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Lead-tellurium oxysalts from Otto Mountain near Baker, California: III. Thorneite, $Pb_6(Te_2^{6+}O_{10})(CO_3)Cl_2(H_2O)$, the first mineral with edge-sharing octahedral tellurate dimers

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Abstract

Thorneite, $Pb_6(Te_2^{6+}O_{10})(CO_3)Cl_2(H_2O)$, is a new tellurate from Otto Mountain near Baker, California, named in honor of Brent Thorne. The new mineral occurs on fracture surfaces and in small vugs in brecciated quartz veins. Thorneite is directly associated with acanthite, cerussite, gold, hessite, iodargyrite, khinite, wulfenite, and three other new tellurates: housleyite, markcooperite, and ottoite. Various other secondary minerals occur in the veins, including three other new secondary tellurium minerals: paratimroseite, telluroperite, and timroseite. Thorneite is monoclinic, space group *C*2/*c*, *a* = 21.305(1), *b* = 11.059(1), *c* = 7.564(1) Å, β = 101.112(4)°, *V* = 1748.8(4) Å^3, and *Z* = 4. Crystals are prismatic to bladed with elongation and striations parallel to **c** and typically occur in parallel and random aggregates. It is yellow and transparent, with pale yellow streak and adamantine luster. Mohs hardness is estimated at 2. The mineral is brittle, with an irregular to splintery fracture and good {100} cleavage. The calculated density is 6.828 g/cm^3. Thorneite is biaxial (+), with large 2*V*, but indices of refraction are too high to be measured. The optic orientation is *Y* = **b**, *Z* ^ **a** = 29° in obtuse β. No pleochroism was observed. Electron microprobe analysis provided PbO 73.90, ZnO 0.03, TeO_3 20.35, Cl 2.29, H_2O 1.28 (structure), CO_2 2.29 (structure), O≡Cl –0.52, total 99.62 wt%; the empirical formula (based on O+Cl = 16) is $(Pb_{5.94}Zn_{0.01})(Te_{2.08}^{6+}O_{10})(C_{1.00}O_3)[Cl_{1.16}O_{0.34}(OH)_{0.50}](H_2O)$. The strongest powder X-ray diffraction lines are [d_{obs} in Å (*hkl*) *I*]: 10.43 (200) 35, 3.733 ($\bar{5}$11, $\bar{2}$02, 002) 27, 3.595 ($\bar{4}$21) 33, 3.351 (112) 66, 3.224 (511, 131) 100, 3.093 ($\bar{2}$22, $\bar{3}$31) 30, 2.900 ($\bar{6}$21) 44, 2.133 (821, 622, 223, 731, 242) 38. The crystal structure (R_1 = 0.028) contains edge-sharing octahedral tellurate dimers, $[Te_2^{6+}O_{10}]^{8-}$ that bond to Pb atoms, which in turn are linked via bonds to Cl atoms, CO_3 triangles, and H_2O molecules.

Keywords: Thorneite, new mineral, tellurate, crystal structure, Otto Mountain, California