

Tungsten-tin mineralization in the Baiganhu area during Paleozoic post-collisional rifting in east Kunlun belt, northern Tibetan plateau

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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. The area contains indicated resources of 174, 913 metric tons WO_3 at a cutoff grade of 0.15 % and 79, 091 metric tons Sn at a cutoff grade of 0.1%. 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. A U-Pb isochron age of cassiterite, 427 ± 13 Ma, suggests that a genetic relationship between the two. The monzogranite consists of K-feldspar (35-40 vol%), plagioclase (25-30 vol%), quartz (25-30 vol%) and biotite (<10 vol%). The intrusion has a geochemical affinity with anorogenic Type 2 granitoids, with high contents of alkalis ($\text{NaO} + \text{K}_2\text{O} = 7.25\text{-}9.18\text{wt}\%$), total REEs (132-346 ppm with $[\text{La}]_n/[\text{Yb}]_n$ 7.75-14.5), and Zr (112-799 ppm), high ratios of $\text{K}_2\text{O}/\text{Na}_2\text{O}$ (1.24-2.06), Ga/Al (2.80-3.11), Y/Nb (1.28-5.15), Rb/Nb (3.27-48.1), and low CaO (1.43-2.21 wt%), TiO_2 (0.24-0.57 wt%), and P_2O_5 (0.06-0.13 wt%). It is peraluminous with A/CNK ratios ranging from 0.94 to 0.99. Zircon saturation temperatures indicate a wide range, from 750 to 921 °C.

Whole-rock $\epsilon_{\text{Nd}}(t)$ range from -2.7 to -3.1 (T_{DM} , 1.04-1.81 Ga) and zircon $\epsilon_{\text{Hf}}(t)$ from + 0.7 to + 4.1 (T_{DM} , 0.90-1.04 Ga). The isotope compositions for scheelite in the ore show a distinctly more crustal signature, with low $\epsilon_{\text{Nd}}(t)$ between -9.7 and -8.7 and high $^{87}\text{Sr}/^{86}\text{Sr}(t)$ between 0.71566 and 0.72485. The data suggest significant crustal contributions to these metals. The quartz-muscovite schist of the Proterozoic Xiaomiao Formation consists of quartz (<60 vol%), muscovite (30-35 vol%) and biotite (<10 vol%), and elevated concentrations of W (6.2 ppm) and Sn (4.6 ppm) compared to upper crustal averages, 1.9 and 2.1 ppm, respectively. The schist ^{207}Pb - ^{206}Pb ages range from 1700 ± 6 Ma to 1898 ± 2 Ma, with whole-rock $\epsilon_{\text{Nd}}(t)$ values from -10.5 to -7.5, and zircon $\epsilon_{\text{Hf}}(t)$ from -31.4 to -18.1. Using these values, the parental magma of monzogranite is calculated to contain an upper mantle-derived melt (18-30%) and Proterozoic crustal component. We propose that post-collisional extension within the eastern Kunlun orogenic terrane allowed mantle upwelling, adiabatic melting of the upper mantle and melting of ancient lithosphere to form the parental magma. Metals were likely incorporated into the parental magmas during the anatectic melting and assimilation of crustal rocks.