

Melting relation of Fe-FeS and Fe-FeS-FeO system at high pressure

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1. Introduction

The Earth's core is supposed to consist of iron-nickel alloy. If core consists of only this alloy, the density of outer core is 10% higher than the calculated density by seismological observation. The density lack is considered to be dissolution of some light elements into outer core (Birch, 1957). Indeed, experimental studies show that some light elements (O, S, H, Si, C) dissolve into the molten iron at high pressure. In those light elements, sulfur is considered to be one of the strong candidates, because sulfur is depleted in the mantle. In these reasons, many studies of Fe-FeS system have been conducted so far. But there are some discrepancies about the experimental results; for example, Usselman (1975) reported that eutectic melting curve (solidus) has positive slope with increasing pressure, in contrast the solidus reported by Fei et al. (1997) has negative slope. In this study, we have conducted melting experiments in the systems of Fe-FeS and Fe-FeS-FeO at pressure range of 7-14 GPa to consider the reason of the difference between two reports.

2. Experimental method

Starting materials are prepared as powders of iron and pyrrhotite in glove box filled by N₂ for avoiding sample oxidization. Sulfur contents of starting materials are 10, 15, 20 and 30 wt.%. MgO and Al₂O₃ were used as capsule materials, and the differences of the effect to the sample are investigated. High-pressure experiments were conducted by ORANGE-2000 and EUDES-700 in Ehime University, and the recovered run products were analyzed by SEM-EDS.

3. Results

Two capsules (MgO and Al₂O₃) showed different effect to the sample. MgO capsule did not oxidize the sample, in contrast Al₂O₃ capsule oxidized the sample. Al₂O₃ capsule may be suitable for experiment including oxygen, though it is difficult to control oxygen content.

Melting experiments were conducted in the temperatures of 800-1500 degree C by 100 degree C at 11.5 GPa. Melting was not observed at 1100 degree C in oxygen free system, but the sample including oxygen has liquid at even 800 degree C. This result in oxygen free system is consistent with Usselman (1975). In Fe-FeS-FeO system, melting temperature is lower than the estimated eutectic temperature between 6 and 15 GPa results reported by Urakawa (1987).

We draw ternary diagram of Fe-FeS-FeO system at 11.5 GPa. As the result, the eutectic composition at 11.5 GPa is more oxygen rich than the suggested eutectic composition from Urakawa (1987). The liquid immiscibility was not observed at this temperature range.

We are going to clarify the melting relations of these two systems in wide pressure and temperature range.