Development of the Median Tectonic Line Fault zone in Mie Prefecture, Southwest Japan : A Possible Interpretation for Strain Localization and Softening

*Toru Takeshita[1], Dong Van Bui[1], Thomas Anthony Czertowicz[1], Shun Arai[2], Takafumi Yamamoto[3], Jun-ichi Ando[3], Norio Shigematsu[4], Koichiro Fujimoto[5]

1. Department of Natural History Sciences, Graduate School of Science, Hokkaido University, 2. Department of Earth Science, Graduate School of Science, Tohoku University, 3. Department of Earth and Planetary Systems Science, Hiroshima University, 4. AIST, 5. Tokyo Gakugei University

We have investigated the development of the Median Tectonic Line (MTL) fault zone in the upper-plate Ryoke granitoids in Mie Prefecture, southwest Japan. In the study area, although c. 80 m thick cataclasite develops in direct proximity to the MTL, mylonitic rocks were pervasively formed before the formation of cataclasite, which can be divided into protomylonite distributed from the MTL to the point 300 m north from it and mylonite distributed from the latter point to the one at c. 800 m further north from the MTL. However, in the protomylonite zone, ultramylonite with the thickness up to c. 50 m is developed in direct proximity to the MTL, which occur as clasts in the cataclasite zone. We also have found that the protomylonite originates from tonalite, while the mylonite originates from granite. Hence, the boundary between the protomylonite and mylonite exactly coincides with the protolith boundary.

We analyze both microstructures and c-axis fabrics in recrystallized quartz grains from the protomylonite and mylonite zones along the MTL. In the protomylonite, sizes of recrystallized grains formed by subgrain rotation (SGR) recrystallization are low ranging between 7-14 microns. In particular, in the ultramylonite, the recrystallized grain sizes ranges between 4-11 microns. The quartz c-axis fabrics mostly show a Y-maximum pattern. On the other hand, the mylonite zone can be divided into two subzones in terms of quartz microstructures. In the subzone from 300 m to 490 m from the MTL, the microstructures are characterized by elongated grains (S-type) with finer recrystallized grain sizes varying between 11-20 microns formed by SGR. On the other hand, in the zone from 490 m to 800 m from the MTL, the microstructures are characterized by relatively equant grains (P-type) with coarser recrystallized grain sizes varying between 49-107 microns and lobate grain boundaries formed by grain-boundary migration (GBM) recrystallization. In both mylonite subzones, a Y-maximum quartz c-axis fabric dominates.

We further analyze microstructures of K-feldspar, and infer deformation temperatures based on the two-feldspar geothermometry after Stormer (1975) and Stormer and Whitney (1985) in the mylonite zone which originated from granite. While K-feldspar porphyroclasts are broken in the S-type mylonite subzone, they are plastically deformed to a sigma shape in the P-type mylonite subzone. Myrmekite pervasively develops at the periphery of K-feldspar porphyroclasts from the entire mylonite zone. Using the chemical compositions of K-feldspar and plagioclase in myrmekite, we infer the deformation temperatures in the mylonite zone. At the northernmost P-type mylonite subzone, the deformation temperatures are calculated at 500 ˚C, which decrease to 400 ˚C at the boundary between the P- and S-type mylonite subzones, and further decrease in the S-type mylonite zone, ranging between 350-400 ˚C.

Plastic deformation is dominant in the granite than in the tonalite at higher temperatures than 500 ˚C, leading to the formation of mylonite in the former area alone, perhaps because granite including abundant K-feldspar is rheologically weaker than tonalite. Subsequently, with decreasing temperature,

plastic deformation becomes localized in the southern part of the mylonite zone. At 400 ˚C, only the S-type mylonite subzone continues to deform, and the protomylonite starts to deform at higher stresses than in the S-type mylonite subzone. With further decreasing temperatures, the plastic deformation of S-type mylonite subzone is abandoned at 350 ˚C, and the further plastic deformation only occurs in the ultramylonite at 300-350 ˚C, leading to the formation of very fine-recrystallized quartz grains and type-I crossed girdle quartz c-axis fabric with R-maxima, which is further followed by cataclasis. We currently do not have a good idea on why the zone of plastic deformation suddenly jumps from the southernmost S-type mylonite subzone, which is 300 m apart from the MTL, to the protomylonite zone in direct proximity to the present MTL, forming ultramylonite. However, since a type-I crossed girdle quartz c-axis fabric with R-maxima is developed in the ultramylonite, it can be inferred that water weakening of quartz either by decreasing the strength of slip systems or facilitating dynamic recrystallization occurs in the protomylonite zone, which could have been caused by infiltration of water along newly formed fractures.

Keywords: Median Tectonic Line, mylonite, quartz c-axis fabric