Raman spectroscopy of Archean black cherts

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Carbonaceous matter converts gradually to graphitic material after their burial. It can be a tracer of degree of thermal metamorphism. Microbe-like structures have been reported in several Archean deposits. For determination of the origin of carbonaceous matter in such deposits, it is a serious constraint, to what extent thermal metamorphism has proceeded. Raman spectroscopy is a useful tool to evaluate the degree of structural order of carbonaceous matter. Typical Raman spectrum shows two Raman bands in the first order region; G-band (G for graphite) at about 1600cm^{-1}, and D-band (D for defects) at about 1350cm^{-1}. G-band is assigned to E_{2g2} in-plane vibrational mode of polyaromatic structure. D-band is not present in a perfectly stacked graphite. This band is induced by structural defects. The G/D peak area ratio corresponds to the lateral size (La) of a crystallite of the graphitic matter. However this relationship cannot be used to the carbonaceous matter of low-maturity-level, and interpretation of Raman spectra of low-maturity carbonaceous matter still remains controversial. Beyssac et al. (2002) interpreted Raman spectra as four components; G-band, and D1-D3 bands. Further, Allwood et al. (2006) claimed the existence of additional D4-band.

In this investigation, we examined the thermal histories of Archean black cherts (3.3-3.2 Ga) from the Dixon Island Formation, Cleaverville Group, the coastal Pilbara terrane, Australia and the Mendon Formation, Onverwacht Group, Barberton greenstone belt, South Africa, together with several coal samples with known vitrinite reflectance using Raman spectroscopy. The coals were collected from the Cretaceous Shimanto belt in Kii Peninsula and Kyushu, Japan. The vitrinite reflectance ranges from *ca.* 1 to 6 (Hashimoto et al., 2004). Several microbe-like structures have been reported in the cherts from the Dixon Island Formation (Kiyokawa et al., 2006).

Raman spectra were obtained using JEOL JRS-SYSTEM 2000 Raman spectrometer. An excitation wavelength of 514.5nm was used on an argon ion laser. The laser beam was focused by a microscope equipped with a 50X objective, leading to a spot diameter of 2um. The power at the sample surface was 1.0 mW. Spectra of first-order region (1000-2000cm^{-1}) were acquired for 30sec. The measurement was repeated three times and they were accumulated.

The G-band position of the vitrinites shifted up with vitrinite reflectance increase, and FWHM (Full width at half maximum) -value of G-band decreased. The FWHM- value was also highly correlated inversely with the G-band position.

The G-band position and FWHM-value of the Archean black cherts suggest high maturity level of the carbonaceous matter, although relatively low degrees of metamorphism in these areas have been reported. In G-band's FWHM-position plot, black cherts data grouped in an area off the line described by the vitrinites, suggesting the same maturity level of the black cherts and the difference in precursor from the vitrinites.