Progress of reaction and pattern formation: Formation of clusters of Al-bearing minerals due to high-pressure metamorphism

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Textures of metamudstones from high-pressure Sanbagawa and low-pressure Tsukuba metamorphic complexes were analyzed for evaluating progress of metamorphic reaction and pattern formation.

High pressure Sanbagawa pelitic schist was corrected from oligoclase-biotite zone (T = 610 degree C and P = 1.0 GPa, Enami, 1998) and low-pressure pelitic granofels was corrected from sillimanite zone (T = 620 degree C and P = 0.3 GPa, Miyazaki, 2001). The both samples have the same quartz volume fraction (about 50%). The Sanbagawa pelitic schist has compositional banding parallel to schistosity. To avoid such strong anisotropy, Plane parallel to schistosity was used for area analysis. The Tsukuba pelitic granofels has no strong schistosity and compositional banding.

Area analysis of the Sanbagawa pelitic schist shows that Al-bearing minerals form clusters. The density correlation function analysis shows that each mineral, such as garnet, albite and chlorite has distinct two lengths: one (rc = 100 - 1000 micro m) corresponds to radius and the other (rc = 3 - 6 mm) corresponds to radius of clusters. Density correlation functions between different minerals shows that garnet-muscovite pair has strong correlation. Image obtained by EPMA also shows that garnets are distributed at interfaces between muscovites and quartzes. On the other hands, Al-bearing minerals in the Tsukuba pelitic granofels interconnect each other and not form clusters. Density correlation functions of all minerals show that they are distributed randomly at short distance. However, they have one characteristic length corresponding to cordierite porphyroblast at longer distance. The characteristic length at longer distance does not appear in the correlation function of Al-minerals. This suggests that cordierite grew with replacing surrounding Al-minerals.

Difference between textures of the high-pressure Sanbagawa pelitic schist and low-pressure Tsukuba pelitic granofels is quite clear. However, its origin is obscure. Difference in dihedral angle of water-quartz system at different pressures may explain the textural difference between the Sanabgawa pelitic schist and the Tsukuba pelitic granofels. Using the dihedral angle by Holness (1993), although metamorphic temperatures of both metamudstones are the same, the dihedral angle of the high-pressure Sanbagawa pelitic schist is smaller than 60 degree, and the dihedral angle of the low-pressure Tsukuba pelitic granofels is larger than 60 degree. Therefore, metamorphic fluid in the Sanbagawa pelitic schist may form 3-D network. It is expected that progress of deformation and reaction will be enhanced by mass transport through interconnected 3-D fluid network and result in formation of clusters of Al-bearing minerals. Localized formation of garnets at interfaces between muscovites and quartzes also will be affected and enhanced by mass-transport through the 3-D network of fluids in quartz domain.