H_2O Partitoning Between Mantle Minerals and Silicate Melts

Awards: 03-52013 (March 2004) MARGINS-Related

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The water contents of mantle melts can be modelled provided we have accurate data on the partitioning of water between common upper-mantle minerals and silicate melts. In addition to modelling mantle melts, the initial water content of natural degassed arc magmas can be estimated by measuring the water content of clinopyroxene phenocrysts in arc lavas, and dividing by an appropriate cpx-melt partition coefficient. To this end, we have been engaged in an experimental study of H_2O partitioning between nominally anhydrous minerals and silicate melts, with H_2O contents in all phases measured by ion probe. Previous experimental results have shown that the clinopyroxene/melt partition coefficients for H_2O vary as a function of tetrahedral Al content due to a coupled substitution of H^+ and Al^{3+} for Si^{4+} in clinopyroxene. OH^- can also be accomodated in the clinopyroxene structure by Mg^{2+} vacencies, a substitution mechanism that is likely important in low-pressure clinopyroxene phenocrysts in arc lavas. Clinopyroxene/liquid H_2O partition coefficients were measured for high pressure melting experiments for a Al free synthetic basalt composition. The experimental results indicate that the capacity of clinopyroxene to incorporate hydroxyl in the absence of Al is limited to ~200 ppm. For the same concentration of water dissolved in the melt, the water content of aluminum-bearing clinopyroxene is ~500 ppm. The partition coefficients for Al free samples are higher than estimates calculated from H_2O solubility data for clinopyroxene and basaltic liquid, allowing more accurate calculations of the undegassed water content of arc magmas.

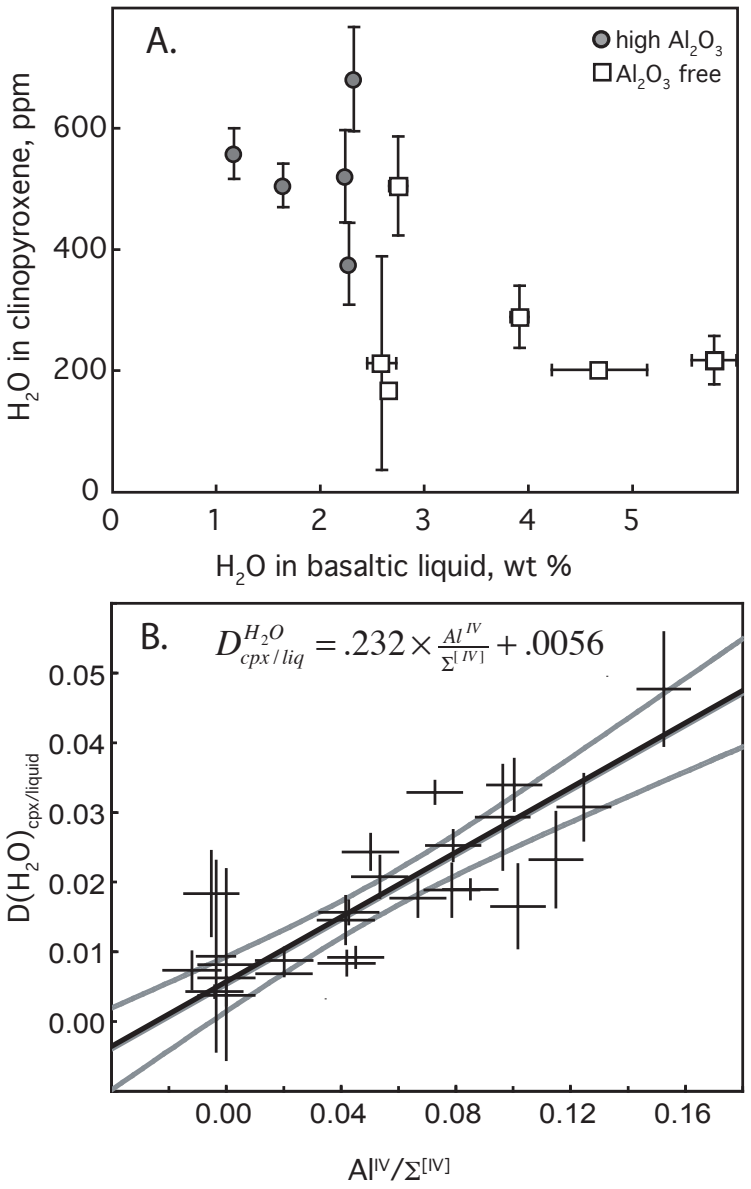

Figure: (A) Clinopyroxene water contents vs. water content of coexisting melt from H_2O-bearing melting experiments with low and high Al_2O_3 content. Constant water content in Al_2O_3 free clinopyroxene indicates saturation of 2 $OH^- = Mg^{2+}$ vacancy substitutions. (B) Clinopyroxene-liquid H_2O partition coefficients as a function of tetrahedral Al content including data from Hauri et al. (2006), Aubaud et al. (2004).

Partitioning of water during melting of the Earth's upper mantle at H_2O-undersaturated conditions Erik H. Hauri , Glenn A. Gaetani , Trevor H. Green Earth and Planetary Science Letters 248 (2006) 715-734

Hydrogen partition coefficients between nominally anhydrous minerals and basaltic melts Cyril Aubaud, Erik H. Hauri, and Marc M. Hirschmann Geophysical Research Letters, Vol. 31, L20611, doi:10.1029/2004GL021341, 2004