A new experimental method for determining cpx/melt trace element partitioning during peridotite melting

M. Lo Cascio[1], Y. Liang[1] and N. Shimizu[2]

[1]Dept. of Geological Sciences, Brown University, Providence, RI 02912 (mauro@brown.edu, Yan_Liang@brown.edu)
[2]Geology and Geophysics, Whoods Hole Oceanographic Istitute, Woods Hole, MA 02543 (nshimizu@whoi.edu)

Theoretical and experimental studies have shown that, at constant *P-T*, solid-solution forming minerals are likely to undergo dissolution and reprecipitation during partial melting [1-2]. Reprecipitation significantly accelerates the rate of crystal-melt reequilibration, and hence trace element distribution and partition during partial melting [1]. To understand the effect of dissolution and reprecipitation on trace element partitioning during peridotite partial melting, we performed a partial melting experiment at 1340°C and 1.5 GPa using a new experimental setup where pre-synthesized rods of clinopyroxenite (Mg# 92) and orthopyroxenite (Mg# 91) where juxtaposed against each other in a graphite-lined Pt-Mo capsule [2]. As discussed in [2], this new set up is an analogue to peridotite bulk melting experiments, since reaction between the clinopyroxenite and orthopyroxenite creates a reactive boundary layer (RBL) that consists of olivine (Mg# 91), new cpx (Mg# 91) and large melt pockets (Mg# 71). The new cpx (up to ~80 µm in size) in the RBL, produced by dissolution-reprecipitation during melting, has lower wollastonite (Wo) and Ca-Tsch content (0.155 and 0.025) than the unreacted cpx (0.307 and 0.061) within the clinopyroxenite. This is very similar to the cpx rim to core variations observed in bulk peridotite partial melting studies. The REE abundance in coexisting new cpx and melt in the RBL were measured using an ion microprobe. The apparent cpx/melt partition coefficients (Kd) for REE were then calculated (0.015 for La, 0.103 for Sm, 0.264 for Yb). Our measured Kd are consistent with the data of [3] but lower than the recently published values for mantle melting ([4] and references therein). This is mainly due to the low Wo and Ca-Tsch content of our new cpx as compared to previous studies. This implies that constraints on mantle melting models based on previous data, such as degree of melting or composition of the source, might have to be reconsidered.

References

[1] Liang (2003) *G-cubed, 4,* doi:10.1029/2002GC000375
[2] Lo Cascio M., Liang Y., and Hess P.C. (2004) G*eophys. Res. Lett., 31,* doi: 10.1029/2004GL020602
[3] MacKay et al. (1986) *Gechim. Cosmochim. Acta, 50,* 927-937
[4] Gaetani G. (2004) *Contrib Mineral Petrol, 147*, 511-527

The solubility of quartz in chloride solutions at 400°-800°c and 0.1-0.9 GPa

K.I. Shmulovich[1], B.W.D. Yardley[2] and C.M. Graham[3]

[1]IEM, Russian Academy of Sciences, 142432 Chernogolovka, Moscow district, Russia; (kshmulovich@pochta.ru)
[2]School of Earth Sciences, University of Leeds, Leeds LS2 9JT, UK; (bruce@earth.leeds.ac.uk)
[3]School of Geosciences, University of Edinburgh, West Mains Road, Edinburgh EH9 3JW, UK; (Colin.Graham@ed.ac.uk)

We have measured quartz solubility, using a single crystal weight loss technique, in aqueous solutions of NaCl, $CaCl_2$ and CsCl over a wide range of crustal conditions, and in many other types of chloride over more restricted conditions. In addition, experiments have been carried out in H_2O-CO_2 and in ternary H_2O-CO_2-NaCl fluids.

At low-P, high-T conditions many salts enhance quartz solubility at low salt concentrations (salt-in effect), although solubility falls at higher salinities. Over most crustal conditions, most salts produce a salt-out effect. The salt-in effect is most readily produced by CsCl, while $CaCl_2$ only produced a salt-in effect at the most extreme conditions investigated (800°C at 0.2 GPa).

Quartz solubility measurements have been fitted to a Setchenow-type equation, modified to take account of the separate effects of the lowering of X_{H_2O}, common to all the systems, and the specific effects of different salts. X_{H_2O} has been calculated assuming all salts are fully associated under all conditions. Salt-in effects are treated as arising through non-ideal behaviour resulting from the effects of salts on water density, rather than the formation of additional silica complexes. Quartz solubility in $H_2O - CO_2$ fluids is almost as ideal, with a solvation number of 3.5. Hence solubility (S) relates to that in pure water (S^o) by:

$$\log S = \log S^o + 3.5 \log X_{H_2O}$$

Quartz solubility in binary salt systems ($H_2O - RCl_n$) can be fitted to the relationship:

$$\log S = \log S^o + 3.5 \log X_{H_2O} + a(mRCl_n)^b$$

where the exponent b has a value of 1 except under conditions where salting-in is observed at low salt concentrations, in which case it is <1. Under most crustal conditions, the solubility of quartz in H_2O-CO_2-NaCl fluids is given to a good approximation by:

$$\log S = \log S^o + 3.5 \log X_{H_2O} + 0.01\ mNaCl$$