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Nizamoffite, $Mn^{2+}Zn_2(PO_4)_2(H_2O)_4$, the Mn analogue of hopeite from the Palermo No. 1 pegmatite, North Groton, New Hampshire

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Abstract

Nizamoffite, ideally $Mn^{2+}Zn_2(PO_4)_2(H_2O)_4$, is a new mineral from the Palermo No.1 pegmatite in North Groton, Grafton County, New Hampshire, U.S.A. It formed as the result of secondary alteration of primary triphylite and associated sphalerite. The crystals occur as colorless prisms up to 1 mm in length and 0.5 mm in diameter. The prisms are elongated and lightly striated parallel to [001] and exhibit the forms {100}, {010}, {230}, {011}, {031}, and {111}. The mineral is transparent and has a white streak, vitreous luster, Mohs hardness of about 3½, brittle tenacity, irregular fracture, and three cleavages: perfect on {010}, good on {100}, and fair on {001}. The measured and calculated densities are 3.00(1) and 2.961 g/cm^3, respectively. It is optically biaxial (–), α = 1.580(1), β = 1.590(1), γ = 1.591(1) (white light), $2V_{meas}$ = 28(1)°, and $2V_{calc}$ = 35°. Nizamoffite exhibits strong dispersion, $r < v$. The optical orientation is X = **a**, Y = **c**, Z = **b**, and the mineral is nonpleochroic. Electron-microprobe analyses (average of 10), with H_2O calculated on structural grounds, provided: CaO 0.20, MgO 0.61, MnO 15.80, ZnO 33.34, Fe_2O_3 2.81, Al_2O_3 0.10, P_2O_5 32.05, H_2O 15.95, total 100.23 wt%. The empirical formula (based on 12 O atoms) is: $(Mn^{2+}_{0.99}Ca_{0.02})_{\Sigma 1.01}(Zn_{1.82}Fe^{3+}_{0.12}Mg_{0.07})_{\Sigma 2.01}(P_{1.00}O_4)_2(H_{1.96}O)_4$. The mineral dissolves readily in cold, dilute HCl. Nizamoffite is orthorhombic, *Pnma*, with the unit-cell parameters: a = 10.6530(4), b = 18.4781(13), c = 5.05845(15) Å, V = 995.74(8) Å^3, and Z = 4. The eight strongest lines in the X-ray powder diffraction pattern are [d_{obs} in Å(I)(hkl)]: 9.27(71)(020); 4.62(37)(040,220); 4.43(24)(111); 3.424(52)(240,221); 2.873(100)(241); 2.644(36)(400,331); 2.540(33)(420,161,002); and 1.953(36)(281). Nizamoffite is isostructural with hopeite. The structure (R_1 = 1.7% for 1014 $F_o > 4\sigma F$) contains corner-sharing zigzag chains of ZnO_4 tetrahedra along [001]. The chains are connected by corner sharing with PO_4 tetrahedra to form sheets parallel to {010}. Three of the four PO_4 vertices link to ZnO_4 tetrahedra in the sheet, while the fourth links to an octahedron between the sheets. Each octahedron links to one tetrahedron from each of two adjacent sheets, thereby linking the sheets in the [010] direction. The octahedron contains Zn in hopeite and Mn in nizamoffite.

Keywords: Nizamoffite, new mineral, crystal structure, hopeite, secondary phosphate, Palermo No. 1 pegmatite, New Hampshire, U.S.A.