

Stability of the high pressure phase Fe_3S_2 up to 175 GPa in the Fe-S-O system

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ABSTRACT

Earth's core is comprised of an iron-nickel alloy that contains 5-15% of a light element component. The siderophile nature of sulfur and large abundance of oxygen in the bulk Earth make them important alloying candidates; therefore, the high-pressure subsolidus phase equilibria of the Fe-FeS-FeO system are important for understanding the possible chemistry of the inner core as well as the first order chemistry of the liquid outer core. Previously, a Fe_3S_2 phase was recognized as a low-pressure intermediate phase in the Fe-FeS system that is stable from 14-21 GPa, but the structure of this phase has not been resolved. We report *in-situ* XRD and chemical analysis of recovered Fe-S-O samples to further examine the stability and structure of Fe_3S_2 as it coexists with other phases in the Fe-S-O system.

In situ high P - T synchrotron XRD experiments were conducted in the laser-heated diamond anvil cell to analyze the equilibrium phases in Fe-S-O compositions between 30 and 175 GPa and up to 2500 K. Up to at least 60 GPa, an orthorhombic Fe_3S_2 phase ($Pmmm$ Laue class) coexists with other phases at lower temperatures, whereas at higher temperatures the stable assemblage becomes Fe_3S , B1-FeO and hcp Fe. With increasing pressure and oxygen content, the Fe_3S_2 phase becomes stable to higher temperatures. Therefore, it may be more stable in oxygen-rich compositions, indicating a possible $\text{Fe}_3(\text{S},\text{O})_2$ solid solution. Chemical analysis of laser-heated samples recovered from 40 GPa and 2000 K using a FIB/SEM confirm that Fe, Fe_3S , and FeO are the equilibrium stoichiometries at these conditions. However, between 80 and 175 GPa, the $\text{Fe}_3(\text{S},\text{O})_2$ phase undergoes a monoclinic distortion and is still present in the XRD data up to 2500 K. The stability of this phase with increasing pressure and oxygen content suggests that it could be present in Fe, S, O-rich planetary cores.