The pearceite-polybasite group of minerals: Crystal chemistry and new nomenclature rules

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ABSTRACT

The present paper reports changes to the existing nomenclature for minerals belonging to the pearceite-polybasite group. Thirty-one samples of minerals in this group from different localities, with variable chemical composition, and showing the 111, 221, and 222 unit-cell types, were studied by means of X-ray single-crystal diffraction and electron microprobe. The unit-cell parameters were modeled using a multiple regression method as a function of the Ag, Sb, and Se contents. The determination of the crystal structures for all the members of the group permits them to be considered as a family of polytypes and for all members to be named pearceite or polybasite. The main reason for doubling the unit-cell parameters is linked to the ordering of silver. The distinction between pearceite and polybasite is easily done with an electron microprobe analysis (As/Sb ratio). A hyphenated italic suffix indicating the crystal system and the cell-type symbol should be added, if crystallographic data are available. Given this designation, the old names antimonpearceite and arsenpolybasite are abandoned here and the old names pearceite and polybasite, previously defined on a structural basis (i.e., 111 and 222), are redefined on a chemical basis. The old name pearceite will be replaced by pearceite-Tac, antimonpearceite by polybasite-Tac, arsenpolybasite-221 by pearceite-T2acc, arsenpolybasite-222 by pearceite-M2a2b2c, polybasite-221 by polybasite-T2acc, and polybasite-222 by polybasite-M2a2b2c. Since all polytypes are composed of two different layers stacked along [001]: layer A, with general composition \([\text{Ag}_9\text{Cu}_4\text{S}_4\text{As}_2\text{S}_7]^{2–}\), and layer B, with general composition \([\text{Ag}_9\text{Cu}_4\text{S}_4]\)2+, the chemical formulae of pearceite and polybasite should be written as \([\text{Ag}_9\text{Cu}_4\text{S}_4\text{As}_2\text{S}_7]\)2– and \([\text{Ag}_9\text{Cu}_4\text{S}_4\text{As}_2\text{S}_7]\), respectively, instead of (Ag,Cu)16(As,Sb)2S11 and (Ag,Cu)16(Sb,As)2S11, as is currently accepted. The new nomenclature rules were approved by the Commission on New Minerals and Mineral Names of the International Mineralogical Association.

Keywords: Pearceite-polybasite, nomenclature rules, crystal chemistry, X-ray data, chemical composition

INTRODUCTION

Sulfosalts belonging to the pearceite-polybasite group are relatively common in nature and were originally discovered in the 19th century (pearceite, Penfield 1896; polybasite, Rose 1829), while the new names antimonpearceite and arsenpolybasite were introduced by Frondel in 1963. The names pearceite and polybasite are grandfathered whereas the names antimonpearceite and arsenpolybasite were approved by the IMA Commission (see report of the IMA-CNMMN, 1967). According to Frondel (1963), these four minerals can be divided on structural basis into two series: the first one, formed by pearceite \((\text{Ag,Cu})_{16}(\text{As,}\text{Sb})_2\text{S}_{11}\) and antimonpearceite \((\text{Ag,Cu})_{16}(\text{Sb,}\text{As})_2\text{S}_{11}\) characterized by “small” unit cell (labeled 111) and high Cu content, and, the second one, formed by polybasite \((\text{Ag,Cu})_{16}(\text{Sb,}\text{As})_2\text{S}_{11}\) and arsenpolybasite \((\text{Ag,Cu})_{16}(\text{As,}\text{Sb})_2\text{S}_{11}\), with double cell parameters (labeled 222) and low Cu content. The chemical and crystallographic details of the four minerals are given in Table 1. Soon after Frondel’s (1963) study, Harris et al. (1965) pointed out the existence of an intermediate type of unit cell labeled 221 for a sample of polybasite from the Las Chispas deposit, Sonora, Mexico. They observed that the intermediate cell 221 was present in some areas of the sample analyzed and was closely associated with the small cell 111, which is present in other seemingly identical areas of the same sample. The same intermediate type of unit cell (i.e., 221) was subsequently reported by Edenharter et al. (1971) and by Minčeva-Stefanova et al. (1979). Phase relations for the system \((\text{Ag,Cu})_{16}(\text{As,}\text{Sb})_2\text{S}_{11}–(\text{Ag,Cu})_{16}(\text{Sb,}\text{As})_2\text{S}_{11}\) were investigated experimentally by Hall (1967) who hypothesized that the variation of Cu content in different samples might play a key role in favoring chemical order-disorder phenomena and, therefore, to be the driving force in stabilizing the different unit cells.

From a chemical standpoint, the members of both series are generally pure containing only minor amounts of Bi, Pb, Zn, and Fe. However, Harris et al. (1965) reported the occurrence of an antimonpearceite sample from the San Carlos mine, Guanajuato, Mexico, containing up to 8.7 wt% Se but limited their study to the determination of the unit-cell parameters and chemical characterization only.