

Crystal structure of protoanthophyllite: A new mineral from the Takase ultramafic complex, Japan

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ABSTRACT

Protoanthophyllite, $(\text{Mg, Fe})_7\text{Si}_8\text{O}_{22}(\text{OH})_2$, is a newly discovered amphibole species from the Takase ultramafic complex in Japan. It occurs as prismatic crystals up to 5 mm in length in a thermally altered serpentinite that experienced contact metamorphism. The protoanthophyllite is associated with forsterite, talc, serpentine minerals, chlorite, chromian spinel, magnetite, pentlandite, and calcite. Some protoanthophyllite crystals contain minute lamellae of anthophyllite, other pyriboles, or both. Protoanthophyllite is biaxial negative, with refractive indices $n_\alpha = 1.593(2)$, n_β (calc.) = 1.609, $n_\gamma = 1.615(2)$, and $2V_x = 64(5)^\circ$. Electron microprobe analyses give an empirical formula of $(\text{Mg}_{6.31}\text{Fe}_{0.61}\text{Na}_{0.06}\text{Mn}_{0.01}\text{Ni}_{0.01})_{\Sigma 7.00}(\text{Si}_{7.90}\text{Al}_{0.14})_{\Sigma 8.04}\text{O}_{22}(\text{OH})_2$. It is orthorhombic with space group $Pnmn$. The unit-cell dimensions are $a = 9.3553(8)$, $b = 17.9308(15)$, and $c = 5.3117(4)$ Å: with $V = 891.0(3)$ Å³ and $Z = 2$. A single-crystal X-ray structure determination shows that, following the convention of Thompson (1981), protoanthophyllite has an (X) configuration. The topology of the silicate tetrahedral chains is similar to that of the anthophyllite A-chains. Silicate tetrahedral chains are O-rotated in protoanthophyllite, whereas those in protoferro-anthophyllite are S-rotated. Iron atoms are concentrated in the 4-coordinated M4 sites. The unit-cell volume is ~1.5% larger than the equivalent volume of anthophyllite with $\text{Mg}/(\text{Mg} + \text{Fe}) = 0.885$, suggesting a high-temperature or low-pressure stability relative to anthophyllite, assuming that protoanthophyllite is not metastable.