Manganilvaite $CaFe^{2+}Fe^{3+}(Mn,Fe^{2+})(Si_2O_7)O(OH)$

Crystal Data: Monoclinic. *Point Group*: 2/*m.* As dipyramidal, prismatic crystals, elongated along [001] and striated along [011], to 1.2 mm, displaying {011}, {110}, {210} and {111}.

Physical Properties: *Cleavage:* Distinct on {100}. *Fracture:* Uneven. *Tenacity*: Brittle. Hardness = 5.5- 6 VHN = 868 (100 g load). D(meas.) = 3.92 D(calc.) = 3.93

Optical Properties: Opaque to semitransparent. *Color:* Black, brownish red in transmitted light, bluish gray to gray in reflected light with red internal reflections. *Streak:* Black to brownish black. *Luster:* Vitreous.
Optical Class: n.d. *Pleochroism:* Bluish gray to lilac-brown. *Anisotropism:* Strong, grayish blue to pale reddish brown.
R_1-R_2: (480) 8.2-9.9, (546) 7.5-9.7, (589) 6.9-9.7, (650) 6.0-9.4

Cell Data: Space Group: $P2_1/a$. a = 13.025(7) b = 8.8514(5) c = 5.8486(3) β = 90.167(1)° Z = 4

X-ray Powder Pattern: Ossikovo deposit, central Rhodope Mountains, Bulgaria.
2.718 (100), 2.848 (90), 2.875 (85), 2.687 (70), 2.180 (48), 1.475 (48), 2.111 (47)

Chemistry:

	(1)
MgO	0.48
Al_2O_3	0.20
SiO_2	29.65
CaO	12.62
TiO_2	0.02
MnO	11.99
FeO(total)	40.93
H_2O	2.21
Total	98.10

(1) Ossikovo deposit, central Rhodope Mountains, Bulgaria; average of 62 electron microprobe analyses supplemented by IR spectroscopy, Fe^{2+}/Fe^{3+} calculated; corresponds to $(Ca_{0.92}Mn^{2+}_{0.08})_{\Sigma=1.00}(Fe^{2+}_{0.97}Mg_{0.05})_{\Sigma=1.02}(Fe^{3+}_{0.96}Al_{0.02})_{\Sigma=0.98}(Mn^{2+}_{0.61}Fe^{2+}_{0.39})_{\Sigma=1.00}(Si_{2.00}O_7)O(OH)$.

Mineral Group: Ilvaite group.

Polymorphism & Series: Forms a continuous series with ilvaite.

Occurrence: From the retrograde, hydrothermal alteration of manganiferous minerals in Pb-Zn-(Mn) contact metamorphic rocks (skarns).

Association: Bustamite, hedenbergite-johannsenite, manganoan ferro-actinolite, rhodonite, rhodochrosite, manganoan calcite and chlorite, andradite, sphalerite, galena, quartz, magnetite.

Distribution: From the Ossikovo and Mogilata deposits, Madan ore district and from the Govedarnika deposit, Laki district, central Rhodope Mountains, Bulgaria.

Name: As the Mn-analogue of *ilvaite*.

Type Material: Geological Institute, Bulgarian Academy of Sciences, Sofia, Bugaria (M1.2003.5-6)

References: (1) Bonev, I.K., R.D. Vassileva, N. Zotov, and K. Kouzmanov (2005) Manganilvaite, $CaFe^{2+}Fe^{3+}(Mn,Fe^{2+})(Si_2O_7)O(OH)$, a new mineral of the ilvaite group from Pb-Zn skarn deposits in the Rhodope Mountains, Bulgaria. Can. Mineral., 43,1027-1042 and 1443. (2) (2006) Amer. Mineral., 91, 712 (abs. ref. 1). (3) Zotov, N., W. Kockelman, S.D. Jacobsen, I. Mitov, D. Paneva, R.D. Vassileva, and I.K. Bonev (2005) Structure and cation ordering in manganilvaite: a combined X-ray diffraction, neutron diffraction, and Mössbauer study. Can. Mineral. 43, 1043-1053.