Lead-tellurium oxysalts from Otto Mountain near Baker, California: VIII. Fuettererite, Pb$_2$Cu$_2^+$Te$_6^+$O$_6$(OH)$_2$Cl$_3$, a new mineral with double spangolite-type sheets

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ABSTRACT

Fuettererite, Pb$_2$Cu$_2^+$Te$_6^+$O$_6$(OH)$_2$Cl$_3$, is a new tellurate from Otto Mountain near Baker, California, named for Otto Fuetterer who is largely responsible for the development of the mining claims on Otto Mountain. The new mineral is known from only two specimens, one from the NE2 vein and the other from the Bird Nest drift. Fuettererite occurs in vugs in quartz, on the first specimen associated with Br-rich clorargyrite, iodargyrite, and telluroperite and on the second specimen associated with angleite, atacamite, atacamite, chalcopyrite, galena, goethite, hematite, 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. Fuettererite is hexagonal, with space group R3, a = 8.4035(12), c = 44.681(4) Å, V = 2732.6(6) Å$^3$, and Z = 6. Crystals are tabular to short prismatic, exhibit the forms {100}, {101}, and {001} and reach a maximum dimension of 50 µm. The color is bluish green, the streak is pale bluish-green, and the luster is adamantine. The Mohs hardness is estimated at between 2 and 3. The new mineral is brittle with irregular fracture and one perfect cleavage on {001}. The calculated density based on the empirical formula is 5.528 g/cm$^3$. Fuettererite is uniaxial (−), with calculated indices of refraction of n$\omega$ = 2.04 and ε = 1.97, and is dichroic bluish-green, E < O. Electron microprobe analysis provided: PbO 41.45, CuO 30.35, Al$_2$O$_3$ 0.23, TeO$_2$ 12.80, Cl 12.08, H$_2$O 3.55 (structure), O=Cl –2.73, total 97.73 wt%. The empirical formula (based on 18 O + Cl apfu) is: Pb$_{2.28}$Cu$_{0.72}$Al$_{0.07}$Te$_{5.70}$O$_{12.80}$Cl$_{1.32}$. The ten strongest powder X-ray diffraction lines are [d$_{\text{obs}}$ in Å (hkl) I]: 6.106 (104) 44, 3.733 (0.12) 100, 2.749 (12T) 53, 2.6686 (12T) 49, 2.5289 (12T) 41, 2.2772 (1.2.11) 38, 1.9637 (315, 1.2.16) 87, 1.8999 (multiple) 48, 1.5976 (multiple) 40, and 1.5843 (410, 1.2.23, 143) 44. The crystal structure of fuettererite ($R_\text{e}$ = 0.031 for 971 reflections with $F > 4\sigma(F)$) contains edge-sharing sheets of CuO$_6$ and TeO$_6$ octahedra. These sheets are virtually identical to that in the structure of spangolite, but in fuettererite they are linked together to form a double sheet. The double octahedral sheets alternate with thick double layers of PbO$_6$Cl$_6$ polyhedra. The CuO$_6$Cl$_6$ octahedra exhibit pronounced Jahn-Teller distortions and the PbO$_6$Cl$_6$ polyhedron has a lopsided distribution of bond lengths attributable to the localization of the Pb$^{2+}$ 6s$^2$ lone-pair electrons.

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

INTRODUCTION

During the course of continuing investigations of the remarkable secondary mineral assemblage at Otto Mountain, near Baker, California (Housley et al. 2011), we have thus far described eight new Pb-Te oxysalts: ottoite, housleyite, thorneite, markcooperite, timroseite, paratimroseite, telluroperite, and chromscheffelite (see Table 1), and have reported the structure determination of munakataite (Kampf et al. 2010g). In this contribution, we describe fuettererite and in the accompanying paper we describe agaita (Kampf et al. 2013, this issue), the ninth and tenth new Pb-Te oxysalt minerals from this deposit.

The new mineral is named fuettererite in honor of Otto Fuetterer (born ca. 1880; died ca. 1970), who is largely responsible for the development of the mining claims on Otto Mountain. In 1940, Fuetterer, a naturalized American citizen born in Germany and then about 60 years old, filed six claims on the hill named Good Hope 1–6. The following year a friend of his, A. G. Andrews (AGA), filed 18 adjacent claims named Aga 1–18; in 1942 Andrews added two more, Aga 19 and 20. They held these claims together until sometime after 1950 when Fuetterer became sole owner of all 26 claims. According to Lois Clark, Baker resident and longtime friend of Fuetterer, he was a well-educated man and had an appreciation and understanding of the sciences. He continued to live on and work the claims until near the time of his death around 1970. During the time he lived on the mountain, originally named “Hopeless Hill,” people in Baker came to call it Otto Mountain and that name, and the name Aga mine stuck when the U.S. Geological Survey produced their latest series of...