

## Application of the Raman carbonaceous material thermometer to the Chichibu-Sanbagawa belt in the Kanto Mountains, Japan

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The structure and tectonic history of the Chichibu-Sanbagawa belt have been investigated by the lithological structure, radiolarian age, radiometric age, deformation microstructural analysis, and X-ray diffraction analysis of carbonaceous material (CM). The structural discontinuities (nappe boundaries) within the Chichibu-Sanbagawa belt are proposed in several studies (e.g., Shimizu 1988, *J.Geol. Soc. Japan*; Isozaki & Maruyama 1991, *J. Geogr.*; Hirajima *et al.* 1992, *J.Geol. Soc. Japan*). However, the boundary between the Chichibu and Sanbagawa belts and their structural relationship are still under debate. In addition, the thermal structure was not well investigated because the geothermometer that can be applied over the temperature range of the Chichibu and Sanbagawa belts was not available. Recently, several studies proposed the geothermometers applying the Raman spectroscopy. Kouketsu *et al.* (2014, *Island Arc*) analyzed the CMs with a wide range of crystallinity, from amorphous carbon to well-crystallized graphite, in sedimentary and metamorphic rocks and proposed a new Raman CM geothermometer. By using this technique, we evaluate the peak temperatures of the rocks in the Chichibu and Sanbagawa belts in the Kanto Mountains, which is the type locality of these belts.

We investigated the mudstone, sandstone, and pelitic schist taken from the Kannagawa, Sanbagawa, and Ayukawa River districts in the Kanto Mountains, Gunma Prefecture. In the studied area, the accretionary complexes of the Northern Chichibu belt are distributed in the south, crystalline schists of the Sanbagawa belt are distributed in the north, and the Mikabu greenstones are exposed between them. The Chichibu belt is divided into three units: Kamiyoshida, Manba, and Kashiwagi units, in descending structural order (Shimizu & Yoshida 2004, *Island Arc*). The Sanbagawa belt is divided into three metamorphic zones: chlorite, garnet, and biotite zones, in order of ascending metamorphic grade (Yano & Tagiri 1998, *J.Geol. Soc. Japan*). The strata gently dip to the north and the metamorphic grade monotonously increases towards the lower structural level.

The Raman spectra of CM in mudstone and sandstone taken from the Chichibu belt include broad peaks that are characteristic of the amorphous carbon structure. The temperatures of most samples estimated by full width and half maximum (FWHM) of the D1-band are around 260-300 °C. Several CMs in the rocks near the Mt. Nishi-Mikabo show the temperature higher than 300 °C.

The intensities of Raman spectra of CM in the Sanbagawa schists are one order weaker than those in the rocks taken from the Chichibu belt. The D4-band, which is the characteristic peak in amorphous carbon, is not observed. Instead, G-band, which is the characteristic peak in well-crystallized graphite, becomes the most prominent peak at higher-grade zone. The metamorphic temperatures are estimated by using the FWHM of D1- and D2-bands and area ratio (R2) of CM Raman spectra. The metamorphic temperatures of the samples are estimated around 360-400 °C, 420-450 °C, and 460-510 °C in the chlorite, garnet, and biotite zones, respectively.

The temperatures estimated from CM show the gap of several tens of degrees or more between the Chichibu and the Sanbagawa belts. Further sampling and analysis will be proceeded.

Keywords: Raman spectroscopy, Carbonaceous material, Geothermometer, Chichibu belt, Sanbagawa belt, Kanto Mountains