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Tungsten mineralization during the evolution of a magmatic-hydrothermal system: Mineralogical evidence from the Xihuashan rare-metal granite in South China

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Abstract

Tungsten deposits are usually associated with granitic intrusions that record a long and complex evolution of the magmatic-hydrothermal system. However, the genetic link between magmatic-hydrothermal evolution and tungsten mineralization remains unclear. The Xihuashan tungsten deposit in South China, an important vein-type wolframite deposit, is closely associated with greisen and multiphase intrusive activity that produced biotite granite, two-mica granite, and muscovite granite. From the biotite granite to the two-mica granite to the muscovite granite, micas vary from siderophyllite to lithian siderophyllite, with decreasing K/Rb and Nb/Ta ratios and increasing Rb and Cs contents. The zoned micas in the muscovite granite and greisen display fluorine-depleted rims, reflecting subsolidus replacement by external aqueous fluids. The presence of siderite indicates a Fe-, Mn-, and CO_2-rich fluid under reducing conditions. The micas in the greisen have higher-F contents and lower Fe^{3+}/Fe^{2+} ratios than those in the muscovite granite, suggesting that the fluids contributing to greisen formation had a relatively high-fluorine content and were reduced. The increase of CO_2 in the fluid enhanced its ability to unlock W from melts/rocks into fluids. The reducing environment also facilitated the tungsten mineralization. During greisenization, the pH value of the fluid increased, which destabilized the polymeric tungstates to form WO_4^{2-}. The mixture of W-rich solution and Fe-, Mn-rich external fluid eventually precipitated as vein-type wolframite in favorable locations. An empirical equation ($Li_2O = 0.0748 \times F^2 + 0.0893 \times F$) was introduced for estimating the Li_2O contents of hydrothermal micas using the F contents determined by EPMA.

Keywords: Rare-metal granite, tungsten mineralization, magmatic-hydrothermal evolution, mica, siderite, South China