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Distribution of fluid and effects on rock properties in a shallow subduction interface: the Cretaceous Shimanto Belt

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Fluid flow along subduction interface is related to heat and mass transfer, and change in rock properties by rock-fluid interaction physically and chemically such as decreasing effective pressure or strengthening by cementation. Such rock-fluid interaction along subduction interface can be related to seismogenesis.
We examined the fluid effects on the micro-fault and a seismogenic fault within the Yokonami melange, the Cretaceous Shimanto Belt, SW Japan. A relatively large fault zone with pseudotachylyte was found at the northern edge of the Yokonami melange. Distribution and thickness of micro-faults with mineral veins, P-T conditions of mineral vein-formation by fluid inclusion analysis, and differential stress from calcite twin density were examined. Effects of fluid on fault properties are discussed using those data.
The Yokonami melange is consisted by blocks of sandstone, siliceous shale, tuff, chert, limestone and greenstone surrounded by shale matrix representing tectonic melange-textures. Melange foliations strike N70?W and dip steeply to the north. At the Goshikigahama area, the Yokonami melange is exposed about 500m long from north to south. In this area, two units of ocean-floor stratigraphy are identified.
Micro-faults cutting the melange foliations are observed pervasively, indicating that the micro-faults were formed after melange formation. Most of the micro-faults are accompanied with mineral veins. The 1 dimensional distribution and thickness of micro-faults with mineral veins were examined. Averaged frequency is ~32 per 10m and averaged thickness is ~ 10 mm per 10m. The northern unit has larger amount of mineral veins than southern unit. The difference in the vein distribution between units suggests the mineral veins are formed before underplating. The accreted steps are commonly observed on the vein surface, indicating that the veins were developed at the time of fault activities. Mineral veins are composed of quartz and calcite. Calcite is commonly surrounded by quartz. The texture of mineral veins shows elongate blocky texture indicating precipitation from advective flow. The temperature and pressure conditions for fluid are ~160MPa and ~180?C in average using fluid inclusion analysis. The temperature is close to the maximum paleo-temperature estimated from vitrinite reflectance. Therefore, the micro-faults are interpreted to be formed around the maximum depth. The seismogenic faults at the northern edge of Yokonami melange can be interpreted as a reactivation of a roof thrust of duplex structure which is related to the underplating. Therefore, the activities of seismogenic faults could be after underplating.
Differential stress was estimated using calcite twin density. Averaged differential stress is ~270 MPa. There is no difference in differential stress between faults within all Yokonami melange in the Goshikigahama area and faults related to the northern seismogenic fault zone.
If the differential stress is almost in-situ condition because micro-faults can be formed around the maximum depth although the calcite twin density should be obtained after mineral vein formation, the differential stress can be interpreted as a failure condition. Using coulomb envelope, we can estimate the absolute value of maximum and minimum principal stress, ~400MPa and 130MPa, respectively and normal stress on the fault is about 265MPa. Fluid pressure of 160MPa indicates ~

0.6 of fluid pressure ratio on micro-faults after fault activity.
If the differential stress is overprinted after vein formation, because there is no difference between differential stress for the Yokonami melange and the seismogenic fault, the mineral veins could make rocks harder to keep the larger differential stress after the micro-faults were sealed.

Keywords: Fluid flow, rock properties, subduction zones, melange, Shimanto Belt