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Petrogenetic insights from chromite in ultramafic cumulates of the Xiarihamu intrusion, northern Tibet Plateau, China

Xie-Yan Song[1,*,†], Kai-Yuan Wang[1,2], Stephen J. Barnes[3,‡], Jun-Nian Yi[1], Lie-Meng Chen[1], and Louise E. Schoneveld[3]

[1]State Key Laboratory of Ore Deposit Geochemistry, Institute of Geochemistry, Chinese Academy of Sciences, Guiyang, 550081, P.R. China
[2]Graduate University of Chinese Academy of Sciences, Beijing 100049, China
[3]CSIRO Mineral Resources, Kensington, Perth, Western Australia 6151, Australia

Abstract

Chromite is one of the earliest crystallized minerals from mafic melts and has been used as an important "petrogenetic indicator." Its composition may be modified by interaction with intercumulate melt and adjacent minerals. Thus, chromite in mafic-ultramafic rocks contains clues to the geochemical affinity, evolution, and mantle source of its parent magmas. The Devonian Xiarihamu intrusion, located in the East Kunlun Orogenic Belt in the northern Tibet Plateau, China, hosts a very large disseminated Ni-Co sulfide deposit. This study focuses on geochemistry of the chromite enclosed in olivine of ultramafic rocks of the intrusion. Enrichments in Mg and Al in the rim of the chromite indicate only minor effects of alteration on the compositions of the chromite. The chromites enclosed in the olivines with forsterite percentage (Fo) lower than 87 are characterized by large variations in major and trace elements, such as large ranges of Cr·100/(Cr+Al) (Cr# = 15–47), Mg·100/(Mg+Fe^{2+}) (Mg# = 41–65), and Al_2O_3 (= 26–53 wt%) as well as 380–3100 ppm V, 70–380 ppm Ga, and 1100–16300 ppm Zn. The chromites display positive correlations between Cr/(Cr+Al) and Ti, Mn, V, Ga, and Sc, inconsistent with fractional crystallization but indicative of an interaction between the chromites, intercumulate melts and hosting minerals. In contrast, chromites hosted in olivine with Fo > 87 in harzburgite have small variations in Cr# (ranging from 37 to 41), Mg# (48 to 51), and Al_2O_3 (30 to 35 wt%) as well as restricted variation in trace elements, indicating relatively weak interaction with trapped liquid and adjacent phases; these compositions are close to those of the most primitive, earliest crystallized chromites. The most primitive chromite has similarities with chromite in mid-ocean ridge basalt (MORB) in TiO_2 and Al_2O_3 contents (0.19–0.32 and 27.9–36.3 wt%, respectively) and depletion of Sc and enrichment of Ga and Zn relative to MORB chromite. The geochemistry of the chromite indicates a partial melting of the asthenospheric mantle that was modified by melts derived from the subduction slab at garnet-stable pressures.

Keywords: Chromite, mineral geochemistry, intercumulate melt, primary magma, trapped liquid, magmatic sulfide, nickel, spinel; New Advances in Subduction Zone Magma Genesis