Occurence of mylonite zones and its implication for seismogeenesis at the bottom of upper crust: an example

Koji Shimada[1]; Hidemi Tanaka[2]; Tsuyoshi Toyoshima[3]; Tomohiro Obara[4]; Tadafumi Niizato[5]

[1] Grad. Sch. Sci., Univ. Tokyo; [2] Dept. of Earth and Planet Sci., Univ. Tokyo; [3] Grad. Sch. Sci. & Tech., Niigata Univ.; [4] JODCO; [5] JNC TGC

To investigate structural and material factors related to seismogenesis of intra-plate earthquakes, geologic study on exhumed seismogenic zones was carried out in the southern Hidaka metamorphic belt (HMB), Hokkaido, Japan. Signs of seismic slip locate at higher thickness share ratio of intensely mylonitized zone accompanied with increasing content of mica to lesser mylonitized portion. It indicates that the seismogenic zone was prepared historically by mylonitization.

Detailed mapping of southern HMB indicate that there are many pseudotachylyte-bearing mylonite zones (Obara et al., in preparation). We selected out strain-localized zones with better outcrop conditions from zones in S-type tonalite, and made route-map, indexing of mylonitization, and columnar sections of fault rocks. Three ductile strain localized zones of ca. 20 to 100 meter in thickness are observed. They are three sequences of combination of strongly and weakly mylonitized zones, rather than three homogeneous mylonite zones. Mylonitic foliation strikes NNW-SSE and dip to the east moderately. Mylonitic lineation dips to the east with larger pitch. The sense of shear in mylonitic rocks is normal with dextral component.

Mylonitization in the Shimono-sawa route is characterized by not only the development of shear planes (composite planer fabrics) accompanied with grain size reduction but also a change of mineral modal composition. Data from the most thick mylonite zone was obtained by point counting (750-1000 points for each thin section). From protolith to mylonite, modal percentage of quartz decreases from ca. 30 % to under 10 %, and mica increases gradually from ca. 20 % to over 70 %. These mica showing fine grain size construct above mentioned composite planer fabrics. Porphyroclasts are composed mainly plagioclase and minor amount of quartz. These porphyroclast systems show mica quarter mat structures often. Mica along weak plane of composite planer fabrics suggests that the rheology in the strain localized zone was characterized by mica rather than quartz which was generally assumed material controlling strength of upper crust.

The occurrence of pseudotachylyte veins, as a clear evidence of seismic activity of fault, is not ubiquitous in the Shimono-sawa route. Most of veins are hosted in mylonite and protomylonite. Outcrop-scale distribution of pseudotachylyte veins indicates concentration of veins near the center of mylonite zone. However, there are intensely mylonitized zone lacking pseudotachylyte veins. Attitudes of generation veins of pseudotachylyte are mostly subparallel to C-plane of mylonite. Veins cut clearly preexisting mylonitic structures. Majority of veins show 2-5 mm in thickness. The sense of slip forming pseudotachylytes is not clear so far because of lacking of clear sense indicator, but striations subparallel to stretching lineation in mylonites on the wall of veins indicate dominantly dip slip. Mylonitization of pseudotachylyte veins are not observed so far.

To consider factors controlling spatial arrangements of pseudotachylyte veins and mylonite zones, each mylonite zone was assessed in neighboring heterogeneous structures. Tentatively, thickness share ratio of intensely mylonitized zone in each portion was calculated. Four local peaks larger than the mean value are observed. The pseudotachylyte veins concentrate near three local peaks of them. This implies that the localities of seismic slip had been controlled not only the intensity of mylonitization but also neighboring heterogeneous layered structures composed of differently strained and rolled mylonitized materials. Therefore, structural development during mylonitization under relatively slower strain-rate than seismic slip, and presumably longer period accompanied with change of mineral modal composition, likely made up structures of seismogenic zone for subsequent intra-plate seismic slip.