American Mineralogist, Volume 107, pages 1181–1189, 2022

Protocaseyite, a new decavanadate mineral containing a $[Al_4(OH)_6(H_2O)_{12}]^{6+}$ linear tetramer, a novel isopolycation

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Abstract

Protocaseyite, $[Al_4(OH)_6(H_2O)_{12}][V_{10}O_{28}]\cdot 8H_2O$, is a new mineral (IMA2020-090) occurring in low-temperature, post-mining, secondary mineral assemblages at the Burro mine, Slick Rock district, San Miguel County, Colorado, U.S.A. Crystals of protocaseyite are saffron-yellow, thick blades, with pale orange-yellow streak, vitreous luster, brittle tenacity, curved fracture, two very good cleavages, a Mohs hardness of 2, and a density of 2.45(2) g/cm^3. The optical properties of protocaseyite could be only partly determined: biaxial with $\alpha = 1.755(5)$, $\beta < 1.80$, $\gamma > 1.80$ (white light); pleochroic with X and Y yellow, Z orange ($X \approx Y < Z$). Electron-probe microanalysis and crystal-structure solution and refinement provided the empirical formula $[(Al_{3.89}Mg_{0.11}Ca_{0.02})_{\Sigma 4.02}(OH)_6(H_2O)_{12}][H_{0.06}V_{10}O_{28}]\cdot 8H_2O$. Protocaseyite is triclinic, $P\bar{1}$, $a = 9.435(2)$, $b = 10.742(3)$, $c = 11.205(3)$ Å, $\alpha = 75.395(7)$, $\beta = 71.057(10)$, $\gamma = 81.286(6)°$, $V = 1036.4(5)$ Å^3, and $Z = 1$. The crystal structure ($R_1 = 0.026$ for 4032 $I_o > 2\sigma I$ reflections) contains both the $[V_{10}O_{28}]^{6-}$ decavanadate polyoxoanion and a novel $[Al_4(OH)_6(H_2O)_{12}]^{6+}$ polyoxocation.

Keywords: Protocaseyite, new mineral, polyoxometalate, crystal structure, Burro mine, San Miguel County, Colorado, U.S.A.