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Raman spectra of carbonaceous material in low-grade thermally-metamorphosed accretionary complex

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Sedimentary rocks contain a trace amount of initially poorly ordered carbonaceous material (CM), which transforms into well-ordered graphite with increasing metamorphic grade. Previous study has demonstrated that peak metamorphic temperature (T) can be estimated by an area ratio R2 (=D1/[G+D1+D2]) of peaks recognized in Raman spectra of CM. This geothermometer can be used at temperature range of 330-650^{o}C (e.g., Bayssac et al., 2002; Aoya et al., 2010). Herein, we present Raman spectra from a suite of samples with different metermorphic temperatures which are estimated by a vitrinite reflectance method: Miocene Hota complex (50^{o}C) (Yamamoto et al., 2005), Cretaceous Shimanto complex (150^{o}C and 230^{o}C) (Mukoyoshi et al., 2006) and Jurassic Ashio complex (300^{o}C). First-order Raman spectrum of CM often decomposed into four peaks of a Raman shift (G peak at about 1580cm-1, D1 peak at about 1350cm^{-1}, D2 peak at about 1620cm^{-1}, D3 peak at about 1500cm^{-1}). In our amorphous CM (coal) samples we recognized other three peaks on the D1 peak around 1150 cm^{-1}, 1220 cm^{-1} and 1450 cm^{-1}. These peaks has been also reported in (e.g., Bar-Ziv et al., 2000; Zaida et al.,2007; Potgieter-Vermaak et al., 2011).

The first-order Raman spectrums of our coal samples, in particular low-temperature samples, are hard to fit with decomposed four peaks using the LabSpec program due to the influence of faint shoulders on D1. Therefore, there is no clear correlation between T and average R2 ratio in each sample. However, the Rama spectrums can be fit with the above seven peaks. The correlation between R2 and T can be described by the following exponential equation:

T (^{o}C) =8.6$*$exp(7.0$*$R2) (R^{2}=0.98)

In addition, when we use an area ratio of D1/[decomposed seven peaks] which is referred to as R6 in this study, the correlation between R6 and T is given by

T (^{o}C) =10.9$*$exp(11.9$*$R6) (R^{2}=0.99)

These correlations can be used for a potential geothermometer for low-grade metamorphosed sediments, in the temperature range of 50-300^{o}C.

Keywords: raman spectroscopy, vitrinite reflectance, carbonaceous material, accretionary complex, geothermometry