Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.35131

Lithospheric structure and magmatic fractionation control the giant Ag metallogenic belt in the Great Xing'an Range

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Magmatic-hydrothermal silver deposits are the main source of silver and commonly occur as clusters along specific metallogenic belts. However, the large-scale magmatic processes leading to the massive silver endowment of those metallogenic belts remain poorly constrained. We integrate whole rock geochemistry and Nd-Hf isotopic data of the Great Xing'an Range metallogenic belt (GXMB, China) to produce regional isotopic maps. Those maps reveal the genetic relationship between silver mineralization and crustal architecture. The whole rock Nd and zircon Hf isotope mapping of the Mesozoic intermediate-felsic rocks in the GXMB reveals that 75% of the belt consists of juvenile isotopic domains ($\varepsilon_{Nd}(t)>0$, $\varepsilon_{Hf}(t)> +4$). The large silver deposits preferentially occur in the most juvenile isotope domains ($\varepsilon_{Nd}(t)> +2$, $\varepsilon_{Hf}(t)> +6.5$), particularly along the paleo-sutures or at intersections between paleo-sutures and faults. However, $\varepsilon_{Nd}(t)$ and $\varepsilon_{Hf}(t)$ values of the Ag-related felsic igneous rocks exhibit significant heterogeneity among deposits with different silver tonnages, suggesting that the proportion of juvenile or ancient crust involved in magmatic evolution is not the dominant factor controlling the endowment of the silver deposits. The large silver deposits in the GXMB are spatially and temporally associated with the Mesozoic A-type granites characterized by high SiO_2 contents and Rb/Sr ratios, indicating a high degree of magmatic fractionation. A strong positive correlation between whole-rock Rb/Sr ratios and Ag reserves of deposits suggests that high degree of magmatic differentiation is the first-order control on silver enrichment in the GXMB. We propose that paleo-sutures and structural junctions are major conduits for juvenile magmas, allowing their accumulation and differentiation into large magmatic reservoirs. Finally, fluid exsolution of the highly fractionated melt from those reservoirs will lead to the formation of silver deposits in the GXMB.