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Tazieffite, $Pb_{20}Cd_2(As,Bi)_{22}S_{50}Cl_{10}$, a new chloro-sulfosalt from Mutnovsky volcano, Kamchatka Peninsula, Russian Federation

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Abstract

Tazieffite, ideally $Pb_{20}Cd_2(As,Bi)_{22}S_{50}Cl_{10}$, is a new mineral from the high-temperature fumaroles of the Mutnovsky volcano, Kamchatka Peninsula, Russian Federation. It occurs as tiny, slender, needle-shaped crystals, up to 400 µm long and 10 µm across, generally forming fibrous aggregates. Tazieffite is closely associated with greenockite, galena, mutnovskite, kudriavite, and Cd-rich cannizzarite. Other minerals spatially associated are pyrite, anhydrite, and cristobalite. Tazieffite is silvery-gray in color, occasionally with a magenta tint when it forms aggregates of extremely fine needles. It has a black streak and metallic luster. In plane-polarized incident light, tazieffite is weakly bireflectant and weakly pleochroic from dark gray to a blue-gray. Between crossed polars, the mineral is weakly anisotropic, without characteristic rotation tints. Reflectance percentages measured in air (R_{min} and R_{max}) for a single grain are 33.9, 34.1 (471.1 nm), 32.8, 33.0 (548.3 nm), 32.4, 32.6 (586.6 nm), and 30.9, 31.1 (652.3 nm), respectively. Electron microprobe analyses yield the following ranges of concentrations: Pb 41.88–44.14 (avg. 42.90), Cd 0.87–1.16 (avg. 1.03), Sn 0.31–0.69 (avg. 0.48), Bi 20.43–22.94 (avg. 21.90), As 8.64–10.73 (avg. 9.66), S 16.10–17.48 (avg. 16.58), Se 0.82–1.28 (avg. 1.04), Cl 2.39–2.77 (avg. 2.63), Br 0.09–0.15 (avg. 0.12), I 0.27–0.58 (avg. 0.42). The empirical chemical formula, calculated on the basis of 44 cations, is $Pb_{20.06}(Cd_{0.89}Sn_{0.39}In_{0.02})_{\Sigma 1.30}(As_{12.49}Bi_{10.15})_{\Sigma 22.64}(S_{50.08}Se_{1.28})_{\Sigma 51.36}(Cl_{7.18}I_{0.32}Br_{0.15})_{\Sigma 7.65}$. Tazieffite is closely related to the halogen-sulfosalt vurroite, $Pb_{20}Sn_2Bi_{22}S_{54}Cl_6$, both from a chemical and structural point of view. It represents the (Cd,As)-dominant of vurroite, according to the coupled heterovalent substitution $Sn^{4+} + 2S^{2-} \rightarrow Cd^{2+} + 2Cl^-$. The crystal structure of tazieffite was refined in the space group $C2/c$ to $R = 0.0370$ for 4271 reflections with $I > 2\sigma(I)$. Unit-cell parameters are $a = 8.3520(17)$, $b = 45.5920(92)$, $c = 27.2610(55)$ Å, $\beta = 98.84(3)°$, with $V = 10257(4)$ Å^3, and $Z = 4$. The structure of tazieffite consists of lozenge-shaped composite rods made of coordination polyhedra of Pb around an octahedrally coordinated (Cd,Sn,Pb) position, interconnected into layers parallel to (010). These layers are separated by ribbons of As and Bi in distorted octahedral coordination. The ribbons form wavy, discontinuous double layers of the PbS archetype. Lone electron pairs of As and Bi are accommodated in the central portions of the PbS-like layers. The possibility that small amounts of NH_4^+ are incorporated in the crystal structure of tazieffite is discussed. The name of this new mineral species (IMA 2008-012) honors Haroun Tazieff (Warszawa, May 11, 1914–Paris, February 6, 1998), famous Belgian/French volcanologist, who was a pioneer in the field study of volcanoes and devoted his life to the study of volcanic gases.

Keywords: Tazieffite, chloro-sulfosalt, Mutnovsky volcano, fumaroles, vurroite isotype