Nitrogen isotope fractionation during terrestrial core-mantle separation

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The origin of the material that formed the Earth and the source of water, carbon, and nitrogen on our planet is an important unresolved problem. Several isotopic systems suggest that enstatite chondrites could be the main source of material that formed the Earth, but this view has recently been challenged by silicon isotope data. Here we report experimental results on nitrogen isotope fractionation between coexisting liquid Fe-rich metal and silicate melt at 1.5 to 7.0 GPa and 1600 to 1800 °C. We observe an isotopic fractionation of $\Delta^{15}N^{metal\text{-}silicate} = -3.5 \pm 1.7‰$ and partition coefficient $D_N^{metal/silicate}$ of 1-150. Our data show that the present-day mantle $\delta^{15}N$ value of −5‰ can be derived from an enstatite chondrite composition via terrestrial core-mantle separation. This observation strongly supports the notion that enstatite chondrites were the main component from which Earth formed and likely also a main source of some of the terrestrial volatiles. Moreover, we show that the positive $\delta^{15}N$ values of oceanic island basalts can be explained by the presence of a Fe-rich metal phase in the deep reduced mantle.