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High-pressure high-temperature transitions in $MgCr_2O_4$ and crystal structures of new $Mg_2Cr_2O_5$ and post-spinel $MgCr_2O_4$ phases with implications for ultrahigh-pressure chromitites in ophiolites†

Takayuki Ishii[1,*], Hiroshi Kojitani[1], Kiyoshi Fujino[2], Hitoshi Yusa[3], Daisuke Mori[1], Yoshiyuki Inaguma[1], Yoshitaka Matsushita[3], Kazunari Yamaura[3] and Masaki Akaogi[1]

[1]Department of Chemistry, Gakushuin University, Mejiro, Toshima-ku, Tokyo 171-8588, Japan
[2]Geodynamics Research Center, Ehime University, Matsuyama, Ehime 790-8577, Japan
[3]National Institute of Materials Science, Namiki, Tsukuba 305-0044, Japan

Abstract

We determined phase relations in $MgCr_2O_4$ at 12–28 GPa and 1000–1600 °C using a multi-anvil apparatus. At 12–15 GPa, spinel-type $MgCr_2O_4$ (magnesiochromite) first decomposes into a mixture of new $Mg_2Cr_2O_5$ phase + corundum-type Cr_2O_3 at 1100–1600 °C, but it dissociates first into MgO periclase + corundum-type Cr_2O_3 at l000 °C. At about 17–19 GPa, the mixture of $Mg_2Cr_2O_5$ phase + corundum-type Cr_2O_3 transforms to a single $MgCr_2O_4$ phase. Structure refinements using synchrotron X-ray powder diffraction data indicated that the high-pressure $MgCr_2O_4$ phase has a $CaTi_2O_4$-type structure (*Cmcm*), and that the basic structure of the $Mg_2Cr_2O_5$ phase is the same as that of recently found modified ludwigite-type $Mg_2Al_2O_5$ and $Fe_2Cr_2O_5$ (*Pbam*). The phase relations in this study may suggest that natural chromitites in the Luobusa ophiolite regarded as the deep-mantle origin were derived from the mantle shallower than the depths corresponding to pressure of 12–15 GPa because of absence of the assemblage of $(Mg,Fe)_2Cr_2O_5 + Cr_2O_3$ in the chromitites.

Keywords: Post-spinel, Rietveld refinement, crystal structure, high pressure, phase transition, magnesiochromite, calcium titanate, chromitite, ophiolite