Deformation history of underthrusting sediments - Implication from tectonic melange in the Shimanto belt

Yujin Kitamura[1]; Gaku Kimura[2]

[1] Earth and Planetary Sci., Univ. of Tokyo; [2] Earth and Planetary Science . Inst., Univ. of Tokyo (Jamstec, IFREE)

Introduction

Recent research progress on structures and change in physical properties of accretionary prism contributes to understand plate boundary processes including earthquake. A combined study of remote sensing in the ocean with geological study of onland analogue is an important approach in this realm. Tectonic melange bounded by pseudotachylyte-bearing fault-rock is thought to be a plate boundary fault (Ikesawa et al., 2003; Kitamura et al., 2005) so that it is noteworthy that the melange records information of plate boundary process in seismogenic zone. In this paper, we aim to acquire information of various stages of subduction from the melange and to discuss sequential change in deformation of underthrusting sediments.

Geology and methods

Studied tectonic melange is composed mainly of sandstone block in shale matrix. It records different stages of deformation according to detailed study of crack filling veins (e.g. Yamaguchi et al., 2005). To reveal the superposed deformation history, we analyzed sandstone and shale which might be different in rheological properties. Three different melanges that have experienced different burial depth were investigated. They are (1)Lower and (2)Upper section of Mugi melange in eastern Shikoku and (3)Makimine melange in eastern Kyushu. All of them belong to the northern Shimanto belt.

Their maximum paleotemperatures are estimated as ca. (1)130-150, (2)180-200,(3)340 degrees Celsius, respectively (Ikesawa et al., 2005; Kiminami and Ohno, 1999). Those temperatures cover the range of seismogenic zone proposed by Hyndman and Wang (1993). We studied on anisotropy of magnetic susceptibility (AMS) in shale and on structure and chemistry of sandstone.

Results

[Magnetic fabrics]

Shale matrix that composite planar fabrics are well developed has accumulated strain. AMS analysis makes it to quantitative data. Result shows different magnetic ellipsoids in each unit. With increase of maximum burial depth, average of anisotropy degree P' changes from (1)1.057, through (2)1.075 to (3)1.128, while average of shape parameter T varies as (1)0.474, (2)0.509 and (3)0.453.

[Aspect ratio of sandstone]

Sandstone blocks occur as boudinaged shape. We measured the long and short axes to obtain the aspect ratio R. Results show log-normal distribution with mode of R=3-4 in (1). Mean value and standard deviation are decrease in (2). In (3), bimodal distribution with dragging to higher R. Size of blocks decreases toward (3). High value of R in (3) is limited in small boudins.

[Deformation of sandstone]

- Black seams and quartz vein vertical to the long axis are commonly found in boudins. Riedel shear is penetrated throughout the shale matrix. Riedel shear cuts sandstone in place Tension cracks or quartz filling veins are often found at their extensions.
- Black seams is recognized as WEB structure consisting of cataclastic shear band. No calcite cements are found in WEB and the web is cut by quartz veins. These occurrences are in accordance with Hashimoto et al. (in press). Grain size reduction and pressure solution are observed in the WEB.

Discussion

- Strain history of tectonic melange during subduction is inferred from AMS analysis. Flattening is dominated in (1) and (2). In (3), AMS shows more strong anisotropy degree and change into plane strain. Result of strain analysis using radiolarian fossils in this area supports this change (Toriumi and Teruya, 1988).
- Decrease of R from (1) to (2) indicates relative shortening in longitudinal direction. Boudinaging due to propagation of riedel shear could be a possible deformation in upper subduction zone. High R appears in (3) and they are always small sandstone blocks. Boudins would be stretched more with onset of plastic deformation of quartz.
- Order of deformation of sandstone is the first web cataclasis, the second cementation, and pressure solution follows. Around updip limit of seismogenic zone, Riedel shear tears the sandstone.