Constraints on scheelite genesis at the Dabaoshan stratabound polymetallic deposit, South China

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Abstract

The genesis of the Dabaoshan stratabound base metal deposit has remained in dispute since its discovery. Scheelite is commonly present in both the Cu-S orebody and adjacent porphyry-style Mo-W mineralization and can provide insights into the hydrothermal history. In the stratabound Cu-S orebodies, there are three stages of mineralization: early-stage, Cu-(W), and late-stage. Two types of scheelite (here referred to as SchA and SchB) are identified in the Cu-(W) mineralization stage. SchA is anhedral and disseminated in massive sulfide ores. It coexists with chalcopyrite and replaces the preexisting arsenic-bearing pyrite. SchA exhibits chaotic cathodoluminescent (CL) textures and contains abundant mineral inclusions, including pyrite, chalcopyrite, arsenopyrite, uraninite, and minor REE-bearing minerals. Chemically, SchA displays middle REE (MREE)-enriched patterns with negative Eu anomalies. SchB occurs in veins crosscutting the stratabound orebodies and shows patchy textures in CL images. Based on CL texture, SchB is subdivided into SchB1 and SchB2. SchB1 is CL-dark and occasionally shows oscillatory zoning, whereas SchB2 is CL-bright and relatively homogeneous. Chemically, SchB1 has a high-U content (mean = 552 ppm) and REE patterns varying from MREE-enriched to MREE-depleted. In contrast, SchB2 is depleted in U (mean = 2.5 ppm) and has MREE-enriched patterns. Compared with SchB, SchA is significantly enriched in Ba.

Scheelite in the stratabound orebodies has similar Y/Ho ratios and trace-element characteristics as Sch3 in the Dabaoshan porphyry system. In situ U-Pb dating of hydrothermal apatite, collected from the Sch3-bearing veins in the footwall of stratabound orebodies, yielded a mineralization age of 160.8 ± 1.1 Ma. Zircon from the Dabaoshan granite porphyry yielded a U-Pb age of 161.8 ± 1.0 Ma. These two ages are consistent within uncertainty, suggesting that the ore-forming fluid responsible for tungsten mineralization in the stratabound orebodies was derived from the porphyry system. When fluid emanating from the deep porphyry system encountered the overlying Lower Qiziqiao Formation and stratabound orebodies, replacement reactions resulted in dramatic variations in physiochemical conditions (e.g., decrease in \( f_\text{O}_2 \), increase in Ca/Fe, As, Ba). During this process, \( \text{U}^{6+} \) was reduced to \( \text{U}^{4+} \), and As and Ba were leached out of the preexisting pyrite and host rock. Fluid-rock interactions triggered a rapid discharge of fluids, forming SchA with chaotic CL textures and abundant inclusions, but uniform REE patterns. SchB (characterized by patches with different chemical characteristics) may have been formed from repeated injection of ascending fluids into fractures crosscutting the preexisting massive sulfide ores. We propose that Jurassic porphyry Mo-W mineralization contributed to tungsten mineralization in the stratabound orebodies. Considering that Cu and W mineralization are genetically related, not only in the footwall but also in the stratabound orebodies, we infer that Cu in the stratabound orebodies was locally sourced from the Jurassic porphyry mineralization.

Keywords: Scheelite, trace elements, stratabound mineralization, Dabaoshan, apatite U-Pb dating

Introduction

Stratabound polymetallic deposits, an important reserve of base metals in South China, are widespread in the Lower Yangtze Region and the Cathaysia Block (Gu et al. 2007; Zaw et al. 2007; Mao et al. 2011b). These deposits are commonly hosted within Late Paleozoic carbonate units and distributed around Mesozoic intermediate-acid magmatic rocks (Gu et al. 2007). Despite being extensively studied, the genesis of these deposits remains controversial, with views broadly falling into two groups: (1) these deposits were associated with the Mesozoic porphyry-skarn systems (e.g., Pan and Dong 1999; Mao et al. 2011b) and (2) these deposits were associated with the Jurassic porphyry systems (e.g., Gu et al. 2007; Zaw et al. 2007). The Dabaoshan deposit, located in the southern part of the Dabaoshan block, is one of the most important stratabound polymetallic deposits in South China. The deposit is characterized by a complex mineralization history involving multiple stages of mineralization, including Cu-(W), Mo-W, and Au-Ag mineralization, which occurred in stratiform Cu-S orebodies and adjacent porphyry-style Mo-W mineralization. The Dabaoshan deposit has been the subject of extensive research, with studies focusing on its mineralogy, petrography, and geochemistry, as well as its geochronology and tectonic setting.