American Mineralogist, Volume 91, pages 261–269, 2006

Alpersite $(Mg,Cu)SO_4 \cdot 7H_2O$, a new mineral of the melanterite group, and cuprian pentahydrite: Their occurrence within mine waste

RONALD C. PETERSON,[1,*] JANE M. HAMMARSTROM,[2] AND ROBERT R. SEAL II[2]

[1]Department of Geological Sciences and Geological Engineering, Queen's University, Kingston, Ontario K7L 3N6, Canada
[2]United States Geological Survey, 954 National Center, Reston, Virginia 20192, U.S.A.

ABSTRACT

Alpersite, $Mg_{0.58}Cu_{0.37}Zn_{0.02}Mn_{0.02}Fe_{0.01}SO_4 \cdot 7H_2O$, a new mineral species with direct relevance to reactions in mine waste, occurs in a mineralogically zoned assemblage in sheltered areas at the abandoned Big Mike mine in central Nevada at a relative humidity of 65% and $T = 4$ °C. Blue alpersite, which is isostructural with melanterite ($FeSO_4 \cdot 7H_2O$), is overlain by a light blue to white layer dominated by pickeringite, alunogen, and epsomite. X-ray diffraction data (Mo$K\alpha$ radiation) from a single crystal of alpersite were refined in $P2_1/c$, resulting in w$R = 0.05$ and cell dimensions $a = 14.166(4)$, $b = 6.534(2)$, $c = 10.838(3)$ Å, $\beta = 105.922(6)°$, $Z = 4$. Site-occupancy refinement, constrained to be consistent with the compositional data, showed Mg to occupy the M1 site and Cu the M2 site. The octahedral distortion of M2 is consistent with 72% Cu occupancy when compared with the site-distortion data of substituted melanterite.

Cuprian pentahydrite, with the formula $(Mg_{0.49}Cu_{0.41}Mn_{0.08}Zn_{0.02})SO_4 \cdot 5H_2O$, was collected from an efflorescent rim on a depression that had held water in a large waste-rock area near Miami, Arizona. After dissolution of the efflorescence in de-ionized water, and evaporation of the supernatant liquid, alpersite precipitated and quickly dehydrated to cuprian pentahydrite. These observations are consistent with previous experimental studies of the system $MgSO_4$-$CuSO_4$-H_2O. It is suspected that alpersite and cuprian pentahydrite are widespread in mine wastes that contain Cu-bearing sulfides, but in which solubilized Fe^{2+} is not available for melanterite crystallization because of oxidation to Fe^{3+} in surface waters of near-neutral pH. Alpersite has likely been overlooked in the past because of the close similarity of its physical properties to those of melanterite and chalcanthite. Alpersite is named after Charles N. Alpers, geochemist with the United States Geological Survey, who has made significant contributions to our understanding of the mineralogical controls of mine-water geochemistry.

Keywords: Alpersite, pentahydrite, crystal structure, environmental mineralogy, new minerals, XRD data, sulfate mineralogy, chalcanthite, Rietveld refinement, acid mine waste