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Iron isotopic fractionation during core formation in large terrestrial planets

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The Fe isotopic compositions of planetary mantles of differentiated inner solar system bodies exhibit a variability of which the origin is debated. The Earth and Moon have heavier-than-chondritic signatures with respect to other planetary bodies (*e.g.* Mars, Vesta) that have chondritic signatures [1]. Several processes could account for this variability, including volatile loss upon giant impacts, accretion with various degrees of nebular and post-nebular Fe loss in planetary building blocks, disproportionation of Fe^{2+} into Fe^{3+} and metallic Fe by bridgmanite crystallisation and deep mantle recycling processes. Core–mantle differentiation, as the largest mass transfer process that occurred on planets, is a potential contributor to Fe isotopic fractionation measured in planetary materials.

Changes in the structure of silicate melts and Fe–Ni alloys may have an effect on the Fe isotopic fractionation factor between them. Due to their different compressibilities, the proportion of Fe^{3+} relative to Fe^{2+} in equilibrium with metallic Fe changes with pressure, and markedly so above 7–8 GPa [2]. However, the Fe isotopic fractionation factor between molten metal and silicate has not been determined for pressures above 7.7 GPa [3], despite the fact that core formation on Earth, Mars and other terrestrial planets is thought to have taken place at significantly higher pressures. In order to quantify the influence of high-pressure core formation on the Fe isotopic variability among the terrestrial planets, we investigated the Fe isotopic fractionation between metal and silicate in the range of 2–17 GPa, and carefully studied the effect of pressure. In detail, these results contribute to clarifying the controls of core formation at high pressure on the variability of the Fe isotopic compositions observed in planetary mantles.

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