Japan Geoscience Union Meeting 2010
(May 23-28 2010 at Makuhari, Chiba, Japan)

MIS010-08 Room: 303 Time: May 23 11:00-11:15

Second Critical Endpoint in the System Peridotite-CO2-H2O

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Under high pressure and temperature conditions, it is known that aqueous fluid and hydrous silicate melt become completely miscible and form supercritical fluid in the system peridotite-H2O [Mibe et al., 2007 JGR]. Because some amounts of CO2 are thought to be present in the Earth's interior, it is important to clarify the effect of CO2 on the second critical endpoint in the system peridotite-CO2-H2O in order to understand the magmatism and mass transport in the Earth's mantle.

Experiments were conducted using X-ray radiography technique together with Kawai-type double -stage multi-anvil high pressure apparatus (SPEED-1500) installed at SPring-8, Japan. Direct X-ray beam, which passes through the anvil gaps of SPEED-1500 and sample under high pressure, is observed with an X-ray camera. We used a sample container which is composed of a AuPd tube and a pair of single crystal diamond lids put on both ends of AuPd tube. The sample was prepared by mixing hydroxides, carbonates, silicate glass, and water. The molar ratio of H2O (XH2O = H2 O/(H2O + CO2)) in the starting material is about 0.80 to 0.94. The experimental conditions are at pressures from 2.0 to 4.5 GPa and at temperatures up to about 1400 deg. C. Pressure is applied first, and then temperature is increased.

In the experiments with XH2O = 0.90-0.94, both C-H-O fluid and silicate melt were observed up to about 3.8 GPa. Above 4.0 GPa, however, we could not distinguish two phases in the radiographic images, indicating that C-H-O fluid and silicate melt can coexist up to 3.8 GPa and there is no difference between these two phases above 4.0 GPa. From these observations, it can be concluded that the second critical endpoint in the system peridotite-CO2-H2O with XH2O = 0.90-0.94 occurs at around 3.9 GPa. In the experiments with more CO2-rich (lower XH2O) compositions, miscibility field between C-H-O fluid and silicate melt seem to still exist at least up to 4.5 GPa.

Our previous results [Mibe et al., 2007 JGR] in the system peridotite-H2O (i.e., CO2-free system) showed that the second critical endpoint occurred at around 3.8 GPa. Therefore, it is revealed that the addition of CO2 in the system causes the elevation of the pressure of second critical endpoint in the system peridotite-CO2-H2O.