Experimental Investigation of Water Solubility in Arc Magmas at Upper Mantle Conditions

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It is generally accepted that partial melting of peridotite is initiated at the base of the mantle wedge by an influx of volatiles (primarily H_2O) from the subducted oceanic lithosphere. However, it remains unclear whether these volatiles are transported into the mantle wedge by an aqueous fluid, a hydrous silicate melt, a supercritical phase, or some combination thereof. The solubility of water in basaltic silicate liquids at upper mantle conditions is an important constraint on the transport of water within the mantle wedge. Previous experimental data for natural compositions were limited to low pressure due to the difficulty of quenching very hydrous glasses from high pressure experiments. As a solution to this problem we have made SIMS measurements of the water content of olivine in equilibrium with basaltic liquid for a series of melting experiments at 1200°C, 10 kilobars where between 0 and 40 wt % H_2O was added to the starting basalt composition. The experimental results show that the H_2O content of olivine increases linearly up to 30 wt % H_2O, at which point the H_2O content of olivine crystals are within error of the fluid saturated solubility of H_2O in olivine. This observation suggests that the solubility of H_2O in basaltic liquid is 30 wt % H_2O, roughly twice the solubility predicted by empirical models of H_2O solubility calibrated from low pressure experiments.

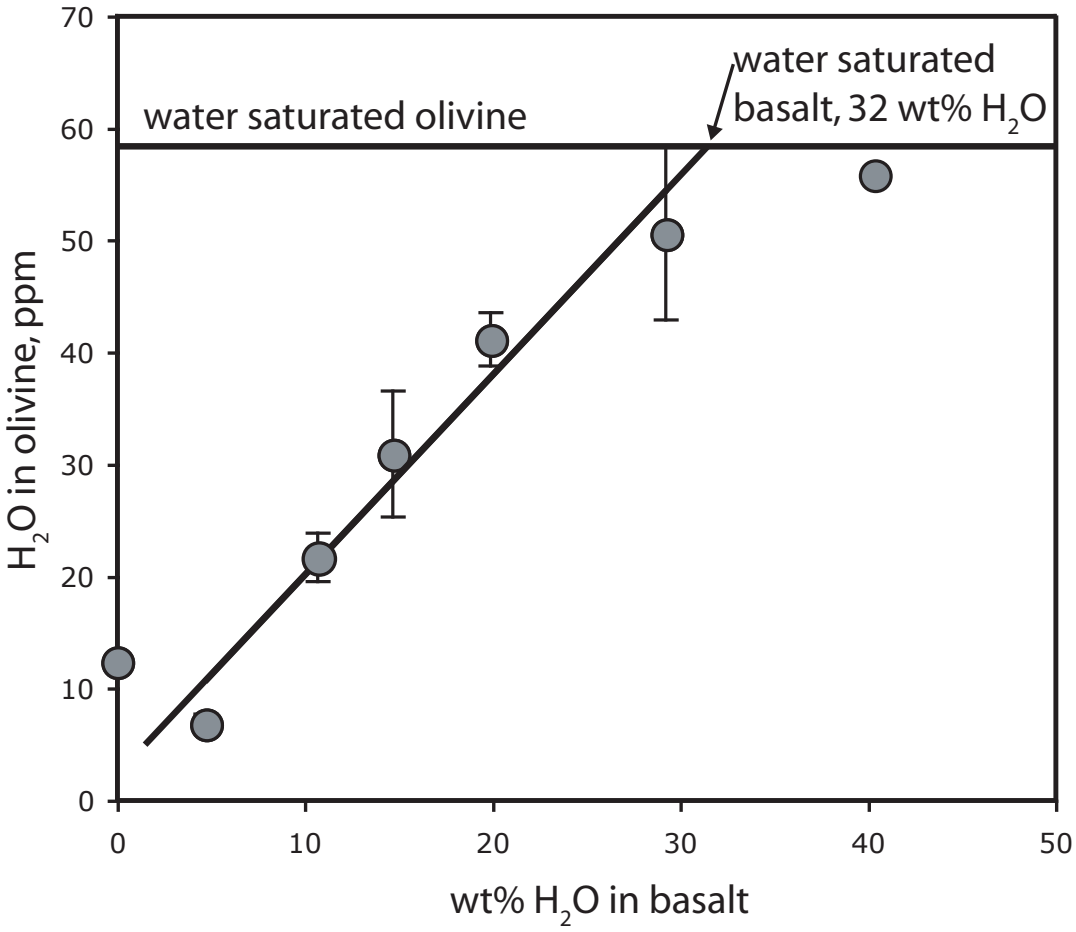

Figure: H_2O in olivine versus H_2O in basaltic liquid from hydrous melting experiments. H_2O in olivine increases linearly up to the water saturated solubility for olivine, indicating that solubility of H_2O in basaltic liquid at 1 kbar is 30 wt% H_2O.