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Pressure-induced hydration in zeolite tetranatrolite

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ABSTRACT

The tetranatrolite-paranatrolite transformation has remained a key problem in understanding the paragenesis of zeolites in the natrolite family. It is accepted that when paranatrolite, approximate formula $Na_{16-x}Ca_xAl_{16+x}Si_{24-x}O_{80}\cdot 24H_2O$, is removed from an aqueous environment and exposed to the atmosphere, it loses water and transforms to tetranatrolite, $Na_{16-x}Ca_xAl_{16+x}Si_{24-x}O_{80}\cdot nH_2O$ ($n \leq 24$). Here we show that this transformation is not only reversible, but that tetranatrolite exhibits two sequential pressure-induced hydrations leading first to paranatrolite and then to a superhydrated tetranatrolite above 0.2 and 3.0 GPa, respectively. We have previously reported similar behavior for the corresponding system with an ordered Si/Al distribution, i.e., natrolite itself, however the ordered version of paranatrolite exists over a much smaller pressure range. The pressure-induced transformations of natrolite and tetranatrolite thus further supports the supposition that paranatrolite is a distinct mineral species, with a pressure-stability field dependent upon composition.

Keywords: Crystal structure, high pressure, phase transition, tetranatrolite, paranatrolite, synchrotron X-ray powder diffraction, pressure-induced hydration