

Solubility of H₂O and CO₂ in ultrapotassic melts at 1200 and 1250 °C and pressure from 50 to 500 MPa

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ABSTRACT

The solubility of H₂O-CO₂ fluids in a synthetic analogue of a phono-tephritic lava composition from Alban Hills (Central Italy) was experimentally determined from 50 to 500 MPa, at 1200 and 1250 °C. Contents of H₂O and CO₂ in experimental glasses were determined by bulk-analytical methods and FTIR spectroscopy. For the quantification of volatile concentrations by IR spectroscopy, we calibrated the absorption coefficients of water-related and carbon-related bands for phono-tephritic compositions. The determined absorption coefficients are 0.62 ± 0.06 L/(mol·cm) for the band at ~ 4500 cm⁻¹ (OH groups) and 1.02 ± 0.03 L/(mol·cm) for the band at ~ 5200 cm⁻¹ (H₂O molecules). The coefficient for the fundamental OH-stretching vibration at 3550 cm⁻¹ is 63.9 ± 5.4 L/(mol·cm). CO₂ is bound in the phono-tephritic glass as CO₃²⁻ exclusively; its concentration was quantified by the peak height of the doublet near the 1500 cm⁻¹ band with the calibrated absorption coefficient of 308 ± 110 L/(mol·cm). Quench crystals were observed in glasses with water contents exceeding 6 wt% even when using a rapid-quench device, limiting the application of IR spectroscopy for water-rich glasses.

H₂O solubility in the ultrapotassic melts (7.52 wt% K₂O) as a function of pressure is similar to the solubility in basaltic melts up to 400 MPa (~ 8 wt%) but is higher at 500 MPa (up to 10.71 wt%). At 500 MPa and 1200 °C, the CO₂ capacity of the phono-tephritic melt is about 0.82 wt%. The high CO₂ capacity is probably related to the high K₂O content of the melt. At both 200 and 500 MPa, the H₂O solubility shows a non linear dependence on X_{H₂O}^f in the whole X_{H₂O}^f range. The variation of CO₂ solubility with X_{CO₂}^f displays a pronounced convex shape especially at 500 MPa, implying that dissolved H₂O promotes the solubility of CO₂.

Our experimental data on CO₂ solubility indicate that the interaction between phono-tephritic magma and carbonate rocks occurring in the Alban Hills magmatic system may result in partial dissolution of CO₂ from limestone into the magma. However, although the CO₂ solubility in phono-tephritic melts is relatively high compared to that in silicic to basaltic melts, the capacity for assimilation of limestone without degassing is nevertheless limited to <1 wt% at the *P-T* conditions of the magma chamber below Alban Hills.

Keywords: H₂O, CO₂, solubility, ultrapotassic magmas, Alban Hills, infrared spectroscopy