

LETTER

**The stability of  $\text{Fe}_5\text{O}_6$  and  $\text{Fe}_4\text{O}_5$  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  $\text{Fe}_3\text{O}_4$  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  $\text{Fe}_5\text{O}_6$  and  $\text{Fe}_4\text{O}_5$  bulk compositions to 61 GPa and to 2720 K. The results show that  $\text{Fe}_5\text{O}_6$  is a high-temperature phase stable above 1600 K and ~10 GPa, while FeO +  $\text{Fe}_4\text{O}_5$  are formed at relatively low temperatures. We observed the decomposition of  $\text{Fe}_5\text{O}_6$  into  $2\text{FeO} + \text{Fe}_3\text{O}_4$  above 38 GPa and the decomposition of  $\text{Fe}_4\text{O}_5$  into FeO + h- $\text{Fe}_3\text{O}_4$  at a similar pressure range. The coexistence of FeO and  $\text{Fe}_3\text{O}_4$  indicates that none of the recently discovered compounds between FeO and  $\text{Fe}_3\text{O}_4$  (i.e.,  $\text{Fe}_5\text{O}_6$ ,  $\text{Fe}_9\text{O}_{11}$ ,  $\text{Fe}_4\text{O}_5$ , and  $\text{Fe}_7\text{O}_9$ ) 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,  $\text{Fe}_4\text{O}_5$ ,  $\text{Fe}_5\text{O}_6$ ; Volatile Elements in Differentiated Planetary Interiors