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Deformation processes of fine-grained polymineralic aggregate in granite mylonites along the Hatagawa Shear Zone

Motoko Kikuchi[1], # Kyuichi Kanagawa[2]

[1] Earth Sci., Chiba Univ., [2] Dept. Earth Sci., Chiba Univ.

The matrix of granite mylonites along the Hatakawa Shear Zone contains a fine-grained polymineralic aggregate (FGPMA) made up of quartz, plagioclase, K-feldspar and biotite, the modal content of which increases up to 60-80% in ultramylonites (Tsurumi et al., 2002). Although the rheology of mylonites containing abundant FGPMA must be controlled by the FGPMA, its deformation mechanism and rheology remain unknown. We discuss deformation processes of the FGPMA, based on the spatial distribution of constituent minerals and the crystallographic orientation data of constituent mineral grains using the electron backscatter diffraction (EBSD) method.

We have analyzed 3 mylonite samples along the Hatagawa Shear Zone, i.e. a less deformed granite mylonite (GM1), a more deformed granite mylonite (GM2), and an ultramylonite (GUM) probably derived from aplite (Tsurumi et al., 2002). We used a specimen coordinate of X axis parallel to lineation, Y axis normal to lineation and parallel to foliation, and Z axis normal to foliation, and used XZ sections for all analyses. We have traced grain boundaries between like mineral grains and phase boundaries between unlike mineral grains from optical and backscatter electron images of FGPMA, and obtained by image analyses of these boundaries such data for each constituent mineral as modal content, grain sizes, aspect ratios, long-axis orientations, and affinity. Affinity of a phase is represented by a ratio of its observed grain-boundary length to the grain-boundary length expected in a random distribution of that phase of the same volume fraction (Kroustrup et al., 1988). Affinity values above 1 indicate clustered phase distributions, while those below 1 indicate anticlustered phase distributions. We also have collected orientation data of quartz, plagioclase and K-feldspar grains in FGPMA, using an HKL Channel 5 EBSD system recently installed at Chiba University, with an accelerating voltage of 17 kV, a beam current of 8 nA, a working distance of 23 mm, and a specimen tilt angle of 73 degrees. Reflector files for quartz, albite and orthoclase were used to index diffraction patterns of quartz, plagioclase and K-feldspar, respectively.

Most quartz grains in the FGPMA of GM1 are smaller than 10 microns, and included in plagioclase derived from myrmekite. In contrast in GM2 and GUM, quartz grains larger than 10 microns derived from quartz ribbons are relatively abundant. The modal contents of quartz in the FGPMA of GM2 and GUM are much larger that that in GM1. In addition, the affinity value of quartz is 0.7 in GM1 indicating anticlustered distribution, while the affinity values are larger than 1 in GM2 and GUM indicating clustered distributions in these two samples. Thus the amount of quartz aggregate derived from quartz ribbons increases in FGPMA with increasing mylonitization. C axes of quartz grains derived from quartz ribbons are preferentially oriented around the Y axis in all samples, which is consistent with c-axis orientations in quartz ribbons (Tsurumi et al., 2002). Hence quartz grains derived from quartz ribbons preserve c-axis orientations developed in quartz ribbons.

Plagioclase in FGPMA is mostly derived from myrmekite (Tsurumi et al., 2002). Plagioclase in GM1 occupies 73 mode%, and has an affinity value of 1.2 indicating clustered distribution. In contrast, plagioclase in GM2 and GUM decreases in modal content to about 45%, and has affinity values of 0.7-0.8 indicating anticlustered distributions. K-feldspar in FGPMA is interstitial, and has affinity values less than 0.5 in all samples indicating anticlustered distributions. Both plagioclase and K-feldspar exhibit rather random crystallographic orientations in all samples, suggesting that both minerals have been deformed by grain boundary sliding.