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P-T pseudosection analysis of high-pressure metapelites: stability of sodic phases in Sambagawa metamorphic rocks

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P-T pseudosection analysis was carried out on the Sambagawa metapelites to determine the mineral equilibrium, especially the stability of Na-rich phases, under high-pressure conditions. This was achieved by means of forward modeling using the Perple_X 07 computer program in the MnO -Na_2O-K_2O-CaO-FeO-MgO-Al_2O_3-SiO_2-H_2O (MnNKCFMASH) and MnO-Na_2O-K_2O-CaO-FeO-MgO-Al_2O_3-SiO_2-H_2O-CO_2(MnNKCFMASHCO_2) systems in the range of P=0.5-2.5 GPa and T=400-600 ^{o}C. The metapelite samples used for this analysis are CS82102701 from the high-grade garnet zone of the Asemi river area, and TH77052717 and ZWK02 from the albite-biotite zone of the Besshi region, central Shikoku. The garnet grains in the Besshi metapelites contain the following Na-rich phases: paragonite in TH77052717, and paragonite, glaucophane, and omphacite in ZWK02. The equilibrium condition of the inclusion assemblage of ZWK02 is estimated to be P=1.7-1.9 GPa and T=470-530 ^{o}C. The quartz Raman barometrical analysis suggests the possibility that the TH77052717 sample as well as the ZWK02 sample have experienced the eclogite facies stage. The CS82102701 and TH77052717 samples have bulk rock compositions similar to those of common Sambagawa metapelites from central Shikoku. On the other hand, the ZWK02 sample exhibits an intermediate composition between that of common metapelite and metabasite.
The phase relationships of the CS82102701 and TH77052717 samples in the MnNKCFMASH system are similar to each other; in addition, they indicate that paragonite is the main Na-rich phase under pressure conditions of 0.5-2.5 GPa, and sodic pyroxene becomes stable at pressure conditions higher than 2.3 GPa. The P-T pseudosection of ZWK02 in MnNKCFMASH system indicates that sodic pyroxene becomes the main Na-rich phase instead of paragonite for P > 0.8-1.2 GPa. Model calculation of a binary system of two compositions (TH77052717 and ZWK02) suggest that the stability fields of paragonite and sodic pyroxene strongly depend on the Na/Al value of the effective bulk rock composition: the stability fields of paragonite and sodic pyroxene respectively decrease and increase with an increase in Na/Al. This result is consistent with the fact that TH77052717 contains paragonite and no omphacite as garnet inclusions. The pseudosection analysis of the ZWK02 sample in the MnNKCFMASHCO_2(XCO_2=0.01) system indicates that under a CO_2-bearing environment, the stability field of sodic pyroxene decreases and paragonite becomes stable in the range of 400-500^{o}C. The effect of CO_2in the stability of paragonite can be explained by the following reaction:

2 Cz + 3 Ab + 4 CO_2+ 2 H_2O = 3 Pg + 4 Cal/Arg + 6 Qtz
2 Cz + 3 Jd + 4 CO_2+ 2 H_2O = 3 Pg + 4 Arg + 3 Qtz

This simulation of the CO_2-bearing system suitably explains the occurrence of coexisting omphacite and paragonite in the ZWK02 sample.
These results show that (1) omphacite is not always the main Na-rich phase in the eclogite facies metapelite, (2) omphacite-free metapelite was probably a common lithology of the Sambagawa eclogite facies stage, and (3) paragonite may be an important index phase of high-pressure

metamorphic metapelite.

Keywords: Metapelite, Pseudosection, Paragonite, Eclogite facies metamorphism, Na phase, Sambagawa belt (Sanbagawa belt)