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Experiments on the stability of cancrinite in the system Na_2O-CaO-Al_2O_3-SiO_2-CO_2-H_2O

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ABSTRACT

The synthesis and upper thermal stability of cancrinite were investigated experimentally in the system Na_2O-CaO-Al_2O_3-SiO_2-CO_2-H_2O at 2 kbar and in the presence of a mixed H_2O-CO_2 fluid. Cancrinite could only be formed under water-rich conditions in this system. The breakdown of cancrinite to nepheline + calcite occurred at decreasing temperatures with increasing X_{CO_2} as expected for a dehydration reaction of the form cancrinite = nepheline + calcite + n_{H_2O}. Partial melting and the formation of melilite was observed at the highest temperatures and for the most H_2O-rich fluid compositions.

The molecular water content of the cancrinite formed at various T-X_{CO_2} conditions was evaluated with a combined infrared (IR)-thermogravimetry (TG) technique. Results suggest (within analytical error) a decrease in the water content of cancrinite toward the breakdown reaction and an apparently constant water content along the breakdown curve. Thermodynamic analysis combining the compositional and phase-equilibrium data from this study was performed and yielded a value of $\Delta H_f^0 = -14722 \pm 147$ kJ and $S^0 = 981 \pm 118$ J/K at 298 K and 1 bar for synthetic cancrinite of the composition $Na_6Ca_{1.5}[Al_6Si_6O_{24}](CO_3)_{1.5} \cdot 1.1(\pm 0.4)H_2O$. This study demonstrates the important role that water plays in controlling the stability of cancrinite in igneous and metamorphic rocks.