

## **Berndlehmannite: A new V-bearing sulfide mineral from the black-shale-hosted Zhongcun vanadium deposit, South China**

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### **ABSTRACT**

Berndlehmannite, Cu(CrV)S<sub>4</sub>, is a newly identified V-bearing sulfide mineral discovered in the black-shale-hosted Zhongcun vanadium deposit, South China. It is abundant in a phosphatic nodule-rich layer and is commonly mineralogically associated with roscoelite, quartz, and framboidal pyrite. Berndlehmannite exhibits a black color in hand specimens with a black streak, and it comprises subhedral grains that vary in size from 20 to 120 μm. The mineral is opaque with a cream-colored polished surface under reflected light. It has a Mohs hardness of 3½ with a {111} perfect cleavage, and its calculated density is 4.17 g·cm<sup>-3</sup>. Berndlehmannite is cubic, with space group *Fd* $\bar{3}m$ ; the unit-cell parameters determined from powder X-ray diffraction data are  $a = 9.8585(22)$  Å,  $V = 958.1(6)$  Å<sup>3</sup>, and  $Z = 8$ . The unit-cell parameters by single-crystal X-ray diffraction are  $a = 9.8374(2)$  Å,  $V = 952.01(6)$  Å<sup>3</sup>,  $Z = 8$ , and the final value of  $R$  is 0.015. The mineral is a member of the carrollite subgroup within the thiospinel group, featuring (Cr,V)S<sub>6</sub> in octahedral coordination and CuS<sub>4</sub> in tetrahedral coordination. The calculated empirical formula from electron-probe microanalysis is (Cu<sub>0.99</sub>Zn<sub>0.02</sub>) $\Sigma_{1.01}$ (Cr<sub>0.87</sub>V<sub>1.00</sub><sup>3+</sup>Sb<sub>0.07</sub>As<sub>0.04</sub>) $\Sigma_{1.98}$ S<sub>4.01</sub> with an average V content of 17.0 wt%. It has the highest V component compared to other V-bearing minerals in black shales and may provide new insight into the vanadium enrichment mechanism in black shales. Berndlehmannite is named to honor Bernd Lehmann (b. 1950), Professor emeritus of Economic Geology at Technische Universität Clausthal, Germany.

**Keywords:** Berndlehmannite, carrollite subgroup, thiospinel, new mineral, crystal structure, black shale, Zhongcun vanadium deposit, China