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Texture and geochemistry of multi-stage hydrothermal scheelite in the Dongyuan porphyry-type W-Mo deposit, South China: implications for the ore-forming process and fluid metasomatism

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Scheelite in the Dongyuan porphyry-type W-Mo deposit, South China, occurs both in porphyritic biotite granite (PBG) and lamprophyre. Three types of scheelite (Sch_A, Sch_B and Sch_C) were identified in the PBG, whereas two types (Sch_a and Sch_b) were recognized in the lamprophyre. The incorporation of REEs into scheelite mainly occurs via $2^{[VIII]}Ca^{2+}=^{[VIII]}REE^{3+}+^{[VIII]}Na^{+}$ substitution. The REE patterns of Sch_A are similar to that of the PBG, indicating that the REEs in Sch_A were inherited from the PBG. Complex textures of scheelite and the similar geochemical properties of Sch_{B1} and Sch_{B3} indicate repeated injections of ore-forming fluids into the PBG during the precipitation of Sch_B. The evolution of ore-forming fluids, along with the precipitation of apatite and early scheelite (Sch_A and Sch_B), resulted in Sch_C with a more intense enrichment in MREE. Sch_a and Sch_B have the same REE patterns, indicating their precipitation from the same ore-forming fluids. The precipitation of zoisite prior to Sch_B contributed to a sharp decrease in MREE and HREE concentrations relative to Sch_A. The Europium anomaly in scheelite indicates an initial increase in oxygen fugacity, followed by a slight decrease from Sch_A to Sch_B and Sch_C. At the same time, the most oxidizing conditions occurred in Sch_a from the lamprophyre. The binary plot of variable elements V versus As in scheelite from the PBG shows similar variations in oxygen fugacity as indicated by the Europium anomaly, suggesting that V versus As may serve as a potential fingerprint for oxygen fugacity in scheelite. The decrease in the Y/Ho ratio from early to late scheelite reflects self-precipitation of early scheelite, given the 2:1 incorporation of REE-Eu (mole) and Y (mole) into scheelite. Calcium necessary for scheelite formation is sourced from the sericitization of calcic plagioclase in the PBG and the biotitization of mafic minerals (e.g., hornblende) in lamprophyre. This study demonstrates that different host rocks significantly influence the evolutionary pathways and physicochemical properties of ore-forming fluids. Water-rock interactions play crucial roles at various stages of scheelite precipitation in the Dongyuan deposit.