



Crystal folding and recrystallization in naturally deformed orthopyroxene: insights from TEM imaging of subgrain/grain boundary development

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Orthopyroxenes from the Hidaka Metamorphic Belt (HMB), were strongly deformed at high temperature, resulting in strong elongation and crystal bending around [010] axis. We analyzed, on the basis of TEM observations, the development of subgrain and grain boundaries accompanying crystal bending, which eventually lead to recrystallization.

On the one hand, part of crystal bending is smooth and accommodated for a fraction by homogeneously distributed dislocations and for the rest by elastic flexure, in a process similar to flexural folding, where the slip interfaces are the clinopyroxene lamellae exsolved within the orthopyroxene crystals.

On the other hand, part of the bending is discontinuous and concentrated in subgrain/grain boundaries, which contain the [010] misorientation axis and whose traces, in the XZ deformation plane, are close to the perpendicular to (100) planes. For low misorientation angles ($\sim 1-2^\circ$), these boundaries are composed of aligned dislocations, with a spacing close to theoretical value for tilt wall made of (100)[001] edge dislocations. For larger angles ($\sim 7^\circ$), individual dislocations are no longer visible, but high-resolution TEM imaging shows the continuity of lattice chains through the boundary. In medium-angle ($\sim 10-11^\circ$) boundaries, this continuity at atomic scale is lost, although larger-scale, periodically arranged elastic strain zones are present on the boundary. For high-angle ($\sim 20^\circ$) boundaries, there is no evidence for any connection between adjacent orthopyroxene domains.

Although the boundaries described above are dominant, recrystallization, which proceeds by progressive rotation around [010] crystallographic axis, requires, to close the recrystallized grain, the formation of a second set of boundaries, with a trace at low angle to (100) plane. For low angles, these boundaries are also constituted of dislocations, whose precise geometry is unclear, but which are distinct from the dominant (100)[001] or any previously described slip system. The activation of unfavorable slip systems is probably the result of the large amount of elastic energy accumulated during crystal folding.