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

U004-10 Room: 302 Time: May 24 14:15-14:35

On the supercritical fluids in the Earth's upper mantle

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Under high pressure and high temperature conditions, it has been shown that the solubility of both water in silicate melt and silicate in aqueous fluid increases with increasing pressure. As a result, silicate melt and aqueous fluid in the Earth's interior is expected to become supercritical fluid (SCF) and the hydrous solidus of the system can no longer be defined beyond a certain critical condition. This condition is called the second (or upper) critical endpoint and is the point of intersection between the critical curve and hydrous solidus. In order to fully understand the mangmatism and material transport in the Earth's interior, we have been determining the second critical endpoint in the systems with volatile-bearing peridotite and basalt using high pressure and high temperature X-ray radiography.

So far, we have determined the second critical endpoints in the systems peridotite-H2O (3.8 GPa) and basalt-H2O (3.4 GPa). Also, the effect of CO2 on these second critical endpoints has been investigated right now.

Interestingly, the pressures of these second critical endpoints roughly coincides with those of the change in dihedral angles formed by olivine and aqueous fluid from non-wetting below 3-4 GPa to wetting above 3-4 GPa [Mibe et al., 1998, Yoshino et al., 2007]. This suggests that free water in the Earth's upper mantle exists as supercritical fluids which can dissolve large amount of silicate components and yet are highly permeable.