Garnet zoning suggesting the correlation between the Higo and Abukuma metamorphic rocks

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The Higo and Abukuma metamorphic rocks are both Cretaceous low P/T metamorphic rocks, located in central Kyushu (the former) and in northeast Japan (the latter), respectively. The correlation between the two metamorphic rocks has been discussed in terms of SHRIMP U-Pb ages of plutonism, metamorphism and sedimentation (Sakashima et al., 2003), although they are separated by more than 1,000 km. This paper presents new evidence for this hypothesis by reporting garnet zoning in the Higo metamorphic rock (HMR) which is very similar to that in the Abukuma metamorphic rock (AMR).

Pelitic and psammitic gneisses in the garnet-cordierite zone in the HMR contains commonly garnet crystals, which are subhedral to euhedral grains of several millimeters in size. We examined chemical zoning of these garnets from 41 samples of pelitic gneiss in the Kousadake area, Kousa and Tomochi Towns, Kumamoto Prefecture. Typical mineral assemblage of the pelitic gneiss is garnet + biotite + K-spar + plagioclase + quartz ± cordierite ± sillimanite. Ilmenite, titanite, and rutile (less common) occur as inclusions in garnet. Garnet zoning can be classified into three types: flat, simple and complex types. The flat type shows no concentration gradient of any component from the core to the rim. The composition ranges from Prp9Alm68Sps3Grs20 to Prp20Alm73Sps3Grs4, depending on the bulk composition of the sample. The simple type shows a gradual change in composition from the core richer in Sps and Grs components (Prp15Alm51Sps26Grs8) to the rim richer in Alm component (Prp15Alm61Sps19Grs3). The complex type has several variations in the zoning, however, all the variations show discontinuous or rapid changes in composition. The complex A type consists of the plateau-like core richer in Sps and Grs components (Prp2Alm36Sps33Grs29) and the rim richer in Alm and Prp components (Prp23Alm67Sps7Grs3). The complex B type shows a core-mantle-rim structure. The core is nearly constant composition with Prp6Alm61Sps14Grs19, followed by a rapid increment of Grs component up to 28 mol % associated with counterpart decrement of Alm and Sps components in the mantle (Prp6Alm58Sps8Grs28). In the rim, Grs and Sps components gradually decrease with counterpart increment of Prp and Alm components to Prp12Alm73Sps5Grs10. The Grs contents in the core of the complex A type and also in the mantle of the complex B type are much higher than those of the simple and flat types, indicating higher pressure condition for the formation. Garnets with these three types of zoning occur randomly in the garnet-cordierite zone of the studied area, suggesting the different nucleation timing of these garnets rather than diffusive homogenization of zoning in higher grade rocks (Yoshimura,1995).

The complex A and B types of zoning are quite similar to those of sector-zoned garnets from the AMR reported by Hiroi et al. (1998), who suggested the followings. These zonings may indicate three stages of garnet growth at different pressures: the earliest stage characterized by relatively low T (~650 C) and medium P (~0.6 GPa), the second stage with much higher pressure up to 1.2 GPa, and the third stage with higher T (~800 C) and lower P (~0.5 GPa). Thus, the HMR may have experienced the P-T path similar to that of the AMR. This similarity of the P-T path together with the consistency of the age of plutonism, metamorphism and sedimentation (Sakashima et a., 2003) strongly suggests that the HMR and AMR may have formed the same geological terrane. The tectonics leading to the large-sale displacement between

the HMR and AMR can be either a nappe tectonics or strike-slip tectonics, although this study cannot provide any information on the tectonics.

References: Hiroi, Y. et al., (1998) JMG, 16, 67-81; Sakashima, T. et al., (2003) Jour. Asian Earth Sci., 21, 1019-1039. Yoshimura,Y.(1995) Mem. Fac. Sci. Kumamoto Univ., 14, 1, 1-18.

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