

CHEMISTRY AND MINERALOGY OF EARTH'S MANTLE

High-pressure high-temperature transitions in MgCr_2O_4 and crystal structures of new $\text{Mg}_2\text{Cr}_2\text{O}_5$ and post-spinel MgCr_2O_4 phases with implications for ultrahigh-pressure chromitites in ophiolites†

TAKAYUKI ISHII^{1,*}, HIROSHI KOJITANI¹, KIYOSHI FUJINO², HITOSHI YUSA³, DAISUKE MORI¹, YOSHIYUKI INAGUMA¹, YOSHITAKA MATSUSHITA³, KAZUNARI YAMAURA³ AND MASAKI AKAOGI¹

¹Department of Chemistry, Gakushuin University, Mejiro, Toshima-ku, Tokyo 171-8588, Japan

²Geodynamics Research Center, Ehime University, Matsuyama, Ehime 790-8577, Japan

³National 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 $\text{Mg}_2\text{Cr}_2\text{O}_5$ phase + corundum-type Cr_2O_3 at 1100–1600 °C, but it dissociates first into MgO periclase + corundum-type Cr_2O_3 at 1000 °C. At about 17–19 GPa, the mixture of $\text{Mg}_2\text{Cr}_2\text{O}_5$ 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 $\text{Mg}_2\text{Cr}_2\text{O}_5$ phase is the same as that of recently found modified ludwigite-type $\text{Mg}_2\text{Al}_2\text{O}_5$ and $\text{Fe}_2\text{Cr}_2\text{O}_5$ (*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 $(\text{Mg,Fe})_2\text{Cr}_2\text{O}_5$ + Cr_2O_3 in the chromitites.

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