Determination of the noble gas partition coefficients between metal-silicate melts under high-pressure and high-temperature conditions

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Analyses of ocean island basalts reveal a geochemical reservoir characterized by unradiogenic, "primordial" noble gas signatures (e.g., high $^{3}He/^{4}He$ and low $^{40}Ar/^{36}Ar$ ratios), likely residing in the deep mantle. There has been much debate about the area holding the "primordial" noble gases deep in the Earth[1], including that the "primordial" noble gasses have been retained in the deepest region of the mantle since 4.4 Ga[2], or in the core since the core-mantle separation[3,4]. However, the validity of latter strongly depends on the quantity of noble gases the core incorporates during accretion and can hold in the present day.

In order to investigate noble gas partitioning behavior between the core and mantle, noble gases were dissolved into metal-silicate melts under high temperature and pressure conditions, and then the samples were quenched, recovered, and analyzed for noble gas concentrations. Noble-gas (He, Ne, Ar, Kr, and Xe) doped silicate glass and iron were melted and equilibrated under high pressure and temperature (3-6 GPa, 1700 and 1800 °C) using a multianvil apparatus at Ehime University. The noble gases in the silicate phase were extracted by an ultraviolet laser ablation apparatus and analyzed using a noble gas mass spectrometer at the University of Tokyo.

Preliminary results show that noble gas partition coefficients D, where D = (noble gas in metal phase)/(noble gas in silicate phase), for Ne, Ar, Kr, and Xe at 8 GPa range from 10^{-4} to 10^{-3}, which is consistent with a previous work [5]. We will extend the pressure range up to 30 GPa, with which the elemental partition between iron and silicate melt would have occurred during core formation [6].

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