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Mineralogical and geochemical investigation on podiform chromitites from the Guleman Ophiolite, eastern Turkey

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The chromitites of the Guleman ophiolites are mostly found in the mantle peridotites of harzburgite and dunite, in a banded, massive and disseminated texture. The chromite crystals of chromitites have a wide range of chemical compositions (Cr_2O_3 = 47–62 wt.% and Al_2O_3 = 5–19 wt.%). Having TiO_2 contents lower than 0.33 wt.%, the chromite crystals have their Cr# and Mg# values in the range of 61–89 and 55–73, respectively, and these values support that those chromitites are podiform and ophiolitic in origin.

The chromitites from the Guleman ophiolite have low whole-rock PGE (Platinum Group Element) contents (PGE = 44–255 ppb, 168 ppb average). On the other hand, the Cr-rich chromitites (Cr# >70; Mg# = 56–72) have lower TiO_2 contents ($\leq$0.2 wt.%) and contain relatively higher content of total PGE (mean 187 ppb) contents, whereas Cr-poor chromitites (Cr# <70; Mg# = 63.5–72.5) have relatively higher TiO_2 contents (0.20–0.33 %wt.) and lower total PGE contents (mean 154 ppb). In general, there is a steady increase of TiO_2 content against the decreasing Cr# values of chromites. Similar to other ophiolitic chromitites elsewhere, the Guleman chromitites have relatively high IPGE (Os+Ir+Ru)/PPGE (Rh+Pt+Pd) ratios (2.5–12.5), and contains PGM (Platinum Group Mineral) inclusions of Os-Ir-Ru phases. Those PGE phases are rarely observed in chromite crystals, and are composed mostly of laurite [(Ru,Os)S_2], followed by erlichmanite [(Os,Ru)S_2], irarsite [(Ir,Rh)SAs] and Os-Ir alloy phases. Laurite crystals are relatively rich in Ru contents [Ru#; (100×Ru)/(Ru+Os) = 45–78]. The presence of Os-Ir alloys, as well as the laurites in ophiolitic chromitites indicates that the chromites started to crystallize at high temperature (1300 °C) and at relatively low fS_2 ($\sim$ –4) conditions. Nevertheless, the presence of erlichmanite and irarsite type PGM in chromite crystals indicates that the chromite crystallization continued at lower temperatures and higher fS_2 conditions, and also indicates that fAs conditions were relatively high during the chromite crystallization. Millerite and pentlandite inclusions represent the most abundant base metal minerals, and olivine inclusions represent the silicate inclusions.

The chromite composition of Guleman chromitites and the calculated parental compositions of the melts that crystallize the chromites, as well as the PGE geochemistry and the mineralogical properties of the primary inclusions within the chromite crystals show that the chromitites, of which their chemical compositions changes in a specific range, are formed as a result of the differentiation of the melt of boninitic character, in an island arc environment associated with subduction. This finding is supported by the steady increase of TiO_2 content depending on the decrease in Cr# values of the chromitites.