Carbonaceous matters in pelitic rocks and in fluid inclusions in quartz veins from the Ryoke metamorphic belt, Yanai district

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In the Yanai district, the Ryoke metamorphic rocks are divided into the following metamorphic zones: chlorite, chlorite-biotite, biotite, muscovite-cordierite, K-feldspar-cordierite, sillimanite-K-feldspar and garnet-cordierite zones (Ikeda, 2004). Quartz veins were collected from the Takabatake outcrop in the biotite zone. Describing the outcrop, Yamamoto et al. (2004) concluded that the quartz veins were formed under flow deformation conditions during retrograde metamorphism, probably above 300C.

Primary fluid inclusions in the veins are rich in gaseous components (CO2 and CH4). The CH4/(CO2+CH4) ratios of the inclusions are as low as 0.1 to 0.2. Salinities estimated by Raman spectra of the stretching band of water (Dubessy et al., 2002) in the inclusions are very low, ranging from 0 to 4 NaCl eq. wt. %. Daughter minerals of carbonaceous matter (CM) and muscovite were also observed in some primary inclusions.

Recently, Beyssac et al. (2002) proposed a new geothermometer (up to 641C) based on the degree of organization of CM indicated by Raman microspectrometry. According to their geothermometer, the CM's in the inclusions show the organization temperatures of 530-560C averaging about 550C. However, as Beyssac et al. (2003) pointed out, Raman spectra of unpolished CM (i.e., covered by a transparent mineral) may show apparently higher degree of organization than well-polished one (i.e., on a polished surface). Based on their equation, the average temperature, 550C, shown by the CM's in the inclusions in the vein quartz should be corrected to 500C on a well-polished surface.

On the other hand, CM's in the host biotite schist indicate temperatures of 450-550C (with 590C from unpolished CM covered by a transparent mineral). The CM's in the pelitic rocks of the K-feldspar-cordierite, garnet-cordierite and sillimanite-K-feldspar zones show 430-540C, 420-630C (with 620-630C from unpolished ones) and 420-600C (with 630-640C from unpolished ones), respectively. It is quite interesting that large CM's growing along the cleavages of biotite in highly metamorphosed rocks commonly show high temperatures, while those surrounded by quartz indicate lower and variable temperatures.

It is widely believed that the organization of CM is an irreversible process. Hence, if all the CM's existed in the host rocks before the peak of metamorphism, they must show the peak metamorphic temperatures. Therefore, it is suggested by the evidence that the CM's showing low temperatures were formed during the retrograde stage. Namely, the fluids saturated with CM continued to exist even in the retrograde process. The estimated fluid compositions of the inclusions show typical characteristics of metamorphic fluids. Since the metamorphic fluids are generally thought to have been formed by dehydration reactions during the progressive metamorphism, it is concluded that high-temperature fluids-feeding prograde metamorphism probably continued to occur in the deeper part of the biotite zone after the peak of the biotite grade metamorphism.

The metamorphic P-T conditions of the studied area have been re-estimated by the equation of state for the H2O-CO2 fluids. The results will also be shown in the presentation.