

Compositional Variations of Chromite from the Hongshishan Ni-Cu-Bearing Mafic-Ultramafic Complex, NW China: Petrogenetic and Metallogenic Implications

Banxiao Ruan,^{1,*} Yingmin Yu,² Xinbiao Lü,^{1,3} Wei Wei,² and Chunming Wu¹

¹Geology Survey, China University of Geosciences, Wuhan 430074, China

²Faculty of Earth Resources, China University of Geosciences, Wuhan 430074, China

³State Key Laboratory of Geological Processes and Mineral Resources, China University of Geosciences, Wuhan 430074, China

*E-mail, 514589797@qq.com

The Hongshishan mafic-ultramafic complex is located on the northeastern Tarim plate. The gabbro unit (272.5 ± 3.5 Ma) occurs along the margins of the complex, while mineralized wehrlite is restricted to the center, and olivine gabbro to the middle. The orebody is of low grade (0.2% Ni). Sulfide aggregates, composed of pentlandite, chalcopyrite, and pyrite, occur along silicate grain boundaries. Chromites within peridotite and wehrlite range in size from 20 to 400 μm , and are divided into three types based on their occurrence and morphology. Type 1 chromites occur as euhedral-subhedral inclusions within silicate minerals, and are relatively homogeneous in composition, occasionally including high-Ti chromites. Type 2 chromites occur as interstitial phases without magnetite rim. Type 3 refers to zoned chromites with Cr-rich core and magnetite rims. Chromite grains commonly contain inclusions of pyroxene, cummingtonite, biotite, ilmenite, and spinel.

The compositional variation between magnetite rim and chromite core is continuous, indicating that the metasomatism occurred during alteration (Kimball, 1990; Prabhakar and Bhattacharya, 2013), with FeO and Fe₂O₃ replacing MgO, Al₂O₃, and little Cr₂O₃. The overall compositional variation shows that type 1 and type 2 chromites constitute the primary trend, while the modified trend is represented by high-Ti chromites and zoned chromites. The Cr#(46–74) of the primary chromites is different from boninites and MORB, but similar to OIB from Hawaiian basalts. The modified chromites may (1) have crystallized from an evolved magma after the crystallization of olivine and then equilibrated with interstitial liquid, or (2) have formed by partial reequilibration with secondary magnetite rim during serpentinization.

The equilibration temperature, calculated using olivine-spinel thermometer, is 1,140 to 1,200°C (1,090°–1,180°C for high-Ti chromite) for type 1 and 1,040° to 1,100°C for type 2, while 910° to 950°C for type 3 represents the temperature of serpentinization. The estimated parental magma has high MgO (14.52%), relatively low FeO (5.2%), and variable TiO₂ (0.83–4.27%) and Al₂O₃ (10.6–15.8%). The high MgO content and high temperature of calculated melt in equilibration with olivine, as well as the high Cr content of the primary chromites, demonstrate that the chromites most likely crystallized from a high-Mg tholeiitic magma in an intracontinental rift setting. The high-Ti chromites may imply that the source of the complex has been subjected to reaction with high-Ti melt, like OIB, after partial mantle melting. The study of Al₂O₃-TiO₂ and TiO₂-Cr# diagrams infers that the complex originated from about 14% partial melting melt, which has then undergone reaction with OIB-like melt rather than

boninites and island-arc tholeiites.

The pyroxene inclusions within chromites are mainly orthopyroxene. In contrast, clinopyroxenes are predominant in the whole complex. This feature may be attributed to crustal assimilation of marble during upwelling of magma, which is also confirmed by sphene, an indicator of high Ca and high Ti of magma. Furthermore, the contamination of quartz schist could decrease S solubility. Meanwhile, the decrease of FeO and temperature would induce S saturation and, consequently, trigger sulfide segregation.