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Pressure effect on excess molar volume of liquid Fe-S

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The excess molar volume of liquid Fe-light element alloys at high pressure represents non-ideality for mixing of end-member components and, therefore, it is very important to estimate the light element contents in the outer core based on the density deficit in the core. Sulfur is considered to be a major candidate of light elements, because it can dissolve into liquid Fe even at low pressure and it is depleted in the crust and mantle relative to the other volatile elements. Previous works (e.g. Poirier, 1994) estimated the light element contents in the core assuming ideal-mixing behavior between iron and light elements, i.e., neglecting their excess volumes. The excess molar volume of liquid Fe-S at 4 GPa was reported to be large and to have a negative value (Nishida et al., 2008). Therefore, if this excess molar volume can be applied at the core condition, the outer core may contain more light elements than the previous estimates. However, pressure effect on the excess molar volume of liquid Fe-S has never been reported.

In this study, we measured the density of liquid Fe-S at 0.5 GPa and 1650 ^{o}C using sink/float method. We fitted the present molar volume assuming Fe-S liquid can be treated as the regular solution. Derived negative excess molar volume of Fe-S at 0.5 GPa and 1650 ^{o}C is larger than that at 4 GPa. The negative excess molar volume of liquid Fe-S decreases with increasing pressure. This result may suggest the excess molar volume of liquid Fe-S at the pressure of the Earth's outer core might be small and negligible.

Keywords: Fe-S, liquid, density, excess molar volume, high pressure