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LETTER

Fe-Ni ideality during core formation on Earth

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ABSTRACT

Earth's core is essentially composed of a light-element bearing iron-nickel alloy (Birch 1964). The nickel content in the core has negligible effects on physical properties such as density and compressibility (e.g., Lin et al. 2003; Kantor et al. 2007; Martorell et al. 2013; Badro et al. 2014). This deters any attempt to determine or even estimate the nickel content of the core using seismological models, as in the case of light elements. It was recently proposed that the presence of nickel should fractionate iron isotopes in small planetary cores (Elardo and Shahar 2017), but the effect for a large (hot) planet such as the Earth would not be measurable; this observation, however, opens up the possibility that Ni can have an effect on element partitioning between the metallic alloy and the silicate melt during core formation. In this case, the siderophile trace-element composition of the mantle would, in turn, constrain the Fe/Ni ratio in the core. Here, we investigated the effect of nickel concentration in the metallic alloy on the partitioning of other elements at conditions directly relevant to core formation, using the laser-heated diamond-anvil cell. We found no measurable effect of nickel concentration on the partitioning of Ni, Cr, and V; the Fe-Ni alloy is chemically ideal over a broad range of Ni concentrations (3.5 to 48.7 wt%). The ideality of the Fe-Ni solution across a wide range of nickel concentration shows that Fe and Ni are not only twins from the standpoint for material properties, but also from that of chemical properties in those high *P-T* conditions.

Keywords: Fe-Ni "ideality", core formation, metal-silicate partitioning, high pressure