

Natrolite may not be a “soda-stone” anymore: Structural study of fully K-, Rb-, and Cs-exchanged natrolite

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ABSTRACT

Since its first discovery in nature, natrolite has been largely known as a sodium aluminosilicate zeolite, showing very limited preference toward cation exchange. Here we show that fully K-exchanged natrolite can be prepared from natural Na-natrolite under mild aqueous conditions and used to subsequently produce Rb- and Cs-exchanged natrolites. These cation-exchanged natrolites exhibit successive volume expansions by ca. 10, 15.7, and 18.5% for K-, Rb-, and Cs-forms, respectively, compared to the original Na-natrolite. This constitutes the largest, ever-reported volume expansion via cation substitution observed in zeolites and occurs by converting the elliptical channels into progressively circular ones. The observed cation-dependent changes in the channel volume and shape thus show the flexibility limits of the natrolite framework and suggest the possible existence of compositionally altered analogues in suitable environments as well as a novel means to tailor the cation selectivity of this class of small pore zeolites toward various industrial and environmental applications.

Keywords: Natrolite, ion-exchange, volume expansion, Rietveld refinement