American Mineralogist, Volume 108, pages 362–382, 2023

Zn-clays in the Kihabe and Nxuu prospects (Aha Hills, Botswana): A XRD and TEM study

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Abstract

Zinc clays are commonly found in oxidized Zn deposits and, even though they rarely represent the main target of the ore exploitation, they can be used as a proxy to restore the genetic conditions during ore-forming processes. This work sheds light on the micro- to nano-mineralogy and on the genesis of Zn-clays in the Kihabe and Nxuu prospects (located in the Aha Hills district, Northern Botswana), through an integrated XRD and TEM study of the mineralized facies occurring in the ore system. The Kihabe and Nxuu ores are hosted in a Neoproterozoic metamorphozed quartzwacke unconformably covered by the recent sedimentary rocks, also containing calcretes, of the Kalahari Group. In the analyzed samples, four distinct mineralogical facies have been recognized: (1) vanadate-calcrete facies, poor of Zn-clays; (2) low Zn-clay facies, characterized mostly by clays showing low Zn concentrations; (3) Zn-clay facies, containing proper Zn clay minerals; and (4) sulfide facies, devoid of Zn-clays. In all the facies detrital dioctahedral mica (muscovite and illite) is interstratified with smectite in the form of random (R0) to short-range ordered (R1) I/S, which locally shows significant Zn concentrations. In the sulfide facies kaolinite overgrowing onto mica packets has been detected. The low Zn-clay facies is dominated by Zn-bearing beidellite, with minor kaolinite and fraipontite. The Zn-clay facies consists mostly of a random (R0) interstratified clay between a 7 Å phase corresponding to fraipontite, and a 2:1 swelling clay component identifiable with the dioctahedral smectite, with minor sauconite.

The micro- to nano-scale paragenetic study performed by TEM indicates that the above-mentioned clays formed through a multistage process, eventually ending with the genesis of Zn-bearing phyllosilicates assemblages. The main steps were: (1) alteration of detrital mica and dissolution of feldspar clasts, which led to the formation of epitaxial kaolinite and replacive beidellite; (2) fertilization of barren clays and formation of replacive to epitaxial fraipontite/smectite and of Zn-bearing mica, through input of Zn^{2+} deriving from sphalerite or willemite dissolution by mixed meteoric-hydrothermal fluids; (3) formation of low tetrahedral charge sauconite, either in pores or as replacement of K-feldspars under surficial hypersaline conditions, possibly also linked to the establishment of the arid climate in region. These processes provide insights into genesis of Zn-Pb-V ore deposits in northwest Botswana. Furthermore, the identification of a Zn-smectite species having a stevensite-like stoichiometry is valuable for future studies dealing with the systematics of clay minerals.

Keywords: Zn-clays, nonsulfide, XRD, TEM, fraipontite, Kihabe, Nxuu, Botswana