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Barium isotope constraint on the formation of A-type granites and tin mineralization in South China

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Increasing studies have shown that many tin deposits are genetically related to A-type granites worldwide [1]. However, the intrinsic connection between the A-type granites and tin deposits is not well understood. Barium is a fluid-mobile alkaline earth element, and Ba isotopes have been used to study its source and migration in magmatic and fluid processes. The Qitianling A-type granite batholith (South China) is spatially and temporally associated with the Furong giant tin deposit (~700,000 tons). Here, we report Ba isotope compositions of the A-type granites to understand the relationship between the A-type granites and tin mineralization.

The Qitianling batholith is a composite pluton with three phases according to their ages and petrography. The less evolved Phase 1 granites have relatively narrow range of $\delta^{138/134}$Ba (-0.24~0.37‰), whereas the highly evolved Phase 2 and 3 granites display significantly variation in $\delta^{138/134}$Ba (-1.78~0.14‰ and -1.56 ~ -0.35‰, respectively). The large age gap (~5-10Ma) and spatial distribution characteristics of the granites indicate that the composite pluton did not result from continuous evolution. The chemical compositions of the Phase 2 granites show influence of fractional crystallization dominated by K-feldspar, which cannot explain the low $\delta^{138/134}$Ba of the Phase 2 and 3 granites [2]. In addition, all granites have similar radiogenic Sr-Nd isotope compositions, suggesting that their sources may have similar geochemical features. Therefore, the Ba isotope variation in Qitianling granites should not reflect the heterogeneous of the source. Instead, the Phase 2 and 3 granites are directly associated with the tin mineralization and show obvious magmatic-hydrothermal interaction features, implying the influence from the Sn-enriched ore-forming fluids. Experimental studies indicate that exsolved magmatic fluids should have lower $\delta^{138/134}$Ba than the magma [3]. Given that the magmatic fluids could be enriched in fluid-mobile elements (e.g., Ba, Sn), we propose that interaction between granites and exotic magmatic fluids produced the light Ba isotope composition of the highly evolved Phase 2 and 3 magmas and the associated tin deposits.

[1] Lehmann, 2020, Lithos, 105756.

[2] Deng et al., 2021, Geochim. Cosmochim. Acta, 292, 115-129.

[3] Guo et al., 2020, Geochem. Perspect. Lett. 16, 6-11.