

Argon solubility in H₂O-CO₂ bearing basaltic melts at upper mantle conditions

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The solubility of Ar in H₂O-CO₂ bearing basaltic melts was experimentally determined in the pressure range 1-5 GPa and at temperatures between 1350 and 1600 °C. We used piston-cylinder apparatus (1-3 GPa) and multi-anvil apparatus (5 GPa). The argon concentrations in the quenched glasses were determined with electron microprobe, and the H₂O and CO₂ contents of the run-products were analyzed by FTIR (Fourier Transform Infra-Red spectroscopy). At a pressure of 1 GPa, Ar solubility in the H₂O-CO₂ bearing basaltic melt is not strongly affected by variations of the $X_{\text{H}_2\text{O-CO}_2}$ ratio, defined as the following (wt.% H₂O/18.02)/(wt.% H₂O/18.02 + wt.% CO₂/44.01), with water content varying from ~0.35 to 5 wt.%. At 3 GPa however, it increases linearly with the $X_{\text{H}_2\text{O-CO}_2}$. It is noted that for glasses with comparable water contents, the Ar solubility decreases with increasing their CO₂ contents. By increasing the pressure to 5 GPa, we did not observe any difference in the Ar solubility in the basaltic melt versus water content. The experimental data can be well described by a thermodynamic model assuming mixing of volatile species and oxygen in the silicate melt. By combining the present and literature data an empirical equation that permits to calculate the Ar solubility in volatile-free and volatile-bearing basaltic liquids up to 10 GPa is derived. The equation is able to reproduce 95% of 59 Ar solubility measurements in natural and model basaltic systems within a standard error of ±15%. The above equations can be used to determine the Ar solubility into basaltic melts as a function of pressure up to 10 GPa, corresponding to a depth of about 350 km, and varying H₂O and CO₂ contents.