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Grain size of dynamically recrystallized quartz controlled by mica

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A quartz-muscovite mylonite from the Honam shear zone of South Korea exhibits a size variation of dynamically recrystallized quartz grains in quartz ribbons depending on muscovite content within the ribbons. The quartz ribbons have a thickness of 0.88 to 0.13 mm in muscovite matrix. The muscovite grains both in quartz ribbons and matrix have a strong preferred orientation with their basal planes parallel to the mylonitic foliation. Grain boundaries of quartz within the ribbons are mostly wavy or lobate although some boundaries are serrated. Quartz grains show sweeping undulatory extinction and deformation bands. Two types of subgrains occur in quartz. The larger subgrains are tabular ones defined by two parallel, straight subgrain boundaries at a high angle to the grain long axis. The smaller subgrains are equiaxed ones occurring in the grain mantle. 55 to 65% of muscovite grains in the ribbons are within quartz grains while the remaining ones exist along grain boundaries of quartzes, suggesting a fast boundary migration of quartz grains during deformation. All these microstructures are indicative of regime 3 dislocation creep (dynamic recovery both by dislocation climb and fast grain boundary migration) by Hirth and Tullis [1992].

The average grain size of quartzes (D) in almost pure quartz ribbons (with mica content $< 0.5\%$ in area) is about 78 μm. A small increase in mica content (M) in the ribbons results in remarkable decrease in quartz grain size up to mica content of about 8% (e.g. $D \approx 30$ μm at $M \approx 8.1\%$). Further increase in mica above 8% leads to a little decrease in quartz grain size (e.g. $D \approx 17$ μm at $M \approx 41.5\%$), with quartz grain size asymptotically approaching about 4.5 μm. This relationship can be expressed as an equation $D = -12.4 \times \ln(M) + 61.7$. Electron backscatter diffraction (EBSD) analyses of the quartz grains show a strong lattice preferred orientation (LPO) in pure quartz ribbons, suggesting dominant slip systems of rhomb <a> and prism <a>. With increase in mica content in the ribbons, the grains favorable for prism <a> and basal <a> slip tend to be dominant although the intensity of LPO becomes weaker. This difference in LPO pattern may result from more contribution of grain boundary sliding to total strain with decrease in quartz grain size and/or from hindrance of oriented growth of quartz grains by mica with increase in mica content.

Keywords: mylonite, dislocation creep, dynamic recrystallization, quartz, mica, lattice preferred orientation.

References

[1] G. Hirth and J. Tullis, *J. Struct. Geol.* **14**, 145 (1992).