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Development of geo- and fault-thermometer using a raman spectoroscopy tecqbuque on carbonaceous material

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In order to develop geothermometer of low-grade metamorphic rocks, we examined Raman spectrum of poorly-ordered carbonaceous materials (CM) with different metamorphic temperatures. The CM samples used in this study were collected from the Miocene Hota complex (50^{o}C) (Yamamoto et al., 2005), the Cretaceous Shimanto complex (150^{o}C and 230^{o}C) (Mukoyoshi et al., 2006) and the Jurassic Ashio complex (300^{o}C) and measured the Raman spectra. In addition, the CM is also matured by frictional heating of a fault even during short-periods coseismic sliding (several seconds' process) (e.g., O'Hara et al 2006). Such maturation of CM can be used for a fault-thermometer to estimate frictional heat along a fault during an earthquake. Thus, we performed laboratory friction experiments on CM to determine how the Raman spectra of the CM change with frictional heat. The experiments were conducted simulated gouge (a mixture of 90 wt% quartz and 10 wt% vitrinite) at slip velocities of 0.0013-1.3 m/s, normal stress of 1.0 MPa and displacement of 15 m under anoxic, nitrogen atmosphere, while measuring temperature in the gouge zone by thermocouples.

Here, we present our preliminary attempt for developing a geothermometer using Raman spectra of CM. On poorly-ordered carbonaceous materials, first-order Raman spectrum 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}) (e.g., Bayssac et al., 2002; Aoya et al., 2010). 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}. The first-order Raman spectra 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. However, the Rama spectra can be fit well when we used the above seven peaks. In this study, we define an area ratio of D1/[decomposed seven peaks] as R6. 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. We will present a potential fault thermometer using Raman spectra of CM in the meeting.

Keywords: raman spectroscopy, vitrinite reflectance, carbonaceous material, geothermometry, frictional heat, fault rock