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Lead-tellurium oxysalts from Otto Mountain near Baker, California: X. Bairdite, $Pb_2Cu_4^{2+}Te_2^{6+}O_{10}(OH)_2(SO_4)(H_2O)$, a new mineral with thick HCP layers

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Abstract

Bairdite, $Pb_2Cu_4^{2+}Te_2^{6+}O_{10}(OH)_2(SO_4)(H_2O)$, is a new tellurate-sulfate from Otto Mountain near Baker, California, U.S.A. It occurs in vugs in quartz associated with khinite, cerussite, goethite, and hematite. It is interpreted as having formed from the partial oxidation of primary sulfides and tellurides during or following brecciation of quartz veins. Bairdite is monoclinic, space group $P2_1/c$, with unit-cell dimensions $a = 14.3126(10)$, $b = 5.2267(3)$, $c = 9.4878(5)$ Å, $\beta = 106.815(7)°$, $V = 679.41(7)$ Å^3, and $Z = 2$. Bairdite occurs as diamond-shaped tabular crystals up to about 250 μm long and 5 μm thick, in subparallel and fan-shaped aggregates. The color is lime green, the streak is pale lime green, and the luster is adamantine. The Mohs hardness is estimated at between 2 and 3. Bairdite is brittle with an irregular fracture and one perfect cleavage on {100}. The calculated density based on the empirical formula is 6.062 g/cm^3. Bairdite is biaxial (+), with calculated indices of refraction of $\alpha = 1.953$, $\beta = 1.966$, and $\gamma = 2.039$. The measured $2V$ is 47(2)°, dispersion is $r < v$, strong and the optical orientation is $Y = \mathbf{b}$; $Z \wedge \mathbf{a} = 34°$ in obtuse angle β. The pleochroism is strong: Z (pale green) <<< X (green) < Y (green). Electron microprobe analyses (average of 4) provided: PbO 34.22, CaO 0.06, CuO 23.80, TeO_3 26.34, SO_3 5.74, H_2O 2.81 (structure), total 92.97 wt%. The empirical formula (based on 17 O atoms pfu) is: $Pb_{2.05}Ca_{0.01}Cu_{3.99}^{2+}Te_{2.00}^{6+}S_{0.96}O_{17.00}H_{4.16}$. The eight strongest powder X-ray diffraction lines are [d_{obs} in Å (*hkl*) *I*]: 4.77 (110,$\bar{1}$02) 50, 4.522 (002,011,$\bar{1}$11) 66, 3.48 (multiple) 62, 2.999 (311,$\bar{4}$11) 97, 2.701 ($\bar{5}$02,$\bar{1}$13,$\bar{2}$13) 79, 2.614 (013,020) 100, 1.727 (multiple) 65, and 1.509 ($\bar{9}$11,033,324) 83. The crystal structure of bairdite ($R_1 = 0.072$ for 1406 reflections with $F_o > 4\sigma F$) contains edge-sharing chains of $Te^{6+}O_6$ and $Cu^{2+}O_6$ octahedra parallel to **b** that are joined by corner-sharing in the **a** direction, forming thick stair-step-like hexagonal close packed layers parallel to {100}. The polyhedral sheet has similarities to those in the structures of timroseite and paratimroseite. The thick interlayer region contains PbO_{10} polyhedra and half-occupied SO_4 groups. Raman and infrared spectral data are presented.

Keywords: Bairdite, new mineral, tellurate, crystal structure, Raman spectroscopy, infrared spectroscopy, HCP layers, timroseite, paratimroseite, Otto Mountain, California