Partitioning of H_2O between mantle minerals and silicate melts

E.H. HAURI[1], G.A.GAETANI[2] AND T.H. GREEN[3]

[1] DTM, Carnegie Institution of Washington, Washington DC, 20015 USA (hauri@dtm.ciw.edu) [2] Woods Hole Oceanographic Institution, Woods Hole, MA USA (ggaetani@whoi.edu) [3] Macquarie University, N.S.W., Australia (tgreen@els.mq.edu.au)

We present initial data from the first systematic study of the partitioning of water between common upper mantle minerals (olivine, pyroxenes, garnet, amphibole, mica) and hydrous silicate melt. This study takes advantage of new SIMS techniques for measuring the abundance of water in nominally anhydrous minerals [1]. To date we have made 361 measurements in 23 experiments [2-4] from 1-4 GPa , 1000-1380 C and melt water contents of 1-22wt% total H_2O. Detection limit for H_2O was 1-4 ppmw.

Partition coefficients were calculated as wt% H_2O in the mineral divided by total wt% H_2O in the glass. Partitioning of water between all minerals and silicate melt appears to be independent of pressure, temperature, and total water content over the range of conditions stu.died. Mineral/glass partition coefficients for olivine (0.00125), orthopyroxene (0.0145), clinopyroxene (0.0139), garnet (0.00316), amphibole (0.160) and mica (0.496) are reproducible between different experiments to within 30-40%. Experiments multiply-saturated with an upper mantle mineral assemblage (ol + opx + cpx ± spinel ± garnet) reproduce opx/olivine (11.6), cpx/olivine (11.1) and garnet/olivine (2.5) partitioning to within 20%.

Water is thus confirmed as a highly incompatible element during upper mantle melting, but amphibole and mica will increase the bulk D for H_2O significantly. A fertile upper mantle peridotite mineralogy (56% ol, 28% opx, 14% cpx, 2% sp) will have a bulk solid/melt $D(H_2O)$ of ~0.007, and this value will change more slowly with %F than D(Ce) as clinopyroxene is consumed during melting. Bulk $D(H_2O)$ is lower for fertile garnet lherzolite, in much the same way as for Ce. The lack of variation of $D(H_2O)$ with melt water content is not predicted by H speciation observed in glasses, but is consistent with T-dependence of water speciation [5]. This observation indicates that water speciation in basaltic melts is likely dominated by OH^- radicals under the conditions of our experiments.

References

[1] Koga, K. et al. (2003) *G-cubed* doi:2002GC000378.
[2] Gaetani, G.A. and Grove, T.L. (1998) *Contrib.Mineral. Petrol.* **131**: 323-346.
[3] Adam, J. and Green, T.H. (1994) *Chem. Geol.* **117**, 219-233.
[4] Green, T.H. et al. (2000) *Lithos* **53** 165-187.
[5] Ihinger, P. et al. (1999) *G.C.A.* **63,** 3567-3578.