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Ore geology, magnetite and sphalerite geochemistry of the Luziyuan Zn-Pb polymetallic deposit in the southern Baoshan block, Sanjiang region (SW China): Implications for ore genesis

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The super-large Luziyuan Zn-Pb polymetallic 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 deposit in the Baoshan block and shows big ore potential at depth with ongoing exploration. Despite decades of study, its genesis is still under debate. Uncertainties remain on whether the deposit is strata-bound/sedimentary-reworked, SEDEX-related or skarn-type, but all of which lack systematic geochemical evidence.

The alteration and mineralization zoning pattern of the metallogenic system evolution at Luziyuan is also manifested by mineral assemblage change from (deep-level) garnet-clinopyroxene(-pyroxenoid-actinolite) calcic-skarn Fe-Cu mineralization (medium-level) pyroxenoid(-clinopyroxene-actinolite) mangano-skarn Zn-Pb-Fe-Cu mineralization (shallow-level) Zn-Pb mineralization in the (chloritized) marble. This matches with a decreasing temperature trend away from the concealed intrusion, and the time-space zoning is consistent with typical distal Zn skarn deposits.

The major findings include: (1) the magnetite has relatively low Al, Ti, Sn, Ga, V, and Cr contents, and falls into the hydrothermal skarn field in the Ni/(Cr+Mn) vs. Ti+V and Ca+Al+Mn vs. Ti+V, Ti vs. Ni/Cr, V vs. Ti, and V/Ti vs. Fe (wt.%) discrimination plots. This supports a skarn-type origin; (2) the sphalerite is enriched in Mn, Fe, and Co and In-depleted, similar to typical skarn-type sphalerite (mostly Co > 200 ppm, Mn > 1000 ppm), but clearly different from that of SEDEX, VMS (enriched in In, Sn, Ga) and MVT (enriched in Ge, Cd, Tl, and As); (3) sphalerite Zn-S isotopes and magnetite Fe-O isotopes indicate that the ore metals were mainly sourced from magmatic-hydrothermal fluids. The deposit geology and geochemical features indicate that the Luziyuan deposit should be classified as a distal skarn Zn-Pb polymetallic deposit, which constitutes a magmatic-hydrothermal mineral system surrounding its ore-causative deeply concealed granitic pluton.