Lusernaite-(Y), $\text{Y}_4\text{Al(CO}_3\text{)}_2(\text{OH,F})_11\cdot6\text{H}_2\text{O}$, 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 $\text{Y}_4\text{Al(CO}_3\text{)}_2(\text{OH,F})_11\cdot6\text{H}_2\text{O}$, 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 $Pnma$, 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, $(hkl)$]: 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$_2$ groups (sharp peak at 1096 cm$^{-1}$); due to the very strong luminescence, the bands of the OH and H$_2$O groups could not be seen.

Chemical analyses by electron microprobe gave (wt%) $\text{Al}_2\text{O}_3$ 6.11, $\text{Y}_2\text{O}_3$ 43.52, $\text{La}_2\text{O}_3$ 0.02, $\text{Ce}_2\text{O}_3$ 0.04, $\text{Nd}_2\text{O}_3$ 0.03, $\text{Sm}_2\text{O}_3$ 0.16, $\text{Gd}_2\text{O}_3$ 1.39, $\text{Dy}_2\text{O}_3$ 3.46, $\text{Er}_2\text{O}_3$ 3.15, $\text{Yb}_2\text{O}_3$ 2.09, $\text{CaO}$ 0.33, $\text{PbO}$ 0.37, $\text{H}_2\text{O}$ 22.76, $\text{CO}_2$ 9.95, $\text{F}$ 1.40, $\text{OH}$ 0.65, $\text{O}$ and CO$_2$ groups could not be seen. The empirical formula based on the assumption of the presence of 2 (CO$_2$)$^-$ groups, 11 (OH,F)$^-$ anions, and 6 H$_2$O groups, in agreement with micro-Raman and structural results, is $(\text{Y}_{1.14}\text{Dy}_{0.16}\text{Er}_{0.15}\text{Yb}_{0.03}\text{Nd}_{0.03}\text{Sm}_{0.03}\text{La}_{0.03}\text{Al}_{0.03}\text{CO}_2)_{0.04}(\text{OH},\text{F})_{0.33}\text{H}_2\text{O})_{0.99}\cdot6\text{H}_2\text{O}$.

The crystal structure was solved by direct methods and refined on the basis of 840 observed reflections consistent to $R = 6.8\%$. 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$_2$ 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

INTRODUCTION

The "Luserna stone," a leucocratic orthogneiss, has been quarried since the Middle Ages, and it is an important building material for its widespread occurrence and use in historical monuments. The first publications about this stone date back to the beginning of the 19th century, with the studies of Barelli (1835) and De Bartolomei (1847), focused on the technological and economic importance of the quarrying activities. The first scientific work can be considered that of Gastaldi (1874), who tentatively reconstructed the lithostratigraphic setting of the "Luserna stone." Since then, a large number of studies about this stone have been published (Sandrone 2001). Surprisingly, only recently the mineralogical peculiarities of this formation have been investigated. Vacci (2002), Piccoli et al. (2007), and Finello et al. (2007) described the minerals occurring in late-stage fractures in the "Luserna stone," reporting more than 40 different...