American Mineralogist, Volume 97, pages 496–502, 2012

Falsterite, $Ca_2MgMn^{2+}_2(Fe^{2+}_{0.5}Fe^{3+}_{0.5})_4Zn_4(PO_4)_8(OH)_4(H_2O)_{14}$, a new secondary phosphate mineral from the Palermo No. 1 pegmatite, North Groton, New Hampshire

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Abstract

Falsterite, ideally $Ca_2MgMn^{2+}_2(Fe^{2+}_{0.5}Fe^{3+}_{0.5})_4Zn_4(PO_4)_8(OH)_4(H_2O)_{14}$, is a new mineral from the Palermo No. 1 pegmatite in North Groton, Grafton County, New Hampshire, U.S.A., and also occurs at the Estes pegmatite quarry, Baldwin, Cumberland County, Maine, U.S.A. It formed as the result of secondary alteration of primary triphylite and associated sphalerite. The crystals occur as very thin greenish-blue plates and rectangular laths, up to 0.7 mm in length, but no more than a few micrometers thick. Laths are flattened on {010}, elongate along [100], and exhibit lamellar twinning. The mineral is transparent and has a very pale greenish-blue streak, vitreous luster, Mohs hardness of about 2, flexible tenacity, irregular fracture, and perfect cleavage on {010}. The measured and calculated densities are 2.78(3) and 2.837 g/cm^3, respectively. It is optically biaxial (–), $\alpha = 1.575(10)$, $\beta = 1.600(5)$, $\gamma = 1.610(5)$ (white light), $2V_{meas} = 60(10)$, and $2V_{calc} = 63.8$. Falsterite exhibits strong dispersion, $r > v$. The optical orientation is $X = \mathbf{b}$, $Y \approx \mathbf{a}$, $Z \approx \mathbf{c}$. Pleochroism is pronounced: X, Z = colorless to very pale yellow, Y = blue green; $Y >> X \approx Z$. Electron-microprobe analyses (average of 7), with FeO and Fe_2O_3 apportioned and H_2O calculated on structural grounds, provided: CaO 6.36, MgO 2.13, MnO 8.10, ZnO 18.49, FeO 8.02, Fe_2O_3 8.90, Al_2O_3 0.02, P_2O_5 31.81, H_2O 16.17, total 100.00 wt%. The empirical formula (based on 50 O atoms) is $Ca_{2.02}Mg_{0.94}Mn^{2+}_{2.04}Fe^{2+}_{1.99}Fe^{3+}_{1.99}Zn_{4.05}P_{7.99}O_{32}(OH)_4(H_2O)_{14}$. The mineral dissolves very easily in cold, dilute HCl. Falsterite is monoclinic, $P2_1/c$, with the unit-cell parameters: $a = 6.3868(18)$, $b = 21.260(7)$, $c = 15.365(5)$ Å, $\beta = 90.564(6)$, $V = 2086.2(1.1)$ Å^3, and $Z = 2$. The eight strongest lines in the X-ray powder diffraction pattern are [d_{obs} in Å(I)(hkl)]: 12.86(34)(011); 10.675(100)(020); 4.834(12)(102,$\bar{1}$12); 4.043(18)($\bar{1}$32); 3.220(25)($\bar{1}$52); 3.107(14)(044); 2.846(19)($\bar{2}$22); 1.596(14)(0·12·4). The structure of falsterite ($R_1 = 6.42\%$ for 714 $F_o > 4\sigma F$) contains edge-sharing chains of $Fe^{2+}/Fe^{3+}O_6$ octahedra and corner-sharing chains of ZnO_4 tetrahedra along [100]. These chains are linked to one another by PO_4 tetrahedra, forming a sheet parallel to {010}. $Mn^{2+}O_6$ octahedra and CaO_7 polyhedra also link to this sheet, resulting in a thick slab. The slabs are bridged in the [010] direction by edge-sharing dimers of MgO_6 octahedra, which link to the slabs by sharing edges with ZnO_4 tetrahedra in adjacent slabs. The structures of falsterite and schoonerite, while topologically quite different, share similar components and structural features.

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