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Frictional heating recoded in virtinite reflectance within coal material concentrated layer: The Cretaceous Shimanto Bel

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A degree of frictional heating by fault activity is related to effective friction coefficient, normal stress, displacement, slip rate and thickness of fault. So if we can detect the frictional heating along fault, the strength of friction of the fault can be constrained even from natural materials. In this study, we tried to detect the evidence of frictional heating along minor faults developed in on-land accretionary complex using vitrinite reflectance. The frictional heating was also identified along shallow deocollement and mega-spaly fault in Nankai trough by detailed examination of distribution of vitrinite reflectance (Sakaguchi et al. 2011). The similar evidence can be observed in the on-land accretionary complex anywhere.

We have found a coal concentrated layer in the coherent unit, Shimanto Belt, Shikoku, SW Japan. The coal concentrated layer is located in a central part of Nonokawa formation. Thickness of the coal concentrated layer is about 80 cm. Some faults are developed within the coal concentrated layer. Thickness of the faults is about a few mm to 1 cm. The fault branches and undulates at some parts. The coal concentrated layer is appropriate to examine the distribution of vitrinite reflectance. The background value of virtinite reflectance in this area is about 1.1% reported by a previous study (Sakaguchi, 1996).

4 samples from host rocks as background and 6 samples from the coal concentrated layer were collected. Samples from the coal concentrated layer distribute 0 cm, 3 cm, 8 cm, 9 cm, 20 cm, 35 cm from a major fault.

Random oriented vitirinite reflectance (Ro) was measured on polished thin sections. The modal value of Ro in host rocks is about 0.98%, which nicely coincides with the values from the previous study. Variations in Ro in host rocks represent relatively larger than that in the coal concentrated layer, which might be due to rework of the virtinite grains. The modal value of Ro in coal concentrated layer is about 0.92 %, which represent a normal distribution in each histogram except for the samples at 0 cm and 3 cm from the fault. In the samples at 0 cm and 3 cm from the fault, another peak and a weak bulge were observed at 0.2-0.3% higher Ro value. Double peak distribution is clear especially in the sample at 0 cm. Those higher peak and bulge possibly indicate the frictional heating along the fault. Spatial distribution of Ro in the thin sections also shows that vitrinite grains with higher Ro concentrate along the fault zone with thickness of 1cm.

We followed the method by O'Hara (2004), a simple method to estimate temperature by frictional heating from vitrinite reflectance. He used a model to convert temperature from Ro, proposed by Sweeny and Burnmum (1990) with high cooling rate as 0.035 degree C/s and 1.0 degree C/s for heated Ro. On the basis of the model, the higher Ro value corresponds about 460 - 540 degree C. Background value of Ro indicate about 146 degree C. We estimated friction coefficient also following O'Hara (2004)'s method using those obtained temperatures (460-540 degree C in fault zone and 146 in background), fault thickness (1cm, 4cm), displacement (1-5m), normal stress (126.2 MPa assuming 30 degree C/km of thermal gradient, 2650 kg/cm3 of density). The estimated frictional coefficient is about 0.14 in the maximum and about 0.01 in the minimum if the thickness is small and displacement is large. This result indicate very small friction coefficient in the coal concentrated layer. The small friction coefficient can be due to fluidization of nature of coal itself.

Keywords: vitrinite