

## **The crystal chemistry and crystal structure of kuksite, $\text{Pb}_3\text{Zn}_3\text{Te}^{6+}\text{P}_2\text{O}_{14}$ , and a note on the crystal structure of yafsoanite, $(\text{Ca,Pb})_3\text{Zn}(\text{TeO}_6)_2$**

**STUART J. MILLS,<sup>1,\*</sup> ANTHONY R. KAMPF,<sup>2</sup> UWE KOLITSCH,<sup>3,4</sup> ROBERT M. HOUSLEY,<sup>5</sup>  
AND MATI RAUDSEPP<sup>1</sup>**

<sup>1</sup>Department of Earth and Ocean Sciences, University of British Columbia, Vancouver, British Columbia V6T 1Z4, Canada

<sup>2</sup>Mineral Sciences Department, Natural History Museum of Los Angeles County, 900 Exposition Boulevard, Los Angeles, California 90007, U.S.A.

<sup>3</sup>Mineralogisch-Petrographische Abt., Naturhistorisches Museum, Burgring 7, A-1010 Wien, Austria

<sup>4</sup>Institut für Mineralogie und Kristallographie, Geozentrum, Universität Wien, Althanstrasse 14, A-1090 Wien, Austria

<sup>5</sup>Division of Geological and Planetary Sciences, California Institute of Technology, Pasadena, California 91125, U.S.A.

### **ABSTRACT**

New discoveries of kuksite,  $\text{Pb}_3\text{Zn}_3\text{Te}^{6+}\text{P}_2\text{O}_{14}$ , from the Black Pine mine, Montana, and Blue Bell claims, California, have enabled a detailed crystal-chemical study of the mineral to be undertaken. Single-crystal X-ray structure refinements of the structure indicate that it is isostructural with dugganite,  $\text{Pb}_3\text{Zn}_3\text{Te}^{6+}\text{As}_2\text{O}_{14}$ , and joëlbruggerite,  $\text{Pb}_3\text{Zn}_3(\text{Sb}^{5+}, \text{Te}^{6+})\text{As}_2\text{O}_{13}(\text{OH}, \text{O})$ . Kuksite from the Black Pine mine crystallizes in space group  $P321$ , with unit-cell dimensions  $a = 8.392(1)$ ,  $c = 5.204(1)$  Å,  $V = 317.39(8)$  Å<sup>3</sup>, and  $Z = 1$  ( $R_1 = 2.91\%$  for 588 reflections [ $F_o > 4\sigma F$ ] and 3.27% for all 624 reflections), while Blue Bell kuksite has the unit cell  $a = 8.3942(5)$ ,  $c = 5.1847(4)$  Å, and  $V = 316.38(4)$  Å<sup>3</sup> ( $R_1 = 3.33\%$  for 443 reflections [ $F_o > 4\sigma F$ ] and 3.73% for all 483 reflections). Chemical analyses indicate that solid-solution series exist between kuksite, dugganite, and joëlbruggerite. Raman spectroscopic and powder X-ray diffraction data are also presented for samples from both occurrences.

The crystal structure of the chemically related species yafsoanite,  $(\text{Ca,Pb})_3\text{Te}_2^{6+}\text{Zn}_3\text{O}_{12}$ , from the type locality (Delbe orebody, Kuranakh Au Deposit, Aldan Shield, Saha Republic, Russia), has been refined to  $R_1 = 2.41\%$  for 135 reflections [ $F_o > 4\sigma F$ ] and 3.68% for all 193 reflections. A garnet-type structure has been confirmed and significantly improves upon the results of an earlier structure determination.

**Keywords:** Kuksite, dugganite, joëlbruggerite, Black Pine, Blue Bell, tellurate, yafsoanite, Delbe orebody, crystal structure