

## Genesis of jordanite-geocronite solid solution series in the Huize Pb-Zn deposit, SW China: Implications for fluid evolution in the late mineralization stage

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### ABSTRACT

The Huize Pb-Zn deposit is renowned for its substantial reserves of Pb and Zn, along with significant by-products such as Ge and Ag. As main ore minerals, textures and chemical compositions of sphalerite and galena have been widely studied. However, sulfosalts have received limited attention, and their compositional evolution remains unknown. In this study, a series of Pb-As-Sb sulfosalts is identified in the Huize deposit, which are associated with galena, pyrite, and arsenopyrite in the late mineralization stage. These sulfosalts belong to the jordanite-geocronite solid solution (JGSS) series and include three generations: As-bearing geocronite ( $\text{Pb}_{14}\text{Sb}_{6-x}\text{As}_x\text{S}_{23}$ ,  $2 \leq x \leq 4$ ) (JGSS-1), Sb-rich jordanite ( $\text{Pb}_{14}\text{As}_x\text{Sb}_{6-x}\text{S}_{23}$ ,  $4 \leq x \leq 5$ ) (JGSS-2), Sb-bearing jordanite ( $\text{Pb}_{14}\text{As}_x\text{Sb}_{6-x}\text{S}_{23}$ ,  $5 \leq x \leq 6$ ) (JGSS-3). Single-crystal X-ray diffraction analysis reveals that the split site (As4/Sb4) can be substituted by As. The occupancies of As1/Sb1 and Pb2/As4/Sb4 sites exhibit higher sensitivity to compositional variations (As, Sb) in the fluids compared to the As2/Sb2 and As3/Sb3 sites. Zoned patterns of Sb-As in JGSS are controlled by various fluid-galena interactions, which play a critical role in the formation of JGSS. Chemical compositions of JGSS reveal that the late-stage ore-forming fluids were predominantly enriched in Sb and As. Geocronite and jordanite likely formed nearly simultaneously through the replacement of galena by Sb-, As-rich fluids under relatively high  $f_{\text{S}_2}$  and high  $f_{\text{O}_2}$  conditions. The increasing As/(As+Sb) ratio of JGSS with orebody depth indicates an upward migration of hydrothermal fluids. The presence of As-Sb-bearing minerals in the late stage of hydrothermal Pb-Zn system demonstrates the geochemical anomalies of Sb and As can serve as effective indicators for Pb-Zn mineralization. This study establishes the genetic relationship between JGSS formation and fluid evolution and provides new insights into the geochemical behavior of Sb and As during ore formation.

**Keywords:** Sulfosalts, geocronite, jordanite, solid solution, Huize Pb-Zn deposit, Southwest China