Estimation of frictional heating temperature of ancient mega-splay faults in the Cretaceous Shimanto accretionary complex, SW Japan

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Subduction zone earthquake is generated by activity of plate boundary megathrust and out-of- sequence thrust (OOST) which branch from the deep portion of the megathrust. It is very important to understand the mechanism of subduction-zone earthquake because most of earthquakes larger than M8 in the world are occurred around subduction zones. Although direct observation of fault rocks in seisomogenic zone is necessary to understand earthquake mechanism, collection of present days fault rocks of megathrust and OOST in seismogenic zone is technologically impossible. Recent study revealed that ancient seismogenic subduction faults are exposed on onland accretionary complexes such as Shimanto accretionary complexes. These faults will provide important information about the characteristics of fault rocks. Estimation of maximum temperature recorded in the fault rock provide us slip parameters during an earthquake because frictional heating temperature is directly related to shear stress and slip distance. Pseudotachylyte is discovered along an ancient OOST in the Shimanto accretionary complexes by previous study. Frictional heating temperature of pseudotachylyte is estimated to 650-1100°C from mineralogical analysis. On the other hand, frictional heating temperature of most of

"pseudotachylyte-less" OOSTs is not estimated because of lack of melted minerals. In recent years, Raman analysis of carbonaceous material (CM) in fault rock is used for estimation of frictional heating temperature of faults. The objective of this study is to estimate the frictional heating temperature of pseudotachylyte-less OOSTs in the Shimanto accretionary complex based on the Raman analysis of CM in the fault rocks. This study area is located on the southern coastal line of the Otsuzaki Peninsula, Kochi Prefecture, Japan. In this area, the Late Cretaceous Shimotsui Formation, Kure Melange and Nonokawa Formation is exposed. The Nonokawa and Shimotsui Formation consist of alteration layers of sandstone and shale. The Kure Mélange is composed of shale with blocks of sandstone, chert and basaltic rocks. More than 18 branched OOSTs are exposed along the southern coastal line of the Otsuzaki Peninsula. Strike of the OOSTs is generally NW and dip is $30^{-}60^{\circ}$ NE. Composite planner fabric of Y plane and P plane which indicates reverse fault shear sense is observed in each faults. Samples of fault rocks was collected from four faults (named F1 to F4) and polished slab and thin section of each faults is prepared for detailed observation and Raman analysis. Principal slip zone of each fault was selected for making thin section. Raman spectra analysis was conducted by Horiba Xplora Raman spectrometer installed in the Osaka University. CM in the fault zone and host rock was identified by the microscopic observation and Raman spectra of each CMs were measured. Raman parameter of intensity ratio of D and G bands (ID/IG) and area ratio of D and G bands (AD/AG) was determined for the temperature estimation. Shape of each spectrum was also carefully observed. Heating temperature was estimated by comparing the determined Raman parameter with reported values of heating experiment. Raman parameter of heating experiment reported by previous study show no significant ID/IG change below than 600°C (in the range of 0.60 from 0.57). In contrast, ID/IG values of experimentally heated CM higher than 700°C drastically increased. Raman parameter of ID/IG and AD/AG of fault zone did not show any systematic change indicating measured faults were not experienced maximum frictional heating temperature higher than 700°C. However, Raman spectra of host rock and fault zone of F1 fault show systematic change and these shape is similar with those of heating experimented CM of 600°C. Thus we conclude that the F1 fault experienced a frictional temperature of 600°C while sliding.

Keywords: Mega splay fault, Raman analysis