Estimation of maxmum sulfur contents in the Earth's core: Constraint from high-pressure experiments.

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Since observed density of the Earth's core is lighter than that of pure iron, one or more light elements are supposed to be included in the Earth's core. Sulfure is one of the candidates for the major light elements, because of its high solar abundance, ubiquitous presence in iron meteorites, and deficit in the Earth's mantle, etc. (e.g. Rama Murthy and Hall 1972, Poirier 1994). In this study, pressure and volume relations of FeS VI are measured up to 215 GPa, corresponding depth to the middle of the outer core, by laser-annealed diamond anvil experiments. The results could give maximum sulfur contents for explaining the density deficit of the Earth's core.

In situ high-pressure and high-temperature experiments were conducted at BL10XU of SPring-8. Experimental procedure is as follows: compressing the sample to a target pressure, annealing at around 1300 K by a Nd:YLF laser, taking a x-ray diffraction pattern after annealing, and increasing pressure to a next target pressure. Such a procedure was repeatedly performed up to about 215 GPa. MgO powder was used as a pressure medium. It also worked as a thermal insulator and a pressure standard (Speziale et al. 2001). FeS VI is stable at least up to about 170 GPa and 1300 K. Although some new peaks appeared at more than 170 GPa, FeS VI peaks were still clearly observed together. So pressure-volume relations of FeS VI were measured up to 215 GPa. Fitting parameters are P_r = 36.0 +/-1.7 GPa, K_r = 306 +/-17 GPa, K'_r = 3.81 +/-0.28 with V_r = 12.615 cm^3/mol by the third order modified Birch-Murnaghan equations of states (Sata et al. 2002).

If it is assumed that the Earth's core is included iron and sulfur only, sulfur contents in the core can be estimated compare to density of the Earth's core (PREM, Dziwonski and Anderson, 1981) and pure iron (Dubrovinsky et al, 2000). First, density difference between the PREM and pure iron was calculated at a geothermal model. Second, density difference between $Fe_{1-x}S_x$ (x atm % sulfur) and pure iron was calculated at room temperature. Sulfur contents (x) were estimated by comparing the two calculated differences. Density of the outer core and the inner core was explained by presence of about 20 atmic % sulfur and about 10 atm % sulfur, respectively. Included errors and applications will be discussed in the meeting.

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