American Mineralogist, Volume 98, pages 1322–1329, 2013

Lusernaite-(Y), $Y_4Al(CO_3)_2(OH,F)_{11}\cdot 6H_2O$, a new mineral species from Luserna Valley, Piedmont, Italy: Description and crystal structure

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Abstract

The new mineral species lusernaite-(Y), ideally $Y_4Al(CO_3)_2(OH,F)_{11}\cdot 6H_2O$, has been discovered in small fractures of the "Luserna Stone," a leucocratic orthogneiss belonging to the Dora-Maira massif, Western Alps, Italy. It occurs as colorless, thin platelets, with white streak and mica-like pearly luster, elongated along [100] and flattened on {010}, arranged in radiating aggregates. Lusernaite-(Y) is associated with aeschynite-(Y), albite, "chlorite," hematite, pyrite, quartz, and titanite. Lusernaite-(Y) has a perfect cleavage on {010} and a less marked one probably on {100}. Its calculated density is 2.810 g/cm^3. In plane-polarized light, it is transparent, with parallel extinction and positive elongation. Lusernaite-(Y) is biaxial positive; its optical orientation is **a** = *Z*, **b** = *X*, **c** = *Y*. Owing to the crystal morphology, only two refractive indices could be measured, corresponding to $\beta = 1.566(2)$ and $\gamma = 1.577(2)$.

Lusernaite-(Y) is orthorhombic, space group *Pmna*, with $a = 7.8412(3)$, $b = 11.0313(5)$, $c = 11.3870(4)$ Å, $V = 984.96(7)$ Å^3, $Z = 2$. Main diffraction lines of the X-ray powder diffraction pattern are [*d* in Å, (*I*), (*hkl*)]: 11.02 (100) (010), 7.90 (49) (011), 5.66 (25) (002), 5.06 (24) (012), 4.258 (33) (112), 3.195 (27) (220), 3.095 (21) (212). Raman spectroscopy confirmed the presence of CO_3 groups (sharp peak at 1096 cm^{-1}); due to the very strong luminescence, the bands of the OH and H_2O groups could not be seen.

Chemical analyses by electron microprobe gave (wt%) Al_2O_3 6.11, Y_2O_3 43.52, La_2O_3 0.02, Ce_2O_3 0.04, Nd_2O_3 0.03, Sm_2O_3 0.16, Gd_2O_3 1.39, Dy_2O_3 3.46, Er_2O_3 3.15, Yb_2O_3 2.09, CaO 0.33, PbO 0.37, H_2O 22.76, CO_2 9.95, F 1.40, O≡F –0.59, sum 94.19; H_2O and CO_2 were determined from structure refinement. The empirical formula by assuming the presence of 2 $(CO_3)^{2-}$ groups, 11 $(OH,F)^-$ anions, and 6 H_2O groups, in agreement with micro-Raman and structural results, is $(Y_{3.41}Dy_{0.16}Er_{0.15}Yb_{0.09}Gd_{0.07}Ca_{0.05}Pb_{0.02}Sm_{0.01})_{\Sigma 3.96}Al_{1.06}(CO_3)_{2.00}(OH_{10.35}F_{0.65})_{\Sigma 11.00}\cdot 6H_2O$.

The crystal structure was solved by direct methods and refined on the basis of 840 observed reflections to $R_1 = 6.8\%$. In the structure of lusernaite-(Y), yttrium and REE cations occupy two distinct sites, Y1 and Y2, both in eightfold coordination. The structure is built by layers parallel to (010), formed by chains of edge-sharing Y-centered polyhedra (Y1), which run along [100], and are connected along **c** through Al-centered octahedra. These chains are decorated on one side by corner-sharing chains of Y-centered polyhedra (Y2), and on the other side by CO_3 groups. Along [001] the decorated chains alternate their polarity.

Lusernaite-(Y), named after the type locality, the Luserna Valley, shows a new kind of structure among the natural carbonates of REE. Its origin is related to the circulation of hydrothermal solutions during the late-stage Alpine tectono-metamorphic events.

Keywords: Lusernaite-(Y), new mineral species, carbonate, yttrium, crystal structure, Luserna stone, Piedmont, Italy