Geochemical analyses of fault-related fluid flow in the ancient accretionary complex

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There are many previous works on faulting and fluid flow, but few studies have been carried out on these in seismogenic zone in subduction zone, especially geochemical aspect. To reveal the origin and behavior of syn-tectonic fluid in the ancient subduction complex, we examined occurrences of veins and carbon and oxygen isotope composition of vein calcite of the Mugi Melange in the Shimanto Belt. The melange preserves a good relationship between rock deformation and fluid flow near the up-dip limit of seismogenic zone.

The Mugi Melange is a mixture of terrigenous turbidites and pelagic sediments including basaltic blocks with systematic shear fabrics (Onishi and Kimura, 1995), and is thought to be an underplated tectonic melange of late Cretaceous to Paleocene age. It is divided into five thrust sheets with sheared basalt layers in the bottoms, appears to be horses of duplex formed in underplating stage. We focused on the duplex rump thrust, and classified three occurrences of veins along the thrust: intra-boudin veins (IBV), network veins (NWV), and fault-parallel veins (FPV). NWV are distributed in the damage zone of duplex ramp thrust, on the other hand FPV are observed just in the fault core of the thrust. NWV and FPV are crosscutting each other, probably showing fault-valve behavior. IBV seen in the necking parts of boudinaged sandstone blocks in the black shale matrix, were formed before duplexing.

We analyzed carbon and oxygen isotopic compositions of calcite in these veins on Finnigan MAT252 mass spectrometer at University of Tokyo. Delta-18 O values are in a limited range, from +16 to +19 permil (SMOW) for all veins. We estimated isotopic compositions of source fluid by using vein precipitation temperature determined by Matsumura et al. (2003). These of IBV are +2 to +8 permil, while these of NWV and FPV are +4 to +12 permil. These values are in the range of metamorphic fluid, neither seawater nor meteoric water. The 1 permil difference between NWV and FPV is explained if the source fluid of FPV was dehydrated at higher temperature than NWV. On the other hand, delta-13 C values of vein calcite range broad, from -18 to -4 permil (PDB). This shows that organic carbon from black shale and inorganic carbon from basaltic rocks were mixed and flowed into ramp thrust.

It is very interesting that NWV and FPV have different isotopic compositions although they were crosscutting each other. This fact probably shows the change of isotopic composition of syn-tectonic fluid in response to earthquake cycles. If FPV showing co- or post- seismic precipitation texture were dehydrated at deeper level, dehydrated water from hydrous minerals flowed intermittently at the vicinity of seismogenic zone in subduction zone. It requires extremely high fracture permeability in the decollement.