Fantappiète, a new mineral of the cancrinite-sodalite group with a 33-layer stacking sequence: Occurrence and crystal structure

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ABSTRACT

This paper reports the occurrence and the crystal structure of fantappiète, a new member of the cancrinite-sodalite group of minerals from Torre Stracciacappe, Trevignano community (Rome, Latium, Italy). The mineral occurs within a volcanic ejectum consisting of dominant sanidine with minor plagioclase, biotite, augitic clinopyroxene, andradite, and iron oxides. Fantappiète (0.7 mm as largest size) is observed within miorilotic cavities of the rock as transparent colorless crystals, showing complex morphologies and striated faces. It is non-pleochroic and uniaxial negative, b = 1.5027(5). Fantappiète is trigonal, space group P321, Z = 1. The empirical chemical formula is: (Na41.2Ca30.0Mg19.6Fe16.9Mn16.9Mg26.0)30(CO3)10.29Cl13.2F2.83(AlSi3O10)(SO4)3.16H2O, which corresponds to the ideal formula [Na42.3Ca31.6Mg16.3Al1.3Si13.2Cl13.2F2.83(Al2Si4O10)(SO4)]33·6H2O.

The five strongest reflections in the X-ray powder pattern are d in Å (I%)(hkl): 3.70 (100) (3 0 0), 3.60 (80) (1 0 23), 2.641 (65) (0 0 33), 6.85 (60) (0 1 10), 6.40 (55) (1 1 0). The single-crystal FTIR spectrum rules out OH groups and shows the presence of H2O and CO2 molecules, as well.

The structure can be described as a stacking sequence of 33 layers of six-membered rings of tetrahedra along the c axis. The stacking sequence is ABACBABACBABACBABAC… where A, B, and C represent the positions of the rings within the layers. This sequence gives rise to liottite, sodalite, and cancrinite cages, alternating along c. Sulfate groups occur within the liottite cages associated by Na, K, and Ca, while highly disordered sulfate groups are located within the sodalite cages. H2O groups occur within the cancrinite cages, bonded to Ca and Na cations. Split positions are found for Na-Ca sites, and are related to disordering of the sulfate groups in the sodalite cages.

Keywords: New minerals, fantappiète, crystal structure, IR spectroscopy, mechanical properties

INTRODUCTION

The cancrinite group of feldspathoids includes several species structurally characterized by layers of six-membered rings of [SiO4] and [AlO4] tetrahedra stacked along the crystallographic c direction. The different stacking sequences give rise to different types of structural channels and cages, also extending along the c-axis (Bonaccorsi and Merlino 2005). These pores may host several anions and molecular groups, such as H2O, Cl, CO3, SO4, and extra-framework cations such as Na, K, and Ca. The stacking sequence can be simple like …ABABAB (where A and B are the positions in successive layers, using the notation of the closest-packed structures) as in cancrinite sensu stricto, or can be complex, leading to a variety of species for which sequences of 4, 6, 8, 10, 12, 14, 16, 28, and 30 layers for the c translation have been described (see Table 2 in Bonaccorsi and Merlino 2005; Chukanov et al. 2008; Rastsvetaeva and Chukanov 2008). Domains with 18 and 24 layer sequences were also observed by transmission electron microscopy (Rinaldi and Wenk 1979). An equal number of layers can also give rise to different sequences, as in marinellite (Bonaccorsi and Orlandi 2003) contrasted with tounkite (Rozenberg et al. 2004), or to different anion-cation populations of the cages. An example of this latter case is represented by afghanite and alloriite that, although having the same type of framework, differ in having Ca-Cl-Ca-Cl (Ballirano et al. 1997) or Na-H2O-Na-H2O (Chukanov et al. 2007; Rastsvetaeva et al. 2007) extra-framework contents, respectively. No sequences with an odd number of layers have been found so far. The mineral described here represents the first case of this type of sequence.

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