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LETTER

The stability of Fe_5O_6 and Fe_4O_5 at high pressure and temperature

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ABSTRACT

The oxygen fugacity in the interior of the Earth is largely controlled by iron-bearing minerals. Recent studies have reported various iron oxides with chemical compositions between FeO and Fe_3O_4 above ~10 GPa. However, the stabilities of these high-pressure iron oxides remain mostly uninvestigated. In this study, we performed in situ X-ray diffraction (XRD) measurements in a laser-heated diamond-anvil cell (DAC) to determine the phase relations in both Fe_5O_6 and Fe_4O_5 bulk compositions to 61 GPa and to 2720 K. The results show that Fe_5O_6 is a high-temperature phase stable above 1600 K and ~10 GPa, while FeO + Fe_4O_5 are formed at relatively low temperatures. We observed the decomposition of Fe_5O_6 into 2FeO + Fe_3O_4 above 38 GPa and the decomposition of Fe_4O_5 into FeO + h-Fe_3O_4 at a similar pressure range. The coexistence of FeO and Fe_3O_4 indicates that none of the recently discovered compounds between FeO and Fe_3O_4 (i.e., Fe_5O_6, Fe_9O_{11}, Fe_4O_5, and Fe_7O_9) are formed beyond ~40 GPa at 1800 K, corresponding to conditions in the shallow lower mantle. Additionally, as some superdeep diamonds have genetic links with these high-pressure iron oxides, our results give constraints on pressure and temperature conditions of their formation.

Keywords: Iron oxide, diamond-anvil cell, high pressure, Fe_4O_5, Fe_5O_6; Volatile Elements in Differentiated Planetary Interiors