

Phosphoellenbergerite

Mg₁₄(PO₄)₆(PO₃OH, CO₃)₂(OH)₆

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Crystal Data: Orthorhombic. *Point Group:* $2/m\ 2/m\ 2/m$. As crystals, tabular on [010] to pseudo-octahedral, with prominent {010}, {100}, {001}, {021}, many other forms, to 1 cm. May be fibrous to massive.

Physical Properties: *Cleavage:* On {010}, poor. *Fracture:* Uneven. Hardness = 4–4.5
D(meas.) = 3.10–3.29 D(calc.) = 3.32

Optical Properties: Transparent to translucent. *Color:* Pale green, olive-green, brownish green; reddish brown if oxidized. *Luster:* Vitreous to subresinous.
Optical Class: Biaxial (+). *Orientation:* $X = a; Y = b; Z = c$. *Dispersion:* $r > v$, distinct.
 $\alpha = 1.663\text{--}1.672$ $\beta = 1.674\text{--}1.680$ $\gamma = 1.699\text{--}1.700$ $2V(\text{meas.}) = 66^\circ\text{--}70^\circ$ $2V(\text{calc.}) = 68^\circ$

Cell Data: *Space Group:* $Pbna$ (synthetic). $a = 9.460(2)$ $b = 10.024(3)$ $c = 8.670(2)$
 $Z = 4$

X-ray Powder Pattern: Hagendorf, Germany; close to reddingite.
3.18 (10), 2.724 (8), 4.25 (7), 2.639 (7), 2.408 (7), 2.222 (7), 1.615 (7)

Chemistry:	(1)	(2)
P ₂ O ₅	34.39	34.61
FeO	37.52	26.27
MnO	13.63	25.94
CaO	1.20	
H ₂ O	13.32	13.18
Total	100.06	100.00

(1) Hagendorf, Germany, average of two analyses; corresponds to $(\text{Fe}_{2.15}\text{Mn}_{0.80}\text{Ca}_{0.10})_{\Sigma=3.05}(\text{PO}_4)_2 \cdot 3.05\text{H}_2\text{O}$. (2) $(\text{Fe, Mn})_3(\text{PO}_4)_2 \cdot 3\text{H}_2\text{O}$ with Fe:Mn = 1:1.

Polymorphism & Series: Forms a series with reddingite.

Occurrence: An alteration product of triphylite in zoned complex granite pegmatites.

Association: Ludlamite, vivianite, huréaulite, lithiophilite, siderite.

Distribution: Large crystals from Hagendorf, Bavaria, Germany. At the Mangualde pegmatite, near Mesquitela, Portugal. In the USA, in the Palermo #1 mine, near North Groton, Grafton Co., New Hampshire; from the Dan Patch mine, 1.5 km west of Keystone, Pennington Co., and the Bull Moose and Tip Top mines, near Custer, Custer Co., South Dakota. At the Énio pegmatite mine, northeast of Galiléia, Minas Gerais, Brazil. From the El Criollo pegmatite, Cerro Blanco, Tanti district, 45 km west of Córdoba, Córdoba Province, Argentina.

Name: For PHOSPHORus and iron, FERRum, in the composition.

Type Material: National Museum of Natural History, Washington, D.C., USA, 150230.

References: (1) Palache, C., H. Berman, and C. Frondel (1951) Dana's system of mineralogy, (7th edition), v. II, 727–729. (2) Moore, P.B. and T. Araki (1976) A mixed-valence solid-solution series: crystal structures of phosphoferrite, $\text{Fe}_3^{\text{II}}(\text{H}_2\text{O})_3[\text{PO}_4]_2$, and kryzhanovskite, $\text{Fe}_3^{\text{III}}(\text{OH})_3[\text{PO}_4]_2$. *Inorg. Chem.*, 15, 316–321. (3) Tennyson, C. (1954) Phosphoferrit und Reddingit von Hagendorf. *Neues Jahrb. Mineral., Abh.*, 87, 185–217 (in German). (4) Moore, P.B. (1971) The $\text{Fe}_3^{2+}(\text{H}_2\text{O})_n(\text{PO}_3)_2$ homologous series: crystal-chemical relationships and oxidized equivalents. *Amer. Mineral.*, 56, 1–17. (5) Moore, P.B., T. Araki, and A.R. Kampf (1980) Nomenclature of the phosphoferrite structure type: refinements of landesite and kryzhanovskite. *Mineral. Mag.*, 43, 789–795.

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