Development of the Median Tectonic Line fault zone, Mie Prefecture, southwest Japan: Strain localization and softening

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The Median Tectonic line (MTL), southwest Japan is the largest-scale fault in Japan, which extends for c. 800 km in the forearc region parallel to the trench. The MTL was originally formed as a broad mylonite zone, which was later overprinted by the formation of narrow cataclasite zones with decreasing temperature during exhumation. In the present paper, we will describe how strain localization occurred in the MTL fault zone, and discuss what is responsible for this strain localization.

In this area (Tsukide, Iidaka-town, Matsusaka-city, Mie Prefecture), The MTL strikes E-W, and dips north at c. 60 degrees (Shigematsu et al., 2012, Tectonophysics). The MTL fault zone in the north side consists of c. 80 m wide cataclasite zone overlain by weakly fractured protomylonite. The cataclasite zone perhaps formed prior to the formation of the MTL (juxtaposition of the Ryoke against the Sambagawa rocks). The cataclasite zone consists of fractured protomylonite at some distance from the MTL, and mylonite and ultramylonite in direct proximity to it.

In this research, geological survey has been conducted in the area up to c. 800 m north from the MTL. As a result, it has been found that there are other two mylonite zones than the one in direct proximity to the MTL, and also a few cataclasite zones which overprint these off-MTL mylonite zones other than the one in direct proximity to the MTL. We have analyzed both microstructures and c-axis fabrics in recrystallized quartz grains with a SEM-EBSD from samples systematically collected in these protomylonite and mylonite zones.

In most of the samples, quartz c-axis fabrics showing a Y-maximum pattern, where the quartz c-axis preferentially aligns parallel to the intermediate stain axis (Y), develop, which are accompanied by type-II crossed girdles intersecting at the Y-axis. On the other hand, in ultramylonite in direct proximity to the MTL, protomylonite at the MTL cataclasite front and mylonite located c. 300 m north from the MTL, a type I crossed girdle quartz c-axis fabric locally develops, which consists of small circles of 30 degree angular radius about the Z (shortening)-axis connected to a great circle through the Y-axis. In the type I crossed girdle c-axis fabric, a rhomb-maxima, which consist of concentration of the quartz c-axis parallel to the orientation at 38 degrees off the Y-axis along the YZ-plane, develop.

The size of quartz recrystallized grains is coarse, 140 microns in the mylonite zone thicker than 100 m located 500 m or more north from the MTL, which decrease to 20-30 microns in the mylonite zone 300 m north from the MTL and protomylonite in direct proximity to the MTL, and further to less than 10 microns in ultramylonite in direct proximity to the MTL. However, it has been found that in protomylonite in direct proximity to the MTL the formation of quartz recrystallized grains with size of 20-30 microns overprinted relatively coarse quartz recrystallized grains with size of c. 70 microns.

Based on the results of microstructural analyses mentioned above, the strain localization processes are interpreted in the following way. First, the Y-maximum quartz c-axis fabric was formed at the temperature conditions of 400-500 degrees (Takeshita, 1996, Journal of Geological Society of Japan), at low differential stresses in all the three mylonite zones. With decreasing temperature, the northernmost mylonite zone stopped to deform, and the two southern mylonite zones continued to deform at relatively high stresses. With further decreasing temperature, only the ultramylonite zone and part of the mylonite zone 300 m north from the MTL continued to deform at temperature conditions of c. 300-400 degrees at very high stresses, leading to the formation of a type I crossed girdle quartz c-axis fabric. At this stage, the strain along the MTL became localized essentially in a narrow zone along the MTL. Although the reason for strain localization is uncertain, it would be most probable that fluids percolated along the narrow zone along the MTL, which perhaps weakened this zone. Otherwise, the northernmost mylonite zone, which is rich in quartz and K-feldspar, and hence mineralogically weaker, could have developed into the MTL fault zone

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