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Fluorwavellite, $Al_3(PO_4)_2(OH)_2F{\cdot}5H_2O$, the fluorine analog of wavellite

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Abstract

Fluorwavellite (IMA2015-077), $Al_3(PO_4)_2(OH)_2F{\cdot}5H_2O$, the F analog of wavellite, is a new mineral from the Silver Coin mine, Valmy, Iron Point district, Humboldt County, Nevada, and the Wood mine, 5 miles NE of Del Rio, Cocke County, Tennessee; at both occurrences it is a low-temperature secondary mineral. Fluorwavellite is essentially identical to wavellite in appearance and physical properties. Optically, fluorwavellite is biaxial positive, with α = 1.522(1), β = 1.531(1), and γ = 1.549(1) (white light). Electron microprobe analyses (average of nine for each co-type locality) provided the empirical formulas $Al_{2.96}(PO_4)_2(OH)_{1.98}F_{1.02}{\cdot}5H_2O$ (+0.12 H) for the Silver Coin mine and $Al_{2.98}(PO_4)_2(OH)_{2.11}F_{0.89}{\cdot}5H_2O$ (+0.06 H) for the Wood mine. Fluorwavellite is orthorhombic, *Pcmn*, with the cell parameters determined on a Wood mine crystal: a = 9.6311(4), b = 17.3731(12), c = 6.9946(3) Å, V = 1170.35(11) Å^3, and Z = 4. The five strongest lines in the X-ray powder diffraction pattern are [d_{obs} in Å (*I*) (*hkl*)]: 8.53 (100) (020,110); 5.65 (26) (101); 3.430 (28) (141,012); 3.223 (41) (240); and 2.580 (28) (331,161,232). The structure of fluorwavellite (R_1 = 3.42% for 1248 $F_o > 4\sigma F$ reflections) is the same as that of wavellite, differing only in having one of the two independent hydroxyl sites replaced by F. A survey of F contents in wavellite-fluorwavellite from the five most common genetic types of occurrence (fluid expulsion, hydrothermal ore alteration, pegmatite phosphate alteration, residual carbonate weathering, and sedimentary leached zone) shows that F content, and the occurrence of wavellite vs. fluorwavellite, does not correlate with the type of the occurrence. It is more likely related to the fluid activity of Al, P, and F, with pH probably being an important factor. The role that wavellite and fluorwavellite play in sequestering F in the environment may be significant.

Keywords: Fluorwavellite; new mineral; crystal structure; Raman spectroscopy; infrared spectroscopy; wavellite; Silver Coin mine, Nevada, U.S.A.; Wood mine, Tennessee, U.S.A.