

Natrolite is not a “soda-stone” anymore: Structural study of alkali (Li⁺), alkaline-earth (Ca²⁺, Sr²⁺, Ba²⁺) and heavy metal (Cd²⁺, Pb²⁺, Ag⁺) cation-exchanged natrolites

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ABSTRACT

We report here the preparation and structural models of alkaline-earth (Ca²⁺, Sr²⁺, Ba²⁺) and heavy metal (Cd²⁺, Pb²⁺, Ag⁺) cation-exchanged natrolites at ambient conditions and compare them to the alkali (Li⁺, Na⁺, K⁺, Rb⁺, Cs⁺) cation forms. The latter two groups all crystallize in the orthorhombic *Fdd2* symmetry as the natural sodium natrolite, whereas the alkaline earth analogues are all found in the monoclinic *Cc* symmetry as scolecite, the natural calcium counterpart. We find the existence of a universal linear relationship between the unit-cell volume and the non-framework cation radius in natrolite. The rotation angles of the fibrous chain units are distributed between 25.5° (Li-form) and 2.9° (Cs-form) to show its inverse proportionality to the non-framework cation radius and the channel opening area. We also propose a possible threshold in the cation radius that dictates the distribution pattern of the non-framework cations and water molecules in the ordered and disordered fashions in natrolite.

Keywords: Natrolite, ion exchange, crystal chemistry, Rietveld refinement