Water solubility in haplogranitic melts coexisting with H_2O-H_2 and H_2O-CO_2 fluids

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The water solubility in haplogranitic melts (normative composition $Ab_{39}Or_{32}Qz_{29}$ labelled AOQ) coexisting with H_2O-H_2 fluids at 800 and 950° C at 1, 2 and 3 kbar vapour pressure has been determined using IR spectroscopy. The experiments were performed in internally heated pressure vessels and the hydrogen fugacity (f_{H_2}) was controlled by oxygen buffer assemblages (WM and IW) using the double capsule technique. The limited lifetimes of these oxygen buffers allow only short duration experiments to be performed (< 3 hours) and equilibrium between initially dry glass blocks and the water of the H_2O-H_2 fluid phase can not be attained. Therefore, water solubility was determined from diffusion profiles
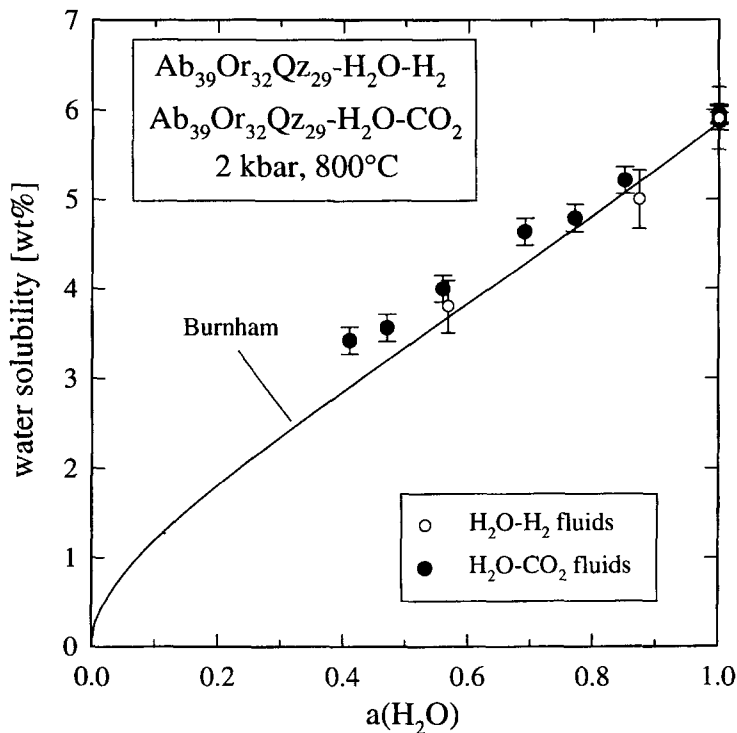

FIG. 1. Water solubility in a haplogranitic melt in equilibrium with H_2O-H_2 and H_2O-CO_2 fluids. The water activities $a(H_2O)$ were calculated using Modified-Redlich-Kwong equations (Kerrick and Jacobs 1981, Grevel and Chatterjee 1992).

(concentration-distance profiles) measured with NIR spectroscopy. The reliability of this experimental strategy could be demonstrated for water saturated conditions with equilibration (long duration) experiments.

The solubility of H_2O in the haplogranitic melt coexisting with H_2O-CO_2 fluids was investigated at temperatures of 800°C and 1100°C and pressures of 2 und 5 kbar. Single glass pieces were sealed with bidistilled water and $Ag_2C_2O_4$ (at 800°C) or $H_2C_2O_4$ (at 1100°C) in Au or Pt capsules. In order to bracket the water solubility both dry and hydrous glasses were used as starting materials. Thus, equilibrium is attained either by in-diffusion or out-diffusion of water in the melt. Both types of starting materials gave identical results implying that the water contents of the run products are close to the equilibrium solubility. Experiments were carried out in cold seal pressure vessels (at 800°C) and internally heated pressure vessels (at 1100°C) for 70 to 480 h depending on temperature. Fluid compositions were determined gravimetrically by measuring the weight loss of the capsules after piercing and after subsequently heating at 60 - 100°C. Water contents of the glasses were measured by Karl-Fischer titration and/or NIR spectroscopy. Crystallisation of alkali feldspars in the melt was observed at 800°C for water activity (a_{H_2O}) in the fluid phase #0.45 at 2 kbar and for #0.40 at 5 kbar.

Our results for mixed fluids (H_2O-H_2 and H_2O-CO_2) show that the water solubility decreases continuously with decreasing water activity in the fluid phase. H_2 and CO_2 have similar effects on the evolution of the water solubility as a function of the fluid composition. It is emphasised that the solubility of pure H_2 and pure CO_2 is more than one order of magnitude smaller than the solubility of pure H_2O. Thus dissolution of both components (H_2 and CO_2) only can have a small effect on the solubility of H_2O in the melt. The similarity of the water activity vs. water solubility curves implies that the deviation from ideality is comparable for H_2O-H_2 and H_2O-CO_2 fluids at experimental conditions in agreement with calculations (Kerrick and Jacobs 1981, Grevel and Chatterjee 1992).

The general shape of the water solubility vs. water activity curve at 800°C and 2 kbar is in a good agreement with the revised Burnham model (Burnham 1975, 1994). However, the experimental values are systematically higher than the calculated values at water activities below 0.75. At 800°C and 5 kbar the experimental data are not well reproduced by calculations after Burnham (1975, 1994).

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