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Tracing the origin of volatile elements with core formation experiments and sulfur isotopes

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Volatile elements, (e.g., H, C, N and S), play multiple and significant roles in planetary evolution. However, the mechanism and timing of their arrival on Earth remains unclear.

It is uncertain whether they accreted after core differentiation[1], simultaneously[2], or on the last stages of Earth and core's formation[3],[4]. As there is no general consensus on which is the most realistic model, further research is needed.

Sulfur is a particularly valuable tracer of this process, as it is both, highly siderophile and volatile. Thus, it may partition in Earth's core while it undergoes partial volatilization during magma ocean phases. It has been suggested that the current sulfur isotopic signature of the mantle cannot be explained solely by mixing of extraterrestrial material, raising the question of whether core-mantle equilibration may have played a role forsetting the mantle's isotopic composition[5].

In order to constrain the effect of core-mantle equilibration on the isotopic signature of sulfur, we perform a series of experiments on piston-cylinder and multi-anvil apparatuses at different conditions of pressure, temperature, composition, oxygen fugacity, and experiment duration. Preliminary results suggest that significant sulfur isotope fractionation occur during metal-silicate equilibria. If confirmed with further experiments, the fractionations would suggest that core-mantle differentiation is a viable mechanism to influence the current mantle sulfur isotopes signature. In future work, modelling of Earth's growth will allow discriminating between early versus late addition of sulfur to the differentiating planet.

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