Heterogeneous deformation and intragranular recrystallization in experimentally deformed fossil-bearing limestone

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Deformation of rocks is heterogeneous particularly when constituent minerals have significant difference in crystallography and/or grain size. Recrystallized grains usually develop from the intragranular region of calcite porphyroclasts in natural shear zones, leading to grain-size reduction and thereby causing rheological change of deforming. However, detailed processes of the intragranular recrystallization and microfabric evolution still remain unclear. To investigate the intragranular recrystallization processes we performed experimental deformation on fossil-bearing limestone using triaxial testing machine. The fossils in the limestone are mainly crinoids and trilobites. The crinoids mostly occur as monocrystalline calcites with larger grain size (700 μm) than that of the matrix (tens μm). In contrast, the trilobites occur as polycrystalline calcites with their grain size (7 μm) much finer than that of matrix. The experiments were performed at temperatures of 500 ~700 ℃, strain rate of 10^{-4}~10^{-5} s^{-1}, confining pressure of 200 MPa and axial strain of up to 30 %. Our strain analyses show that bulk strain is more accommodated in the fine-grained calcites with increase in temperature. In deformed fine-grained calcites of trilobites, fabric strength becomes much weaker with increasing temperature and some grain growth occurs forming equant shape of grains with straight boundaries. These suggest that intergranular process is important in fine-grained calcites of trilobites. In contrast, dynamic recrystallization occurs within the monocrystalline fossil domain of deformed crinoids. The recrystallized grains develop along or near e-twin boundaries and have similar grain size to that of the subgrains (30 μm) formed adjacent to e-twin boundaries. There is a strong correlation of misorientation distribution between the recrystallized grains and e-twin boundaries, suggesting that the intragranular recrystallization in the crinoid fossil is dominated by rotation recrystallization along e-twin boundaries, resulting in misorientation inheritance from the e-twin boundaries. Thus, e-twin boundaries play an important role in intragranular recrystallization processes and grain-size reduction of deforming calcites.

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