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Fluctuations of trace elements of the multi-stage calcite in the Giant Luziyuan Distal Skarn Zn-Pb-Fe Deposit, SW China: Implications for ore-forming process

RONG XU, WEN-CHANG LI AND YUAN-CAN YING
Kunming University of Science and Technology

The giant Luziyuan Zn-Pb-Fe deposit is located in the southern Baoshan block, central-southern Sanjiang Tethyan Metallogenic Domain (SW China). The Luziyuan deposit contains over 4.2 million tonnes (Mt) of contained Zn + Pb metal reserves at 5.09% Zn and 2.40% Pb, and 301 Mt of Fe ore resources at 30.02% TFe, which is the largest and most representative Zn-Pb-Fe deposit in the Baoshan block and shows big ore potential at depth with ongoing exploration. Despite many advances in understanding its genesis, the detailed ore-forming processes are still unclear.

Based on mineral assemblages and crosscutting relationships, it is identified that calcites occurred through the pre-, syn-, and post-ore stage at Luziyan. All the Luziyuan calcite samples exhibit broadly similar continental crust-normalized trace element distribution patterns, suggesting a likely common origin. Notably, they are also enriched in Mn, Mg, as well as ore-forming elements such as Zn, Pb, Fe, and minor Cu, potentially indicating a close relationship with mineralization. Overall, all the Luziyuan calcite samples display a broadly similar "flat-type" REY distribution pattern, characterized by slight depletion in LREE (La–Eu) and minor enrichment in HREE (Gd–Lu), but show no positive correlation between $\sum$REE and $(La/Lu)_{PAAS}$, nor negative correlation between $\sum$REE and Sr. Therefore, simple crystallization control alone is unlikely to produce the Luziyuan REY characteristics. The LREE depletion is mainly attributed to the removal and purification of substantial LREE during the post-precipitation recrystallization of calcites at Luziyan. Calcite samples from the pre-, syn-, and post-ore stage successively exhibits a positive Eu anomaly, no significant Eu or Ce anomalies, and a negative Eu anomaly, indicating that the initial ore-forming fluids were sourced primarily from crustal magmatic-hydrothermal fluids, and may have changed from oxidizing to reducing along with their evolution pathway.