Pre-subducting deformation of oceanic crust: A case study from the Mugi Melange, the Shimanto Belt

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Although subducting oceanic crust is one of the major components of seismogenic zone in suduction zone, few studies have been carried out on its mechanical behavior. In addition, there are few descriptions of oceanic basalts that are tectonically involved into accretionary complexes. The lack of criterion to distinguish pre-subducting deformation (at mid-oceanic ridge or trench-outer-rise) and co- or post-subducting deformation (at plate boundary or within accretionary prism) may be one of the reasons. In this study, we report the new information about pre-subducting deformation of the oceanic crust.

We investigated the Mugi Melange in the Shimanto Belt, SW Japan. In the study area, basaltic rocks repeat four times in melange which are mainly composed of Paleocene blackshale. Kiminami et al. (1992) regarded these basaltic rocks as in-situ basalts of late Cretaceous ridge subduction, but Onishi and Kimura (1995) pointed out the intense shear fractures and regarded them as underplated fragments of oceanic crust. Matsumura et al. (2003) determined the P-T conditions of veins along the boundary fault between basaltic rocks and black shale as 135 to 245 degrees C and 107 to 149MPa, and they suggested that basaltic rocks were underplated at the vicinity of updip limit of seismogenic zone.

Basaltic rocks are composed of massive basalt, pillow lava, pillow breccia, hyaloclastite, and hydrothermal chert. They were cataclastically deformed and mixed with red or black shale. Many calcite veins are observed inside basaltic rocks: cooling cracks in pillow lava, necking part of chert boudin, minor fault which bound massive basalt and pillow lava. In this study, we analyzed carbon and oxygen isotopic compositions of these veins. Delta-13 C values of intra-basalt calcite veins are concentrated to -0.7 to +1.7 permil (PDB) regardless of their occurrences. This result makes a sharp contrast with those within black shale and shale / basalt boundary fault. As the delta-13 C value of zero permil accords with marine carbonates, most calcite veins in basaltic rocks may have been precipitated from seawater. On the other hand, because delta-18 O values of intra-basalt calcite veins are +14.5 permil to +18.5 permil (SMOW), precipitation of vein at about 80 to 120 degrees C is inferred if they were precipitated from seawater. These facts suggest that most intra-basalt veins were precipitated at ridge geothermal system.

Evidences that some of these veins are obviously relative to deformation such as boudinage of chert implies that intra-basalt deformations were not only due to subduction-related but also ridge processes. The new isotopic results confirmed that basaltic rocks in the Mugi Melange were generated and deformed at oceanic ridge, and revealed that isotopic analyses of calcite veins are effective to clarify deformation field of basaltic rocks. In addition, occurance of shale-basalt boundary fault at weak parts such as hyaloclastite and pillow breccia, suggests that inhomogeneity in initial deformation of oceanic crust restricts the faulting behavior of underplating. In the presentation, we will show the detailed structural and petrologial data and propose the model of initial deformation of oceanic crust.