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Lead-tellurium oxysalts from Otto Mountain near Baker, California: IX. Agaite, $Pb_3Cu^{2+}Te^{6+}O_5(OH)_2(CO_3)$, a new mineral with CuO_5-TeO_6 polyhedral sheets

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Abstract

Agaite, $Pb_3Cu^{2+}Te^{6+}O_5(OH)_2(CO_3)$, is a new tellurate from the Aga mine on Otto Mountain near Baker, California, U.S.A. The new mineral is known from only one specimen. It occurs on quartz in association with cerussite, Br-rich chlorargyrite, chrysocolla, goethite, khinite, markcooperite, muscovite, phosphohedyphane, timroseite, and wulfenite. It is interpreted as having formed from the partial oxidation of primary sulfides and tellurides during or following brecciation of quartz veins. Agaite is orthorhombic, space group $Pca2_1$, with unit-cell dimensions $a = 10.6522(7)$, $b = 9.1630(5)$, $c = 9.6011(7)$ Å, $V = 937.12(11)$ Å^3, and $Z = 4$. Agaite crystals form as blades flattened on {010} and probably elongated on [001], and are up to about 20 μm thick and 200 μm in length. The color is blue, the streak is pale blue, and the luster is adamantine. The Mohs hardness is estimated at between 2 and 3. Agaite is brittle with an irregular fracture and one perfect cleavage on {010}. The calculated density based on the empirical formula is 6.987 g/cm^3. Agaite is biaxial (–), with calculated indices of refraction of $\alpha = 2.015$, $\beta = 2.065$, and $\gamma = 2.070°$. The measured $2V$ is 34(5)° and the optical orientation is X = **b**, Y = **c**, and Z = **a**. It is pleochroic: X = pale blue, Y and Z = blue; $X < Y = Z$. Electron microprobe analyses (average of 4) provided: PbO 65.91, CuO 7.75, TeO_3 17.41, CO_2 4.33 (structure), H_2O 1.78 (structure), total 97.18 wt%. The empirical formula (based on 10 O apfu) is: $Pb_{3.00}Cu^{2+}_{0.99}Te^{6+}_{1.01}O_5(OH)_2(CO_3)$. The eight strongest powder X-ray diffraction lines are [d_{obs} in Å (*hkl*) *I*]: 4.26 (012) 28, 4.165 (211) 14, 3.303 (022, 310, 221) 100, 2.7472 (131, 203, 312) 68, 2.571 (032, 401, 231) 14, 2.0814 (332, 422) 21, 2.0306 (511) 17, and 1.7468 (multiple) 40. The crystal structure of agaite ($R_1 = 0.033$ for 1913 reflections with $F_o > 4\sigma F$) contains edge-sharing chains of $Cu^{2+}O_5$ square pyramids and $Te^{6+}O_6$ octahedra parallel to **a** that are joined by corner-sharing in the **c** direction, forming a polyhedral sheet parallel to {010}. The polyhedral sheet is very similar to those in the structures of timroseite and paratimroseite. The thick interlayer region contains 8- and 9-coordinated Pb^{2+}, as well as CO_3 and OH groups. The Pb coordinations have lopsided distributions of bond lengths attributable to the localization of the Pb^{2+} $6s^2$ lone-pair electrons.

Keywords: Agaite, new mineral, tellurate, crystal structure, Pb^{2+} $6s^2$ lone-pair, timroseite, paratimroseite, Otto Mountain, California