

Geochronology and Sr-Nd-Os-S isotopes of the Tulargen magmatic Ni-Cu deposit in the Central Asian orogenic belt, NW China

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The Tulargen Ni-Cu ore deposit is one of the three largest magmatic sulfide deposits in East Tianshan, within the southern margin of the Central Asian Orogenic Belt in Xinjiang, NW China. The Ni and Cu grades of the Tulargen deposit are much higher than other major deposits in the region. The Tulargen deposit is associated with the No. I mafic-ultramafic intrusion that is composed of lherzolite, olivine websterite, and gabbro. An intrusive contact is present between the gabbroic and ultramafic units. The contact between the ultramafic rocks is gradational. Sulfide mineralization is restricted to the ultramafic unit. It occurs as disseminated, net-textured, and semi-massive sulfide ores in the base of the ultramafic unit, plus a massive sulfide dike in the footwall. Pyrrhotite, pentlandite, and chalcopyrite are the principle sulfide minerals. Like two separate gabbroic intrusions nearby (No. II and III), the gabbroic unit of the Tulargen No. I intrusion is barren of ore. Previous study reported a zircon U-Pb age of ~300 Ma for the gabbroic unit of the Tulargen No. I intrusion. The U-Pb age of zircon crystals from the ultramafic unit of the Tulargen No. I intrusion, determined by us, is ~276 Ma, which is ~25 myr younger than the age of the associated gabbroic unit. The ultramafic rocks of the Tulargen No. I intrusion are all characterized by light REE enrichments relative to heavy REE, pronounced negative Nb-Ta anomalies, low initial $^{87}\text{Sr}/^{86}\text{Sr}$ ratios from 0.7034 to 0.7037, and elevated $\epsilon\text{Nd}(t)$ values from 4.85 to 6.89. These data indicate that the parental magma was derived from a depleted mantle source, experienced only minor amounts of crustal contamination, and already had some degrees of negative Nb-Ta anomalies prior to crustal contamination. Several sulfide ore samples from the Tulargen deposit contain 3 to 138 ppb Re and 0.02 to 0.97 ppb Os, yielding high Re/Os ratios from 54 to 325, which are significantly higher than the mantle value. The γOs values of the sulfide ore samples vary from 637 to 1041, indicating the addition of crustal Os to the parental magma. Because Os in the crust is most commonly hosted in sulfides or organic matter, the Os isotopic data clearly indicate assimilation of crustal sulfide or organic matter. The $\delta^{34}\text{S}$ values of the sulfide ore samples ($n = 33$) are from -0.3 to 1.47‰, which overlaps but tends to be higher than the range of MORB (-1.57 to +0.60 ‰). The Os-S isotopic data together generally support the notion that the addition of crustal sulfur played a role in triggering sulfide saturation in the parental magma of the Tulargen magmatic sulfide deposit. Lack of significant sulfide mineralization in the associated gabbro unit and the nearby gabbroic intrusions indicates that gabbroic intrusions in the region are not good Ni exploration targets.