Clarification of the influence of water on mantle wedge melting

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The location of a region of water-saturated mantle melting can be predicted if we know the P-T dependence of the water-saturated peridotite solidus and can model the temperature distribution in a particular subduction setting. A number of experimental studies in the 1970s defined the P-T conditions for the water-saturated solidus of lherzolite. A new experimental study by Grove et al. [1] suggests major revision of earlier work ([2] and references therein). This new work locates the water-saturated lherzolite solidus with a negative $\delta T/\delta P$ to 3.5 GPa, 800°C, from which point the solidus increases with pressure to 840°C at 5GPa. Additional major differences in the new work are the presence of chlorite as a subsolidus and above-solidus phase from 2 GPa to 3.2 GPa and the restriction of pargasitic amphibole to pressures <2 GPa, compared with 3GPa found in earlier work.

We reproduced the observations of Grove et al. (2006) with 14.5% H_2O but demonstrate that glass observed in the experimental charges below 1000°C is quenched from a water-rich fluid phase. By varying the water content of the charge we are able to differentiate between fluid-saturated silicate melt and the coexisting water-rich fluid-phase for water contents in the peridotite between 0.073% and 14.5% H_2O. Pargasite is stable to 3GPa at 1000°C with low water contents (2.9%, 1.45%, 0.145% and 0.073% H_2O) and at this P and T has a modal abundance of 3-5% of the peridotite. Pargasite is destabilised at higher water contents of 14.5% and 7.25% as sodium and potassium enter the fluid rather than the crystalline phases. At 2.5GPa coexisting melt and fluid have ~25% and ~80% by wt of H_2O respectively. We demonstrate that the fluid-saturated solidus of the lherzolite model mantle composition is at 1000°C<T<1025°C at 2.5 GPa and 1200°C<T<1225°C at 4 GPa. The second critical end point for this composition must lie at > 4 GPa. The near-solidus melt at 2.5 GPa. is a very silica-undersaturated olivine nephelinite.

[1] Grove, T.L., Chatterjee, Parman, and Medard, (2006) *EPSL* **249**, 74-89. [2] Green, D. H. (1976) *Canadian Mineral.* **14**, 255-268.

Role of electrochemical reactions in pressure solution

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We have measured changes in the electrical potential difference between quartz and mica surfaces that correlate with the changing quartz dissolution rate when surfaces are pressed together at relatively low pressures (2-3 atm) in aqueous electrolyte solutions using a Surface Force Apparatus. No detectable dissolution or voltage potential is measured in symmetrical systems (e.g. mica-mica or quartz-quartz) indicating that the dissolution can not be attributed to a simple pressure effect. The origin of the electrical potential is interpreted as overlapping of the double layers of dissimilar surfaces when they are forced into close proximity in electrolyte solution. This electrical potential, for as yet unknown reasons, appears to be the driving force for the dissolution, rather than pressure.