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Minor and trace element abundances of scheelite from tungsten-tin deposits in the Baiganhu area, East Kunlun Belt, northwestern China and their bearing on metallogenesis

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The recent discovery of large W-Sn deposits in the Baiganhu area in the northern margin of the Tibetan plateau makes the area a new world-class W-Sn metallogenic province with indicated resources of 174,913 tonnes WO_3. The mineralization is hosted by a 431 Ma monzogranite and associated skarns, greisens and quartz veins in the quartz-muscovite schist of the Proterozoic Xiaomiao Formation. The W-Sn deposits formed through three stages. The first stage involved the crystallization of scheelite in tremolite-diopside skarns along the contact between monzogranite and the Xiaomiao formation. Carbonate rocks in the host Xiaomiao formation close to the skarns are extensively recrystallized to form marble. Siliclastic rocks of the Xiaomiao formation are altered to white mica-quartz schist. Scheelite in the skarn produces dark blue CL responses, with MoO_3 (0.013-0.119 wt%), total REEs (250-1180 ppm), Y (70.0-298 ppm), a convex upward REE pattern, LREE/HREE (1.04-6.49), Eu/Eu* (0.19-0.96), Nb/Ta (0.08-0.74), and Zr/Hf (4.88-20.7). Monzogranite contains the total REEs (132-326 ppm) and Eu/Eu* (0.45-0.84) and shows similar REE patterns, suggesting that the parental magmas supplied ore-forming fluids. The interpretation is consistent with previously reported fluid inclusion data.

The second event is the development of greisen-type deposits, where quartz, muscovite, tourmaline, fluorite, wolframite and scheelite crystallized in the upper part and wall rocks of monzogranite intrusions. The host rocks are silicified and chloritized. Scheelite in the greisen-type ore shows yellow CL, with MoO_3 (0.009-0.079 wt%), total REEs (2750-4180 ppm), Y (456-1000 ppm), LREE/HREE (1.12-2.67), Eu/Eu* (0.01-0.02), Nb/Ta (1.16-2.20), and Zr/Hf (4.03-7.79).

The third event formed quartz-vein ore in the Xiaomiao formation and muscovite-bearing zone of monzogranite. Cross-cutting relationships clearly indicate the veining after the greisenization. The veins are composed of quartz, wolframite, cassiterite, and minor chlorite and scheelite in chloritized wall rocks. Scheelite shows light blue CL, with MoO_3 (0.009-0.087 wt%), total REEs (43.5-420 ppm), Y (32.0-127 ppm), LREE/HREE (0.14-2.26), Eu/Eu* (1.20-66.6), Nb/Ta (0.01-0.59), and Zr/Hf (2.81-10.1). It shows a slight concave REE pattern with very high Eu, indicating the interaction of mineralizing hydrothermal fluids with intrusions to leach Eu at moderate temperatures.

Yellow Cl response of scheelite is generally considered to reflect high Mo, but this study shows that the CL color is not related to Mo. Instead, the color is related with REE contents. Since scheelite does not contain significant amounts of alkalis, we suggest that trivalent REEs likely substituted into Ca site of scheelite; $3Ca^{2+}=2REE^{3+}+\square$. The low Nb/Ta and Zr/Hf ratios of scheelite suggest that the ore constituents were derived from the crustal rocks. This is consistent

with the crustal isotope signature for scheelite in the ore ($\varepsilon_{Nd}(t)$= -9.7 - -8.7, $^{87}Sr/^{86}Sr(t)$=0.7157-0.7249; t = 431 Ma).