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Trace elements and Sr-Nd isotopes of scheelite: Implications for the W-Cu-Mo polymetallic mineralization of the Shimensi deposit, South China

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Abstract

The Shimensi deposit (South China) is a newly discovered W-Cu-Mo polymetallic deposit with a reserve of 0.76 million tones WO_3, one of the largest tungsten deposits in the world. We report elemental and Sr-Nd isotopic data for scheelites from the giant deposit, to determine the source region and genesis of the deposit. Scheelite is the most important ore mineral in the Shimensi deposit. Trace elements (including REEs) and Nd-Sr isotopic compositions of scheelites were used to constrain the origin of the mineralizing fluids and metals. Our data reveal that the REEs of scheelite are mainly controlled by the substitution mechanism $3Ca^{2+} = 2REE^{3+} + \square Ca$, where $\square Ca$ is a Ca-site vacancy. Scheelites from the Shimensi deposit show negative Eu anomalies in some samples, but positive Eu anomalies in others in the chondrite-normalized REE patterns. The variation of Eu anomalies recorded the ore-forming processes. Considering the close spatial and temporal relationship between the mineralization and porphyritic granite, we think the negative Eu anomalies were inherited from the porphyritic granite and the positive ones from destruction of plagioclase of country rock during fluid-rock interaction. The variation of cathodeluminescence (CL) color of a single scheelite from red to blue and to yellow was likely associated with the increase of REE contents. The scheelites hosted in the Mesozoic porphyritic granite with negative Eu anomalies formed in a primitive ore-forming fluid, whereas the scheelites hosted in Neoproterozoic granite with positive Eu anomalies precipitated in an evolved ore-forming fluid. The high Nb, Ta, LREE contents, and LREE-enriched REE patterns of scheelites from the Shimensi deposit reveal a close relationship with magmatic hydrothermal fluids.

The scheelites from the Shimensi deposit are characterized by low $\varepsilon_{Nd}(t)$ values (–6.1 ≈ –8.1) and unusually high and varied initial $^{87}Sr/^{86}Sr$ ratios (0.7230~0.7657). The $\varepsilon_{Nd}(t)$ values of scheelites are consistent with those of the Mesozoic porphyritic granite, but the Sr isotopic ratios are significantly higher than those of the granites, and importantly, beyond the Sr isotopic range of normal granites. This suggests that the ore-forming fluids and metals cannot be attributed to the Mesozoic porphyritic granites alone, the local Neoproterozoic Shuangqiaoshan Group schists/gneisses with high Rb/Sr ratios and thus radiogenic Sr isotopic compositions should have contributed to the ore-forming fluids and metals, particularly, in a later stage of ore-forming process, by intense fluid-rock interaction. This is different from a commonly accepted model that the ore-forming fluids and metals were exsolved exclusively from the granite plutons.

Keywords: Scheelite, trace element, REE, Sr-Nd isotopes, Shimensi