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Whole-rock and accessory mineral compositions of Late Jurassic Highly Fractionated Granites in the Xianghualing Area, South China: Implications for Rare-Metal Mineralization

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With the increasing global demand for strategic (or critical) metals such as W, Sn, Nb, Ta, Li, and Be, understanding the mechanisms governing rare-metal enrichment in mineral deposits has become a growing concern. In South China, most of important rare-metal mineralization is associated with Late Jurassic highly fractionated granites. The Xianghualing deposit, located in the Nanling W–Sn metallogenic belt in central South China, is renowned for its high abundances of W, Sn, Nb, and Ta, with 0.134 Mt Sn metal, 0.028 Mt WO_3, and 22 kt (Ta, Nb)$_2O_5$ [1]. The mineralization of these metals is primarily associated with the highly fractionated Laiziling granite. The Laiziling granite shows a distinct vertical zonation, transitioning from biotite alkali-feldspar granite at the base to albite granite, greisen, and pegmatite shells at the top. The biotite alkali-feldspar granite is considered the Sn–W metallogenic parent rock, whereas the pegmatite is closely linked to Nb–Ta–Li–Be enrichment [2]. In this study, a series of biotite alkali-feldspar granites, albite granites, and pegmatite from the Laiziling pluton, as well as apatite, monazite, and zircon from these rocks, were studied to improve our understanding of mechanism related to rare-metal enrichment. The U-Pb dating of monazites from different granites yield lower intercept ages from 156 to 151 Ma, whereas the U-Pb dating of apatite from pegmatite yields a lower intercept age of 151.3 ± 0.81 Ma (1σ, MSWD = 3.7). Zircon from both the granites and pegmatite exhibits similar negative εHf(t) values (−5.4 to −2.4 for granites, t = 153 Ma; −6.3 to −2.1 for pegmatite, t = 151 Ma, respectively). The geochemical results of accessory minerals indicate a continuous evolution of the granites and pegmatites in the Xianghualing area. All the studied granites are characterized by high SiO_2 contents (72.96-77.47 wt%). The pegmatite is notably enriched in Ta, Li, Nb, Cs, Rb and other alkali metal elements. Our results imply that a high degree of fractional crystallization plays a crucial role in rare-metal mineralization in the Xianghualing area.

[1] Li et al. (2018) Ore Geol Rev 312, 1-20. [2] Wu et al. (2023) Earth Planet Sci Lett 613, 118186.