American Mineralogist, Volume 106, pages 290–300, 2021

New insights into the crystal chemistry of sauconite (Zn-smectite) from the Skorpion zinc deposit (Namibia) via a multi-methodological approach

Emanuela Schingaro[1,*], Gennaro Ventruti[1], Doriana Vinci[1], Giuseppina Balassone[2], Nicola Mondillo[2], Fernando Nieto[3], Maria Lacalamita[1], and Matteo Leoni[4,5]

[1]Dipartimento di Scienze della Terra e Geoambientali, Università degli Studi di Bari Aldo Moro, Via Orabona 4, I-70125, Bari, Italy
[2]Dipartimento di Scienze della Terra, dell'Ambiente e delle Risorse, Università "Federico II", Complesso Universitario Monte S. Angelo, Via Cintia, I-80126, Napoli, Italy
[3]Departamento de Mineralogía y Petrología, IACT, Universidad de Granada-CSIC, Av. Fuentenueva s/n, 18002, Granada, Spain
[4]Saudi Aramco Research and Development Center, P.O. Box 5000, 31311, Dhahran, Saudi Arabia
[5]Dipartimento di Ingegneria Civile, Ambientale e Meccanica, Università di Trento, Via Mesiano, 38123 Trento, Italy

Abstract

A multi-methodical characterization of a sauconite (Zn-bearing trioctahedral smectite) specimen from the Skorpion ore deposit (Namibia) was performed by combining X-ray powder diffraction (XRPD), cation exchange capacity (CEC) analysis, differential thermal analysis (DTA), thermogravimetry (TG), Fourier transform infrared spectroscopy (FTIR), and transmission electron microscopy (TEM-HRTEM-AEM). The X-ray diffraction pattern exhibits the typical features of turbostratic stacking disorder with symmetrical basal 00*l* reflections and long-tailed *hk* bands, as confirmed by TEM observations. Besides sauconite, the sample contains minor amounts of kaolinite, dioctahedral smectite, and quartz. CEC analysis provides a total of Ca (~69%), Mg (~26%), Na (~4%), and K (0.7%) exchangeable cations. Therefore, Zn is located exclusively within the octahedral site of sauconite. TG analysis of the sample yields a total mass loss of about 17%. Three endothermic peaks can be observed in the DTA curve, associated with dehydration and dehydroxylation of the material. An exothermic peak at 820 °C is also present as a consequence of decomposition and recrystallization. The infrared spectrum shows the typical Zn_3OH stretching signature at 3648 cm^{-1}, whereas, in the OH/H_2O stretching region two bands at 3585 and 3440 cm^{-1} can be attributed to stretching vibrations of the inner hydration sphere of the interlayer cations and to absorbed H_2O stretching vibration, respectively. Diagnostic bands of kaolinite impurity at ~3698 and 3620 cm^{-1} are also found, whereas 2:1 dioctahedral layer silicates may contribute to the 3585 and 3620 cm^{-1} bands. Finally, using the one-layer supercell approach implemented in the BGMN software, a satisfactory XRPD profile fitting model for the Skorpion sauconite was obtained. These findings have implications not only for economic geology/recovery of critical metals but also, more generally, in the field of environmental sciences.

Keywords: Sauconite, nonsulfide ore deposits, Skorpion (Namibia), CEC, XRPD profile modeling, thermal analysis, FTIR, TEM