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Rongibbsite, $Pb_2(Si_4Al)O_{11}(OH)$, a new zeolitic aluminosilicate mineral with an interrupted framework from Maricopa County, Arizona, U.S.A.

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Abstract

A new zeolitic aluminosilicate mineral species, rongibbsite, ideally $Pb_2(Si_4Al)O_{11}(OH)$, has been found in a quartz vein in the Proterozoic gneiss of the Big Horn Mountains, Maricopa County, Arizona, U.S.A. The mineral is of secondary origin and is associated with wickenburgite, fornacite, mimetite, murdochite, and creaseyite. Rongibbsite crystals are bladed (elongated along the **c** axis, up to 0.70 × 0.20 × 0.05 mm), often in tufts. Dominant forms are {100}, {010}, {001}, and {10$\bar{1}$}. Twinning is common across (100). The mineral is colorless, transparent with white streak and vitreous luster. It is brittle and has a Mohs hardness of ~5; cleavage is perfect on {100} and no parting was observed. The calculated density is 4.43 g/cm^3. Optically, rongibbsite is biaxial (+), with $n_\alpha = 1.690$, $n_\beta = 1.694$, $n_\gamma = 1.700$, $c^Z = 26°$, $2V_{meas} = 65(2)°$. It is insoluble in water, acetone, or hydrochloric acid. Electron microprobe analysis yielded an empirical formula $Pb_{2.05}(Si_{3.89}Al_{1.11})O_{11}(OH)$.

Rongibbsite is monoclinic, with space group *I*2/*m* and unit-cell parameters $a = 7.8356(6)$, $b = 13.913(1)$, $c = 10.278(1)$ Å, $\beta = 92.925(4)°$, and $V = 1119.0(2)$ Å^3. Its structure features an interrupted framework made of three symmetrically distinct TO_4 tetrahedra (T = Si + Al). The framework density is 17.9 T per 1000 Å^3. Unlike many known interrupted frameworks in zeolite-type materials, which are usually broken up by OH or F, the framework in rongibbsite is interrupted by O atoms. There are various corner-shared tetrahedral rings in the framework of rongibbsite, including two types of 4-membered, three 6-membered, and one 8-membered rings. The extraframework Pb and OH reside alternately in the channels formed by the 8-membered rings. The Pb cations are disordered over two split sites, Pb and Pb′, with site occupancies of 0.8 and 0.2, respectively, and a Pb-Pb′ distance of 0.229 Å, providing a structural explanation for the two strong Raman bands (at 3527 and 3444 cm^{-1}) attributable to the O-H stretching vibrations. The average bond lengths for the T1, T2, and T3 tetrahedra are 1.620, 1.648, and 1.681 Å, respectively, indicating that the preference of Al for the three tetrahedral sites is T3 >> T2 > T1. Rongibbsite represents the first natural aluminosilicate with Pb as the only extraframework cation.

Keywords: Rongibbsite, zeolitic aluminosilicate, Pb-bearing, interrupted framework, crystal structure, X-ray diffraction, Raman spectra