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Hydrogen in an early magma ocean: Implications for Earth's core composition

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The accretion of planets from primordial materials and their subsequent differentiation to form a core and a mantle are fundamental questions in terrestrial and solar system. Many of the questions about the processes are still open and much debated. Here we present new experiments simulating the earliest conditions of planet accretion by performing molten metal – silicate liquid partitioning experiments between 1 and 5 GPa, and use them to determine an accurate picture of the behaviour of hydrogen during terrestrial core formation. The originality of our approach is to use concentrations of volatile elements (C, H, and S) that are close to those supposed to be during the accretion of the Earth and segregation of its core. The results show that the metal-silicate partition coefficients of hydrogen are within 5×10^{-3} – 9.3×10^{-1} for pressures < 5 GPa, consistent with the experimental studies at similar conditions (e.g. Clesi *et al*., 2018; Malavergne *et al*., 2019). These coefficients are mainly dependent on the chemical composition of the metallic phase, but consistent with interaction parameters of H with C, Si and S (being the lowest for C-rich alloys and the highest for S-rich phases). The final stages of Earth's core formation that involve high pressures and high temperatures conditions, hydrogen seems to be siderophile with > 20. We will discuss our results in the light of all existing data in terms of the partitioning of hydrogen between metal and silicate in an early magma ocean and we will provide strong constraints on the hydrogen content of the Earth's core.

References

Clesi *et al*., (2018) Science Advances, **4**: e1701876.
Malavergne *et al*., (2019) Icarus **321**, 473-485.