record [2], and that a range of 0.2–0.8 times the mass of Earth's modern oceans has been subducted into the mantle over the past 3 billion years. Furthermore, we find that the Earth's mid-mantle between 500 and 1000 km has likely remained metal saturated with 0.1–0.3% Fe^{0} since its formation, and the presence of such a metal saturated layer acts as a water filter, maintaining a heterogeneous water distribution within a convecting mantle. [1] Stixrude & Lithgow-Bertelloni, *Geophys. J. Int.*, in review. [2] Aulbach & Smart (2023), *Annu. Rev. Earth Planet. Sci.* 51, 521–49.