Low-temperature alkali silicate melt and fluid in the system Na_2O-K_2O-Al_2O_3-SiO_2-H_2O

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We have revisited phase equilibria at the peralkaline, low temperature segment of the feldspar-quartz cotectic in the system SiO_2-Al_2O_3-Na_2O-K_2O-H_2O at pressures up to 1.3 GPa and temperatures up to 800 ^oC using a combination of hydrothermal diamond cell (HDAC), and cold-seal rapid quench experiments. Starting charges were mixtures of synthetic glasses and double-distilled water. HDAC runs were accompanied by *in situ* studies of crystal and liquid phases by confocal laser Raman spectroscopy. Quenched products were analyzed by electron microprobe. In quartz-saturated HDAC runs, frequency shift of the 464 cm^{-1} Raman peak of quartz was used for pressure evaluations [1], in addition to vapour disappearance techniques.

The HDAC experiments were aimed at tracing the key topological elements of the system, such as quartz and feldspar liquidi, melt-fluid bimodal and critical curves. Alkali silicate melt and aqueous fluid in HDAC at T above 450-500 ^oC showed high mutual solubility and very low viscosity. However, the absence of crystals and the formation of water-rich glass (or gel) at high melt fractions and T below 300 ^oC indicated a transition to metastable behaviour. Distinct melt and fluid phases were nevertheless observed in a broad range of P-T conditions from 300 to 800 ^oC, and pressure up to 1.3 GPa implying sub-critical conditions.

Quench runs in cold seal pressure vessels at 0.1 and 0.2 GPa were used primarily for detailed microprobe study of crystals and glass. Incongruent dissolution of starting glasses in aqueous fluid caused the formation of metastable corundum and nepheline. Prolonged run durations of 8-12 weeks resulted in disappearance of corundum, but did not eliminate nepheline from complex intergrowths with orthoclase. Albite was absent from quench products, and did not form in HDAC either. Fluid-saturated glass in equilibrium with quartz and orthoclase (with nepheline inclusions) at 450-600 ^oC and 0.1 GPa contains 68-70 % SiO_2, 9-9.4 % Na_2O, 7 % K_2O, and only 0.4-1 % Al_2O_3 (by weight). Low totals imply 14-16 wt. % of dissolved H_2O.

Our results demonstrate that strongly peralkaline water-bearing alkali silicate melt and highly concentrated alkali silicate aqueous fluid can be generated at T as low as 450 ^oC and P of only 0.1 GPa in equilibrium with quartz and K-feldspar. In nature, similar peralkaline melts and fluids are likely to play important roles in the formation of granitic pegmatites, in crustal anatexis, and in subduction zones.

References

[1] Schmidt C. and Ziemann M.A (2002) *Am. Mineral.* **85,** 1725-1734.