Wide variety of crystallinity of carbonaceous materials in metasedimentary schists in the Yuli belt, eastern Taiwan

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The Yuli belt in eastern Taiwan is recognized as one of the youngest blueschist terranes in the World (Ota and Kaneko, 2010). The Yuli belt is an attractive area to study the exhumation of high-pressure rocks and arc-continent collision. A few tectonic blocks containing glaucophan and/or omphacite are distributed in the Yuli belt and the peak metamorphic conditions of these blocks were estimated as ~1.3 GPa/~550 ˚C (Baziotis et al., 2017). However, the metamorphic condition of dominant metasedimentary schists is still unclear due to the lack of the indicative minerals for thermodynamic calculations.

We conducted Raman spectroscopic analyses of carbonaceous materials (CM) in the metasedimentary schists in the Yuli belt and estimated the peak temperatures using the Raman CM geothermometer. The measured samples contain mainly quartz, albite, muscovite, chlorite, and CM. The occurrence of garnet grains in the studied samples is rare. Some samples show wide variety of CM temperatures from ~330 to ~620 ˚C. In contrast, the crystallinity of CM grains in the metasedimentary schists in the Sanbagawa belt in southwest Japan does not show large variations, and the difference between the highest and the lowest temperature is within ~150 ˚C in most samples.

The above results indicate that the CM grains in metasedimentary schists in the Yuli belt show wide variety of crystallinity compared to the Sanbagawa belt. In addition, it is also characteristic that the estimated CM temperatures of the metasedimentary schists in the Yuli belt exhibit far higher than the metamorphic temperatures expected from the mineral assemblages; that is, the mineral assemblage of the metasedimentary schists in the Yuli belt looks like the rocks in the chlorite zone in the Sanbagawa belt, whose estimated metamorphic temperature is 330±30 ˚C (Enami et al., 1994), but the estimated CM temperatures are much higher up to 620 ˚C. In order to explain the futures of the CM temperatures in the Yuli belt, the following two interpretations are possible: (1) the presence of abundant detrital graphite in the metasedimentary schists, and (2) the presence of CMs with different reaction rates in short reaction time of the Yuli metamorphism.

The first idea of the presence of abundant detrital graphite is supported by the distribution of detrital zircon age in the Yuli belt. U-Pb ages of detrital zircons in silicic schists in the Yuli belt show wide variety from ~2600 Ma to ~15 Ma (Yui et al., 2012; Chen et al, 2017). The wide range of U-Pb ages is interpreted as a product mixing of various sedimentary strata prior to metamorphism. In addition, the high frequency Jurassic-Cretaceous peak is considered as igneous rock origin. From these zircon data, there is a high possibility that the metasedimentary rocks in the Yuli belt also contain a large number of high-temperature detrital CM affecting the large-scale igneous activity. On the other hand, the Sanbagawa metasedimentary schists, whose CM temperature does not show variations, are considered as pelagic sediment origin, and most U-Pb ages in the Sanbagawa belt are Jurassic-Cretaceous. The second idea related to the kinetics of CM is based on the report that the rapid burial and exhumation rate of the Yuli belt (Willett et al., 2003; Dadson et al., 2003). If the Yuli metamorphism was very short, CM might be in the middle of reaction and may not reflect the peak metamorphic temperature. In addition, there are two types of CM, easily graphitizable carbon and hardly graphitizable carbon, and if there is a difference in reaction speed depending on the type of CM, it may be possible to explain the broad variation of CM temperatures in the Yuli belt.

The above results indicate that the CM temperatures using Raman CM geothermometers show not only the peak metamorphic temperature but also reflect the information of the protolith or the metamorphic history of the metamorphic belts.

Keywords: Yuli belt, Raman carbonaceous material geothermometer, Detrital graphite, Kinetics