Experimental study of the $MgSiO_3$–$MgTiO_3$ ($\pm Al_2O_3$) system at 10–24 GPa and 1600°C

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Incorporation of minor elements in mantle phases was mostly studied on a qualitative level, although even small portions of them may have a certain impact on the PT-parameters of phase transitions. Titanium is one of such elements with the low bulk concentrations in the Earth's mantle (0.2 wt% TiO_2). However, Ti-rich lithologies may occur in the mantle as a result of oceanic crust subduction (MORB has ~ 3 wt% TiO_2). Experiments in the enstatite–geikielite (±pyrope) join at 10–24 GPa and 1600°C were aimed to the study of conditions of the formation, structural features of Ti-bearing phases. We investigated the full range of starting compositions with steps of 10 mol% and 2 GPa in multi-anvil experiments, which allowed us to plot the PX diagram for the En–Gkl system. The main phases obtained in experiments were: rutile, olivine/wadsleyite, enstatite, geikielite, $MgTiSi_2O_7$ with the weberite structure type and two phases with perovskite-type structure. For Prp–Gkl system garnet is stable throughout the wide pressure range.

Addition of Al to the starting material allows us to simulate the composition of natural bridgmanites, since lower mantle Brd are characterized by significant Al contents. In contrast to Al, the high contents of Ti can stabilize bridgmanite-like compounds at considerably lower pressure (18 GPa) in comparison with pure $MgSiO_3$-Brd.

Small crystals of Ti-rich phases were examined by single-crystal X-ray diffractometer. $MgTiSi_2O_7$ was found to crystallize with the weberite-3T structure type, sp. gr. $P3_121$, with a=6.3351(7), c=16.325(2)Å, V=567.4(1)Å^3. The Al-Ti-Brd was found to be orthorhombic, sp. gr. *Pnma*, with a = 14.767(3), b = 6.958(1), c = 4.812(1)Å, V = 494.4(2)Å^3, which represents a $3\mathbf{a}\times\mathbf{b}\times\mathbf{c}$ superstructure of the typical *Pnma* perovskite structure. For Ti-rich bridgmanite was found that the lattice parameters linearly increase with increasing the $MgTiO_3$ component.

This study was supported by the Russian Science Foundation (project no. 17-17-01169).