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Chromium-bearing phases in the Earth's mantle: Evidence from experiments in the Mg_2SiO_4–$MgCr_2O_4$ system at 10–24 GPa and 1600 °C

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Abstract

Phase relations in the system Mg_2SiO_4–$MgCr_2O_4$ were studied at 10–24 GPa and 1600 °C using a high-pressure Kawai-type multi-anvil apparatus. We investigated the full range of starting compositions for the forsterite-magnesiochromite system to derive a *P*–*X* phase diagram and synthesize chromium-bearing phases, such as garnet, wadsleyite, ringwoodite, and bridgmanite of a wide compositional range. Samples synthesized at 10 GPa contain olivine with small chromium content and magnesiochromite. Mg_2SiO_4 wadsleyite is characterized by the pressure-dependent higher chromium solubility (up to 7.4 wt% Cr_2O_3). The maximal solubility of chromium in ringwoodite in the studied system (~18.5 wt% Cr_2O_3) was detected at P = 23 GPa, which is close to the upper boundary of the ringwoodite stability. Addition of chromium to the system moves the boundaries of olivine/wadsleyite and wadsleyite/ringwoodite phase transformations to lower pressures. Our experiments simulate Cr-rich phase assemblages found as inclusions in diamonds, mantle xenoliths, and UHP podiform chromitites.

Keywords: Magnesiochromite, forsterite, olivine, wadsleyite, ringwoodite, knorringite, majorite, bridgmanite, mantle, high-*P*-*T* experiments, phase relations