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The effect of temperature and bulk composition on the solution mechanism of phosphorus in peraluminous haplogranitic magma

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ABSTRACT

Solution mechanisms of P in peraluminous glasses and melts in the system CaO-Na_2O-K_2O-Al_2O_3-SiO_2-P_2O_5 have been examined with in-situ microRaman spectroscopy from ambient temperature to near 1200 °C. The principal aim was to examine the relative stabilities of phosphate complexes as functions of P content, peraluminosity, and temperature. Increasing peraluminosity was accomplished by increasing the proportions of Al^{3+} and Ca^{2+} of constant SiO_2 content. The molar ratio Al_2O_3/($CaO+Na_2O+K_2O$) (A/CNK) ranged from ~1 to ~1.3.

In all compositions, P^{5+} is bonded to Al^{3+} to form $AlPO_4$ complexes. In addition, there is evidence for pyrophosphate complexing (P_2O_7). In melts with the highest (Ca+Na+K)/P, there is probably also a small fraction of orthophosphate complexes present. The relative importance of $AlPO_4$-like complexes is correlated positively with peraluminosity (A/CNK), P_2O_5 content, and increasing temperature at temperatures above that of the glass transition. These structural relationships among phosphate complexes are coupled with decreasing polymerization of the aluminosilicate melts.