

Thermodynamic and structural behavior of analcime–leucite analogue systems

GUY L. HOVIS,^{1,*} JACQUES ROUX,² AND ELIZABETH RODRIGUES³

¹Department of Geology and Environmental Geosciences, Lafayette College, Easton, Pennsylvania 18042, U.S.A.

²ISTO, CNRS-Université d'Orléans, 1A, rue de la Férollerie, 45071 Orléans cedex 2, France

³UFPA–CCEN, Departamento de Química, Rua Augusto Correa no. 1, 66.075-110, Belém, Pará, Brazil

ABSTRACT

Two synthetic solid-solution series, analcime to Rb-leucite and analcime to Cs-leucite (pollucite), have been investigated to understand more fully the thermodynamic and structural behavior of analcime-leucite and similar mineral systems. Unit-cell dimensions and volumes in these series expand with the substitution of analcime component in either Rb-leucite or pollucite, as H₂O molecules structurally replace the smaller entities Rb⁺ or Cs⁺, respectively. Unit-cell volumes vary linearly as functions of composition, but with changing slopes over several segments of compositional space, akin to thermal expansion in K-, Rb-, and Cs-end-member materials studied by previous workers. When symmetry changes displacively from tetragonal to isometric, as in the Rb-bearing series, the slope of volume expansion changes. Once structures have reached full expansion, volume slopes flatten and are little affected by additional analcime component. Enthalpies of solution measured at 50 °C in 20.1 wt% hydrofluoric acid show single-slope linear relationships over the entire compositional ranges of both series. Thus, despite positive volumes of mixing, there are no enthalpies of mixing in either series, nor is there energetic evidence of displacive tetragonal/isometric inversion or the various stages of structural expansion. Overall, the data suggest that the analcime–leucite system also can be modeled as close to thermodynamically ideal. The limited solid solution between natural analcime and leucite must be attributed to energetically favored heterogeneous equilibria involving minerals such as feldspars and other feldspathoids, and not to immiscibility between the end-members.