



## **Supercritical behavior in the basalt-H<sub>2</sub>O system: Experimental evidence and consequences for subduction zone metasomatism**

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At crustal pressures, phase relations in natural rock-H<sub>2</sub>O systems involve low density aqueous fluids (supercritical with respect to the endpoint of the H<sub>2</sub>O liquid-vapor curve) and/or high density hydrous melts. The wide miscibility gap between these two liquid phases leads to a dichotomy of mobile phases with quite distinct element solubilities and geochemical signatures. As pressure increases, the fluid-melt miscibility gap closes at ever lower temperatures, until the crest of the miscibility gap intersects the fluid-saturated solidus at its endpoint, leaving a single liquid that has chemical and physical properties continuously evolving with temperature, and which is supercritical with respect to the endpoint of the fluid-saturated solidus. These facts are well known and the principal necessary phase diagrams have been completed at latest with Ricci (1951). The question is then, at what conditions would the endpoint of the solidus be relevant for natural rock compositions. We have experimentally determined this endpoint in a K-free MOR basalt system through measurement of the composition of the liquid phase from a diamond trap including H<sub>2</sub>O-contents (Kessel et al., 2005, EPSL). The experiments constrain 'classical melting' at 4 and 5 GPa but a continuously evolving liquid composition at 6 GPa. The subsolidus assemblage consisted always of omphacitic cpx + grossular-rich garnet + coesite + rutile ± kyanite. Major element compositions of the fluid/melt phase evolve at all pressures from peralkaline, H<sub>2</sub>O-rich, 'granitic' compositions to metaluminous, 'andesitic' to basaltic compositions with increasing temperature. Locating the endpoint of the fluid-saturated solidus between 5 and 6 GPa, and just above 1000 °C indicates that at higher pressures, the dichotomy of fluid versus melt ceases to exist in the oceanic crust.

The consequences of the solidus' endpoint on the trace element characteristics of the metasomatizing agents emanating from the subducted oceanic crust produced by the breakdown of hydrous phases or by fluxing with H<sub>2</sub>O-rich fluids originating from dehydration of the underlying serpentinites were investigated by measuring trace element partitioning between cpx, gar and liquid, the latter either being an aqueous fluid, a hydrous melt, or a supercritical liquid. Hydrous melts and supercritical liquids (the latter down to at least 200 °C below the hypothetical extension of the solidus) are almost indistinguishable in their trace element pattern, in particular, both have bulk  $D_{Th}^{solid/liquid} > D_u^{solid/liquid}$ , the mobility of Th and Be is even increased in the supercritical liquid (Kessel et al, 2005, Nature). Thus, recycling rates of these elements are not indicative of melting, and in the fast and steep circum-pacific subduction zones, they most likely testify for production of a mobile phase from the subducting crust in the supercritical liquid regime (beyond the endpoint of the solidus), i.e. at pressure in excess of 5 GPa corresponding to depth of 160km.