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Apatite as a tracer to fingerprint the magmatic-hydrothermal process of the giant Gejiu tin deposit, Yunnan Province, China

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Apatite is a ubiquitous accessory mineral and its chemical composition is sensitive to magmatic and hydrothermal processes. In this study, we present a detailed texture, paragenesis, and in-situ chemical composition of apatite developed in the mineralized granite and basalt from the giant Gejiu tin deposit of South China, to explore the insights into the magmatic-hydrothermal process relative to ore formation. Under the cathodoluminescence condition, all the apatite samples share common bright cores and dark edges. The cores inherit the composition of the primary magma and the rims record the subsequent ore-related hydrothermal processes. Chemical analyses suggest that the apatite samples collected from granite and basalt are dominated by the fluorapatite and fluorochloroapatite, respectively. In-situ analyses of the zoned apatite samples documented that the dark rims have lower concentrations of Cl, Fe, Mn, and LREE and higher contents of Sr, S, and HREE relative to the bright cores. This coincident variation in the rims and cores of apatite developed in granite and basalt indicates that these samples have experienced the similar overgrowth during the ore-forming process. Experimental petrology has confirmed that the solubility of Sn is higher in low pH and Cl-rich fluid. The depletion of Cl in apatite indicates that Cl is preference to fluids during the interaction between the ore-forming fluids and host igneous rocks. Thus, the Cl concentration in cores of apatite from granite and basalt implies that the initial Cl content of granite is lower than basalt and the Cl may be mainly derived from the altered basalt. Moreover, the depletion of Fe, Mn, and LREE in the rims indicates that the hydrothermal fluid has lower pH which is beneficial to improve the solubility of Sn. Thus, the Cl from altered basalt and lower pH of ore-forming fluids favor the enrichment of Sn and further contribute to the formation of the giant tin deposit.