Dispersion of quartz aggregates and formation of fine-grained polyphase aggregates in granitic ultramylonites

Kazuhiko Ishii[1]; Takamoto Okudaira[2]; Kyuichi Kanagawa[3]; Norio Shigematsu[4]

[1] Phys. Sci., Osaka Pref. Univ.; [2] Dept. Geosci., Osaka City Univ.; [3] Dept. Earth Sci., Chiba Univ.; [4] GSJ, AIST

Ductile shear zones are regarded as localized zones of ductile shear strain and are mostly composed of finer grained rocks than surrounding weakly deformed host rocks. This grain-size reduction and mechanism switch from dislocation creep to grain-size-sensitive creep have been considered to be the most probable process for strain softening that causes strain localization. The presence of a dispersed second phase or the formation of polyphase aggregates, which inhibits grain growth and maintains fine grain size, favors this mechanism change. This idea is supported by the fact that many ultramylonites are composed of fine-grained polyphase aggregates. The mechanical mixing and metamorphic reaction is considered to be possible processes for the formation of fine-grained polyphase aggregates, although detailed processes are not clear. In this study, we describe microstructures of mylonite-ultramylonite samples from the Konoyama mylonite zone, one of the Ryoke internal shear zones, SW Japan, to discuss the formation process of fine-grained polyphase aggregates.

The studied samples are granodioritic mylonites deformed under upper greenschist phases condition. The microstructural changes from mylonites to ultramylonites are characterized by grain size reduction of plagioclase and K-feldspar porphyroclasts, a development of fine-grained aggregates such as Pl-Kfs bands and Kfs bands and an increase in modal content of Pl-Kfs bands. The dominant processes for grain size reduction of porphyroclasts were the fracturing of plagioclase along cleavage and the replacement of K-feldspar by myrmekite. K-feldspar precipitated in fractures and tails on porphyroclasts to form Pl-Kfs bands and Kfs bands.

In contrast to plagioclase and K-feldspar porphyroclasts, Quartz deformed by dislocation creep and remains as monomineralic bands even in ultramylonites. Microstructures of Qtz bands in mylonites are characterized by elongated grain shape with subgrains and development of CPO with Y-maximum c-axis fabric pattern. Qtz bands in ultramylonites also show strong CPO but their grain shape is less elongated and their grain size is similar to subgrain size of Qtz bands in mylonites. Qtz bands thicken largely around hinge area of intrafolial fold in ultramylonites, in contrast to constant thickness of feldspar-rich fine-grained aggregates. These microstructures indicate that Qtz bands were weaker (less viscous) than feldspar-rich fine-grained aggregates and controlled the rheological property of ultramylonites.

In addition, there are quartz grains dispersedly distributed around some Qtz bands in the ultramylonite. The space between the dispersed quartz grains is filled with K-feldspar. The distribution of the K-feldspar is isotropic without showing preferred orientation. There is no K-feldspar within Qtz bands and the boundaries between Qtz bands and dispersed quartz grains are rather sharp. The dispersed quartz grains show CPO with similar pattern as, but weaker than that of Qtz bands. The grain size of dispersed quartz grains is smaller than that of Qtz bands. These microstructures indicate that dispersed quartz grains were formed by inter-granular and intra-granular cracking of quartz grains on the surface of Qtz bands under high fluid pressure, and precipitation of K-feldspar. This process can be one of dominant processes for the formation of fine-grained polyphase aggregates in ultramylonites.