

Petrogenesis and Ni-Cu Sulfide Mineralization of Early Permian Mafic-Ultramafic Complexes in the Beishan Area, Xinjiang

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Many small ultramafic-mafic intrusions, accompanied with series of economically magmatic Ni-Cu sulfide deposits, e.g., Qixin, Podong, Poyi Ni-Cu deposits, were discovered in the Beishan area, southern margin of the Central Asian Orogenic Belt (CABO). Sparsely disseminated sulfide mineralization occurs in the Poyi and Qixin Iherzolite, whereas densely disseminated sulfide occurs in the Podong orthopyroxene-bearing ultramafic-mafic intrusions. Zircon U-Pb geochronological dating suggests these mafic-ultramafic intrusions were formed during the early Permian (294-273 Ma). These mafic-ultramafic samples show low La/Yb ratios, LILE enrichment, HFSE depletion (e.g., Nb and Ta), and high $\delta^{18}\text{O}$ (5.36-9.26‰), implying that they were derived from the shallow sub-lithospheric mantle metasomatized by subducted slab-derived fluid. The generation of these early Permian mafic-ultramafic intrusions associated with Ni-Cu sulfide mineralization in the Beishan area may be attributed to post-orogenic extension and a ~280 Ma mantle plume event. The Podong mineralized units show relatively lower $\epsilon_{\text{Nd}}(t)$ (-1.00 - +0.51) compared to those of the Poyi and Qixin mineralized samples ($\epsilon_{\text{Nd}}(t)$ = +4.29 - +6.97), suggesting the addition of more contaminated material in the former. Furthermore, in the $f\text{O}_2$ calculation of parent magma between the olivine and Cr-spinel compositions, the Podong mineralized units show relative lower ΔQFM (-0.5 - +1.5) and olivine Ni contents (200 - 3427 ppm), resulting in the effective sulfide immiscible process. In contrast, the relatively higher ΔQFM (+0.3 - +2.5 and +2 - +3.5) and olivine Ni contents (2,771-6,747 ppm and 1,097-4,244 ppm) for Poyi and Qixin mineralized samples suggest the parent magma was characterized by relatively oxidized conditions, and sulfide segregation may be limited or occur in the deep magma chamber. The above observation confirms the orthopyroxene-bearing portions (e.g., Podong olivine gabbro and gabbro) may be a potential exploration target for Ni-Cu deposits in the Beishan area.