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A combined rapid-quench and H_2-membrane setup for internally heated pressure vessels: Description and application for water solubility in basaltic melts

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ABSTRACT

This study presents improvements of internally heated pressure vessels to realize high-pressure experiments at controlled f_{O_2} in low-viscosity systems such as basaltic ones. The new design is a combination of two experimental techniques: a hydrogen sensor membrane made of platinum to measure f_{H_2}, and therefore f_{O_2}, and a rapid-quench system to avoid crystallization of low-viscosity melts during quench. The experimental setup has been tested successfully at temperatures up to 1250 °C and pressures up to 500 MPa. Basaltic melts containing up to 9.38 wt% water can be quenched as bubble-free and crystal-free glasses. The improvements allow synthesis of hydrated glass or partly crystallized samples with a large volume (for further studies) and to perform routine phase-equilibrium studies in basaltic systems at geologically relevant conditions. We used the new technique to determine the effect of f_{O_2} on water solubility in a melt with MORB composition. The results show that there is a small but significant decrease of water solubility with decreasing f_{O_2} from MnO-Mn_3O_4 to QFM buffer conditions in the pressure range 50–200 MPa. Kinetic problems in crystallization experiments in basaltic systems and the duration necessary to attain equilibrium Fe^{2+}/Fe^{3+} ratio in the charge are discussed.