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Lead-tellurium oxysalts from Otto Mountain near Baker, California: V. Timroseite, $Pb_2Cu_5^{2+}(Te^{6+}O_6)_2(OH)_2$, and paratimroseite, $Pb_2Cu_4^{2+}(Te^{6+}O_6)_2(H_2O)_2$, two new tellurates with Te-Cu polyhedral sheets

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Abstract

Timroseite, $Pb_2Cu_5^{2+}(Te^{6+}O_6)_2(OH)_2$, and paratimroseite, $Pb_2Cu_4^{2+}(Te^{6+}O_6)_2(H_2O)_2$, are two new tellurates from Otto Mountain near Baker, California. Timroseite is named in honor of Timothy (Tim) P. Rose and paratimroseite is named for its relationship to timroseite. Both new minerals occur on fracture surfaces and in small vugs in brecciated quartz veins. Timroseite is directly associated with acanthite, cerussite, bromine-rich chlorargyrite, chrysocolla, gold, housleyite, iodargyrite, khinite-4*O*, markcooperite, ottoite, paratimroseite, thorneite, vauquelinite, and wulfenite. Paratimroseite is directly associated with calcite, cerussite, housleyite, khinite-4*O*, markcooperite, and timroseite. Timroseite is orthorhombic, space group $P2_1nm$, a = 5.2000(2), b = 9.6225(4), c = 11.5340(5) Å, V = 577.13(4) Å^3, and Z = 2. Paratimroseite is orthorhombic, space group $P2_12_12_1$, a = 5.1943(4), b = 9.6198(10), c = 11.6746(11) Å, V = 583.35(9) Å^3, and Z = 2. Timroseite commonly occurs as olive to lime green, irregular, rounded masses and rarely in crystals as dark olive green, equant rhombs, and diamond-shaped plates in subparallel sheaf-like aggregates. It has a very pale yellowish green streak, dull to adamantine luster, a hardness of about 2½ (Mohs), brittle tenacity, irregular fracture, no cleavage, and a calculated density of 6.981 g/cm^3. Paratimroseite occurs as vibrant "neon" green blades typically intergrown in irregular clusters and as lime green botryoids. It has a very pale green streak, dull to adamantine luster, a hardness of about 3 (Mohs), brittle tenacity, irregular fracture, good {001} cleavage, and a calculated density of 6.556 g/cm^3. Timroseite is biaxial (+) with a large 2V, indices of refraction > 2, orientation X = **b**, Y = **a**, Z = **c** and pleochroism: X = greenish yellow, Y = yellowish green, Z = dark green ($Z > Y > X$). Paratimroseite is biaxial (–) with a large 2V, indices of refraction > 2, orientation X = **c**, Y = **b**, Z = **a** and pleochroism: X = light green, Y = green, Z = green ($Y = Z >> X$). Electron microprobe analysis of timroseite provided PbO 35.85, CuO 29.57, TeO_3 27.75, Cl 0.04, H_2O 1.38 (structure), O≡Cl –0.01, total 94.58 wt%; the empirical formula (based on O+Cl = 14) is $Pb_{2.07}Cu_{4.80}^{2+}Te_{2.04}^{6+}O_{12}(OH)_{1.98}Cl_{0.02}$. Electron microprobe analysis of paratimroseite provided PbO 36.11, CuO 26.27, TeO_3 29.80, Cl 0.04, H_2O 3.01 (structure), O≡Cl –0.01, total 95.22 wt%; the empirical formula (based on O+Cl = 14) is $Pb_{1.94}Cu_{3.96}^{2+}Te_{2.03}^{6+}O_{12}(H_2O)_{1.99}Cl_{0.01}$. The strongest powder X-ray diffraction lines for timroseite are [d_{obs} in Å (*hkl*) *I*]: 3.693 (022) 43, 3.578 (112) 44, 3.008 (023) 84, 2.950 (113) 88, 2.732 (130) 100, 1.785 (multiple) 33, 1.475 (332) 36; and for paratimroseite 4.771 (101) 76, 4.463 (021) 32, 3.544 (120) 44, 3.029 (023,122) 100, 2.973 (113) 48, 2.665 (131) 41, 2.469 (114) 40, 2.246 (221) 34. The crystal structures of timroseite (R_1 = 0.029) and paratimroseite (R_1 = 0.039) are very closely related. The structures are based upon edge- and corner-sharing sheets of Te and Cu polyhedra parallel to (001) and the sheets in both structures are identical in topology and virtually identical in geometry. In timroseite, the sheets are joined to one another along c by sharing the apical O atoms of Cu octahedra, as well as by sharing edges and corners with an additional CuO_5 square pyramid located between the sheets. The sheets in paratimroseite are joined only via Pb-O and H bonds.

Keywords: Timroseite, paratimroseite, new mineral, tellurate, crystal structure, Otto Mountain, California