

Solubility, activity and phase relationships in silicate-H₂O systems: insights from new hydrothermal experimental techniques

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The last decade has seen renewed interest in hydrothermal experimental petrology, particularly with regard to near- or complete miscibility between silicate melts and hydrous fluids at high-P conditions. Inherent quench problems associated with hydrothermal experiments require that rock-H₂O behavior be either directly observed (e.g., hydrothermal diamond-anvil) or solubility relationships at run conditions be preserved (e.g., diamond trap).

This research project has seen the development of a cold-seal, thick-walled 6mm Ag-capsule, suitable for ½" piston cylinder pressure vessels. The cold-seal technique has previously been tried and tested for the various parameters crucial to hydrothermal experiments (e.g., inertness, temperature gradients, H-diffusion and P/T-calibrations). Application of the cold-seal technique has, however, been restricted to 5/8" pressure vessels. In order to approach conditions near the second critical end-point (a position in P-T-X space where the mutual solubility of silicate melts and hydrous fluids become unity), cold-seal experimental runs must be carried out at conditions beyond the 5/8" working range (~25kb). Hence, the ½" pressure vessel design is aimed at addressing rock-H₂O relationships at P-conditions analogous to deeper subduction zone environments (i.e., up to ~45kb).

In addition to extending the cold-seal working range, this research has worked towards developing a technique whereby high-P rock-fluid interaction is monitored by water activity. By combining metal-metal oxide f_{O_2} buffers (e.g., Re-ReO₂) with sliding f_{H_2} sensors (e.g., Ni-Pd noble metal alloy) it is possible to determine the water activity for a given rock-H₂O system. If f_{O_2} within the experimental charge is fixed by a MMO buffer, changes in f_{H_2} (monitored by a H-sensor) reflect changes in a_{H_2O} due to changes in silicate-H₂O solubility.

Finally, this experimental setup may be used to study synthetic, high-P fluid inclusions, while also monitoring phase and trace element systematics with changing P-T-X conditions.