

The crystal structure of stichtite, re-examination of barbertonite, and the nature of polytypism in MgCr hydrocalcites

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ABSTRACT

Stichtite, ideally $\text{Mg}_6\text{Cr}_2\text{CO}_3(\text{OH})_{16}\cdot 4\text{H}_2\text{O}$, from Stichtite Hill, Tasmania, Australia, and barbertonite, also ideally $\text{Mg}_6\text{Cr}_2\text{CO}_3(\text{OH})_{16}\cdot 4\text{H}_2\text{O}$, from the Kaapsehoop asbestos mine, South Africa, have been studied by powder X-ray diffraction and their structures have been refined using the Rietveld method. Stichtite from Stichtite Hill crystallizes in the rhombohedral space group $R\bar{3}m$, with unit-cell parameters $a = 3.09575(3)$ and $c = 23.5069(6)$ Å, $V = 195.099(6)$ Å³, with $Z = 3/8$. Barbertonite from the Kaapsehoop asbestos mine crystallizes in the hexagonal space group $P6_3/mmc$. The co-type specimens of barbertonite were found to be intergrown mixtures consisting of barbertonite and stichtite. Unit-cell parameters of barbertonite from the co-type specimens were $a = 3.09689(6)$, $c = 15.6193(8)$ Å, and $V = 129.731(8)$ Å³ and $a = 3.09646(6)$, $c = 15.627(1)$ Å $V = 129.76(1)$ Å³, and $Z = 1/4$. Rietveld refinements of both stichtite and barbertonite show that they are polytypes rather than polymorphs and do not represent distinct mineral species. Several possible nomenclature systems are discussed for the naming of hydrocalcite minerals and groups. Raman band assignments are also presented for stichtite from Stichtite Hill.

Stichtite and hydrocalcite minerals make up a large proportion of the ore at the Mount Keith nickel mine in Western Australia. Bulk powder diffraction shows the ore contains 6.1 wt% stichtite and 5.6 wt% iowaite. Hydrocalcite group minerals provide an important potential reservoir of CO₂. At Mount Keith, the amount of CO₂ mined as stichtite could exceed 45 000 metric tons per year, while exchange of Cl for CO₃ could fix in excess of 40 000 metric tons CO₂ per year if end-member iowaite is reacted to form pyroaurite.

Keywords: Stichtite, barbertonite, polytype, hydrocalcite, carbon sequestration, Stichtite Hill, Kaapsehoop asbestos mine, X-ray diffraction