

The Impact of Early Sulfur Saturation and Calc-Crustal Contamination on Ore-Forming Processes Within the Posan Mafic-Ultramafic Complex: Derivation from the Shallow Depleted Mantle, Beishan Region, NW China

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The Posan ultramafic intrusion is one of the ± 280 Ma Pobei mafic-ultramafic complexes located in the Beishan rift, northeastern margin of the Tarim craton. Given that three recently completed drill holes did not reveal economic mineralization, it is necessary to understand the ore potential of this little ultramafic intrusion. Results of field work indicate that the Posan intrusion was formed by five stages of magmatism. Stages I, II, and III are dominated by gabbros, gabbro-norites, and olivine-gabbro; stages IV and V are of ultramafic composition and display features typical of layered intrusions.

Theoretically, the Posan ultramafic intrusion meets the first requirement to form nickel sulfides, with a high-MgO parental magma (12.4%). Moreover, the low Ni content of olivines (less than 1,900 ppm) and the presence of spinel within the sulfide paragenesis demonstrate that the Posan intrusion has undergone early sulfur saturation, before or during fractional crystallization of spinel. In stage IV, the continuous decrease of Ni contents of olivines, along with fractional crystallization, calc-crustal contamination (irregular distributed plagioclase, high Th/Yb ratios, Nb and Zr depletion, and K, Rb, Ba, U, Th, and Pb enrichment) instead of sulfur-rich crustal contamination, and high oxygen fugacity levels ($2.1 < f_{O_2} \text{ QFM} < 3.0$), results in the absence of disseminated sulfides.

The use of clinopyroxene $\text{TiO}_2\text{-Al}_2\text{O}_3$ diagrams confirms that the Beishan mafic-ultramafic complexes form in a rift-related environment rather than an arc-related one. Low TiO_2/Yb and Nb/Yb ratios reflect that the Beishan complexes are derived from shallow depleted mantle without garnet. Considering the temporal and spatial relationship of the Tarim large igneous province and the large number of mafic-ultramafic intrusions in the Beishan region, it is reasonable to speculate that the Beishan mafic-ultramafic complexes, including the Posan intrusion (275.8 ± 2.7 Ma), have a genetic affiliation with the early Permian Tarim plume, but do not directly come from it.