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# The crystal structure of tetranatrolite from Mont Saint-Hilaire, Québec, and its chemical and structural relationship to paranatrolite and gonnardite

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## ABSTRACT

The structure of tetranatrolite from Mont Saint-Hilaire, Québec (U.S. National Museum sample R1830) with $a = 13.197(7)$ Å, $c = 6.630(9)$ Å, and space group $I\bar{4}2d$, was refined using single-crystal X-ray data. A representative formula of tetranatrolite determined from electron microprobe analysis is $Na_{12.50}K_{0.01}Ca_{2.93}Sr_{0.11}Al_{19.09}Si_{20.91}O_{79.74}\cdot nH_2O$. The structure has the basic natrolite Si-Al-O framework configuration with Na, Ca, Sr, and K residing within inter-framework cages. Aluminum is disordered over the T1 and T2 tetrahedral sites, with T2 > T1. Water molecules O4 and O5 coordinate the intercage atoms and have high displacement parameters, indicating disorder within the cages. The Mont Saint-Hilaire tetranatrolite structure is compared to four previously determined structures, two tetranatrolite samples from Khibiny and Lovozero, Russia and two "gonnardite" samples from Tvedalen, Norway and Gignat, France. Observations are given to indicate that the Norwegian sample deduced to be tetranatrolite rather than gonnardite. Although the crystal structures of tetranatrolite and gonnardite are very similar, it is shown that the tetranatrolite compositions differ significantly from those of gonnardite. The tetranatrolite composition series varies along the join $Na_{16}Al_{16}Si_{24}O_{80}$–$Na_{12}Ca_4Al_{20}Si_{20}O_{80}$, and is represented by the formula $Na_{16-x}Ca_xAl_{16+x}Si_{24-x}O_{80}\cdot nH_2O$, where $x$ extends from approximately 2.4 to 3.9. In contrast, gonnardites from Arkansas and Austria have compositions that vary along the join $Na_{16}Al_{16}Si_{24}O_{80}$–$Na_4Ca_8Al_{20}Si_{20}O_{80}$, which are represented by the formula $\square_xNa_{16-3x}Ca_{2x}Al_{16+x}Si_{24-x}O_{80}\cdot nH_2O$ and where $\square$ indicates vacant intercage cation sites and $x$ varies from approximately 0.3 to 3.2. Tetranatrolite is a dehydration product of paranatrolite and probably does not have a true stability field.