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

STEFANO MERLINO1,* AND PAOLO ORLANDI

1Dipartimento di Scienze della Terra, Università di Pisa, Italy

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, Ca3Ge(OH)6(SO4)1.08(CO3)0.92⋅12H2O, 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/m. Carraraite is optically uniaxial (–), ω = 1.509, ε = 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 [Ca3Ge(OH)6⋅12H2O]4+ running along c and interconnected through hydrogen bonding to (SO4)2– and (CO3)2– groups.

Zaccagnaite, Zn4Al2(OH)12(CO3)3⋅3H2O, 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 P63/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 (Zn2/3Al1/3)(OH)2 and an interlayer composed of carbonate groups and water molecules.

INTRODUCTION

Carrara marble is a very pure metamorphic limestone, Liassic in age, that outcrops in the Apuan Alps, a tertiary mountain chain in the north of Tuscany, Italy. It has been quarried in the Apuan Alps for more than 2000 years and has been appreciated worldwide since the Roman conquest of the Apuan territories. “The popularity of Carrara marble was due in part to the wide range of varieties available (statuary, flowered, veined, brecciated, bardiglio, etc.), to the constancy of its quality, scarcity of defects, large size of single blocks that could be extracted, excellent physical and mechanical characteristics, and long-lasting strength and beauty. The Romans were masters at selecting the finest and more durable marbles. Many Roman monuments still preserve their delicate bas-reliefs while the marble decorations on medieval cathedrals a thousands years younger show major deterioration” (Franzini et al. 1987).

From a mineralogical point of view Carrara marble is also known for the numerous fine and rare minerals that occur within small cavities hosted by typical metamorphic structures, such as boudins or tension gashes. The cavities lie within definite levels, generally dolomitic horizons that underwent brittle deformation during Tertiary metamorphism (Orlandi and Franzini 1994). Metamorphic solutions circulating within the cavities were responsible for a small and sporadic mineralization characterized by many rare mineralogical species, present as minute and well-defined crystals. Approximately 100 mineral species have been identified for this occurrence. The most common are quartz, gypsum, fluorite, and dolomite but most of the species are sulfides and sulfosalts; among these colusite, sulvanite, sphalerite, and wurtzite are well known to mineral collectors worldwide for the beauty and perfection of the crystals and for epitaxial overgrowths (Orlandi 2000). The minerals were deposited over a range of temperatures from about 350 °C to room temperature.

In this paper we present chemical, physical, crystallographic, and structural data for two new mineral species, carraraite and zaccagnaite. These minerals crystallized within the cavities of the marble during a late stage of deposition and were formed through hydrothermal alteration of sulfides and sulfosalts in the presence of aluminum-rich hydrothermal fluids (crystals of nordstrandite and dawsonite frequently occur within the cavities).

The minerals and their names were approved by the Commission on New Minerals and Mineral Names of the International Mineralogical Association. Type material of the two new species has been deposited at Museo di Storia Naturale e del Territorio, University of Pisa, Via Roma 103, I-56011 Calci (PI), Italy.

* E-mail: merlino@dst.unipi.it