Ambrinoite, $(K,NH_4)_2(As,Sb)_8S_{13}\cdot H_2O$, a new mineral from Upper Susa Valley, Piedmont, Italy: The first natural (K,NH_4)-hydrated sulfosalt

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ABSTRACT

Ambrinoite, ideally $(K,NH_4)_2(As,Sb)_8S_{13}\cdot H_2O$, occurs as a rare sulfosalt species in the Triassic evaporitic formation of *Gessi* (gypsum) outcropping near the hamlet of Signols (Oulx, Susa Valley, Torino, Piedmont, Italy). The new species is associated with sulfur and orpiment; in the same occurrence galkhaite, stibnite, and enargite were also identified. Ambrinoite occurs as aggregates of tabular crystals up to 1 mm in length. The color is red, with an orange-red streak; the luster is vitreous to resinous. The mineral is transparent; its microhardness $VHN_{(10\ g)} = 30$ kg/mm^2, corresponding to a Mohs hardness of about 2. Electron microprobe analysis gives the empirical formula $[K_{1.43}(NH_4)_{0.42}Na_{0.02}Tl_{0.01}]_{\Sigma=1.88}$ $(As_{5.82}Sb_{2.18})_{\Sigma=8.00}S_{13.22}\cdot 1.2H_2O$, close to stoichiometric $[K_{1.5}(NH_4)_{0.5}]_{\Sigma=2}(As_6Sb_2)_{\Sigma=8}S_{13}\cdot H_2O$; the calculated density is 3.276 g/cm^3. Micro-Raman spectroscopy confirmed the presence of water and ammonium cation. Ambrinoite is triclinic, space group $P\bar{1}$, with $a = 9.704(1)$, $b = 11.579(1)$, $c = 12.102(2)$ Å, $\alpha = 112.82(1)$, $\beta = 103.44(1)$, $\gamma = 90.49(1)°$, $V = 1211.6(3)$ Å^3, $Z = 2$. The strongest X-ray powder diffraction lines [d in Å (I) (hkl)] are: 10.78 (100) (001), 5.79 (55) (0$\bar{2}$1), 4.23 (35) (102), 5.31 (34) ($\bar{1}$02), 5.39 (32) (002). Its crystal structure has been solved by X-ray single-crystal diffraction on the basis of 2667 unique reflections, with a final $R = 0.035$. It is formed by two kinds of modules: slabs $(110)_{PbS}$ of modified PbS archetype (type A slabs) and openwork slabs with channels accomodating $(K,NH_4)^+$ cations and H_2O molecules (type B slabs). Its structure can be described as an order-disorder (OD) structure, built up by two different kinds of layers. Taking into account only the short (As,Sb)-S bonds, (As,Sb)S$_3$ triangular pyramids form double chains similar to those described in other natural and synthetic compounds, among which its homeotype gillulyite, as well as gerstleyite. Ambrinoite belongs to the hutchinsonite merotypic family. It is probably the product of late-stage hydrothermal fluid circulation. The name of this new mineral species (IMA 2009-071) honors Pierluigi Ambrino (b. 1947), the mineral collector who kindly provided us with the studied specimens.

Keywords: Ambrinoite, sulfosalt, potassium, ammonium, crystal structure, gillulyite, Signols, Upper Susa Valley, Torino, Piedmont, Italy