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Phase relation of Mercury's interior

Miho Ishii[1*], Eiji Ohtani[1], Hidenori Terasaki[1], Konstantin Litasov[1]

[1]Graduate School of Science, Tohoku Univ.

Mercury, the innermost planet of the solar system, is proved that it is constructed of a large metallic core and thin silicate mantle. Some compositional and mineralogical models of Mercury's silicate mantle are proved in previous works (e.g., Morgan and Anders, 1980; Verhoeven et al., 20 09). However, these previous works of the Mercurian mantle have been investigated by thermodynamic calculation and experimental approach has never been performed. In this study, phase relation experiments were perfomed in the ranges of 4 - 10 GPa and 1500 °C in order to understand the structure of the Mercury's mantle. High pressure experiments were conducted using multi-anvil apparatus. A starting material was synthesized metal-rich chondrite, which is proposed as a bulk composition of Mercury (Taylor and Scott, 2005). Graphite was used as sample capsule. The recovered samples were analyzed using SEM-EDS.

In phase equilibrium experiments, Olivine (Ol), Clinopyroxene (Cpx), Orthopyroxene (Opx), and Garnet (Gt) were observed under all of the experimental conditions. Based on observed mineral phases and their compositions, mass balance calculations were performed to obtain the mineral proportions. Amount of Ol was almost constant, and those of Cpx and Gt increased, and that Opx decreased with increasing pressure. These tendencies can be interpreted by the effect of pressure on the amounts of Ca and Al in each phase. These mineral proportions based in the present experimental study provide the information of Mercury's mantle structure. These results are different from mineral proportions based on thermodynamic calculations (Verhoeven et al., 2009). However, the redox condition of Mercurian interior is considered to be more reducing than the present experiments.

Keywords: Mercury, mantle