

Carraraite and zaccagnaite, two new minerals from the Carrara marble quarries: their chemical compositions, physical properties, and structural features

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ABSTRACT

Two new mineral species, carraraite and zaccagnaite, were found in cavities in calcite veins in marble quarries of the Carrara basin (Apuan Alps, Italy). Carraraite, $\text{Ca}_3\text{Ge}(\text{OH})_6(\text{SO}_4)_{1.08}(\text{CO}_3)_{0.92}\cdot 12\text{H}_2\text{O}$, occurs as submillimetric crystals, tabular on {001}. The cell dimensions are $a = 11.056$ (3), $c = 10.629$ (6) Å, and the space group is $P6_3/m$. Carraraite is optically uniaxial (–), $\omega = 1.509$, $\epsilon = 1.479$. The strongest lines of the X-ray diffraction pattern are at d -spacings (Å): 9.57 (vs) (100), 5.53 (s) (110), 3.83 (s) (112), 3.56 (ms) (202), 2.74 (ms) (302). Carraraite is a new member of the ettringite-thaumasite group, which is characterized by columns of composition $[\text{Ca}_3\text{Ge}(\text{OH})_6\cdot 12\text{H}_2\text{O}]^{4+}$ running along c and interconnected through hydrogen bonding to $(\text{SO}_4)^{2-}$ and $(\text{CO}_3)^{2-}$ groups.

Zaccagnaite, $\text{Zn}_4\text{Al}_2(\text{OH})_{12}(\text{CO}_3)_3\cdot 3\text{H}_2\text{O}$, occurs as minute hexagonal crystals, elongated parallel to [001]. The cell dimensions are $a = 3.0725$ (3), $c = 15.114$ (4) Å and the space group is $P6_3/mmc$. The crystals are always covered by a thin crust of fraipontite. The strongest lines of the X-ray diffraction pattern are at d -spacings (Å): 7.51 (vs) (002), 3.794 (m) (004), 1.542 (ms) (108), 1.539 (ms) (110). Zaccagnaite is a new member of the hydrotalcite-manasseite family; its structure is characterized by a regular alternation of brucite-like layers with composition $(\text{Zn}_{2/3}\text{Al}_{1/3})(\text{OH})_2$ and an interlayer composed of carbonate groups and water molecules.