High-pressure and high-temperature stability of Mg-rich staurolite in FeO-MgO-Al2O3-SiO2-H2O system

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Pure Mg-staurolite (ideally $Mg_4Al_{18}Si_8O_{48}H_2$) is stable at the pressure range of 12 kbar to 66 kbar [1-3]. Fockenberg [3] experimentally investigated possible breakdown reactions of Mg-staurolite in the system MgO-Al_2O_3-SiO_2-H_2O, and he reported that, at 850 degree-C, the Mg-staurolite decomposes into the assembly of enstatite + kyanite + corundum at around 14 kbar. Although the high-pressure and high-temperature stability of Fe-bearing Mg-rich staurolite in the system FeO-MgO-Al_2O_3-SiO_2-H_2O is unclear, such Mg-rich staurolites corresponding to X_{Mg} = 0.7 or more have been reported from eclogite facies rocks [*e.g.* 4]. Whereas, more Fe-rich Mg-staurolites to be the X_{Mg} range of 0.4 to 0.6 are found as inclusion minerals surrounded by sapphirine in poikiloblastic garnet from ultrahigh-temperature (UHT) metamorphic rocks [*e.g.* 5-7]. Because the sapphirine can be formed by the prograde reaction: staurolite = garnet + magnesian sapphirine + kyanite + H_2O, the original of relic staurolite should be more Mg-rich composition rather than X_{Mg} = 0.4-0.6 [6 and 7], and thus the staurolite inclusions in UHT rocks can be regarded as relic evidences for a constraining the *P-T* condition of the prograde high-pressure metamorphic stage before the peak UHT stage. Hence, to demonstrate the stability of Fe-bearing Mg-rich staurolite [= $(Mg_{0.74}Fe_{0.26})_4Al_{18}Si_8O_{48}H_2$], we started high-pressure and high-temperature experiment.

Procedure of a preliminary experiment is as follows. At first, reagents of Fe_2O_3, MgO, Al_2O_3 and SiO_2 were mixed to be the bulk composition of $Mg_{0.74}Fe_{0.26}$-staurolite approximated to one of Enami *et al.* [4], and this mixture was deoxidized within electron furnace under low fO_2 condition (around QFM buffer) at 1000 degree-C for 40 hours, and moreover at 1200 degree-C for 15 hours (mixture-1). The mixture-1 with distilled water (about 10 wt %) was used as a starting material for the preliminary experiment. Gold tube (inner diameter: 1.8 mm) was used as sample container. This experiment was performed at 18 kbar and 850 degree-C for 70 hours by using the Boyd-England type piston-cylinder apparatus housed at Tokyo Institute of Technology.

As an experimental result obtained at 18 kbar, large euhedral crystals of staurolite (over 100 microns) with the matrix, which consists of the fine crystals of corundum and pyroxene (only few microns) within melt, were synthesized. The synthetic staurolite and melt contain H_2O corresponding to about 2 wt % and 20 wt %, respectively. Because all of the fine corundum and pyroxene were found as anhedral crystals and inclusions, which were consumed due to formation of host staurolite, we insist that they are meta-stable phases at 18 kbar and only euhedral staurolite should be stable at this pressure condition. In the present, we are performing additional experiments in order to reveal the lower pressure limit of stability field of $Mg_{0.74}Fe_{0.26}$-staurolite at 850 degree-C. We will present the results of these preliminary and additional experiments.

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