Appendix: Method

The most commonly used vitrinite reflectance microscopic analyzer illuminates a wide field, 100 μm in diameter, because it was developed for observations and measurements of large vitrinite particles in coalmines. Fault zones, however, contain only small vitrinite particles, and a large field of illumination increases the background noise because of reflections from other minerals. We build a new device which has a double illumination system: a Critical-type light source illuminates only a 3.2-μm-diameter area for spot measurements, and a Köhler-type light source illuminates a wide field for petrographical observation. The measured vitrinite particles were petrographically distinguished under an optical microscope. Some reworked coal fragments occur in sediments, and they are round or trapezoidal in shape and have high reflectance. For this study, we used partly bituminized coal fragments to determine vitrinite reflectance. The partly bituminized coal coexisting with low-grade brown coal means a high temperature has not been received before. For other details, this study follows several industrial standards (e.g. ISO 7404, ASTM 2798, and JIS M8816).

The thermal model was based on the vitrinite kinetic model (Sweeney and Burnham, 1990) and on a general thermal diffusion model. The thermal diffusion length was obtained with one-dimensional, time dependent thermal conduction equation, $\partial T/\partial t = (k/\rho C)(\partial^2 T)/(\partial y^2)$, where T is temperature, t is time, k is thermal conductivity, C is the specific heat capacity of the fault rock, and ρ is the rock density. The diffusion length y is given by $y^2 = kt$. The core samples from this site have a rock density of 1800 kg/m^3, a thermal conductivity of 1.8 W/m K (Kinoshita et al., 2009), and a specific heat of 1749 J/kg K (Hirono et al., 2009). The thickness of the heat source was assumed to be the width of the high vitrinite reflectance zone that is 20 mm in the megasplay fault and 2 mm in the frontal thrust.