PHASE-DEPENDENT RECRYSTALLIZATION AND ITS IMPACT ON MIXING

a case study from the Lanzo upper mantle shear zone, Italy

Olivine

Olivine recrystallization (rxs) starts in porphyroclastic textures and continues until ultramylonites. Ol microfabrics are divided in neoblasts in multiphase assemblages (1), recrystallized porphyroclasts (2) and neoblast layers (3). Both latter microfabrics are ± monomineralic (ol~90 area%) with low mixing intensities (>90% ol-ol boundaries). However, olivine is the dominant mixing phase during opx/cpx porphyroclast rxs.

Dynamically recrystallized ol porphyroclasts

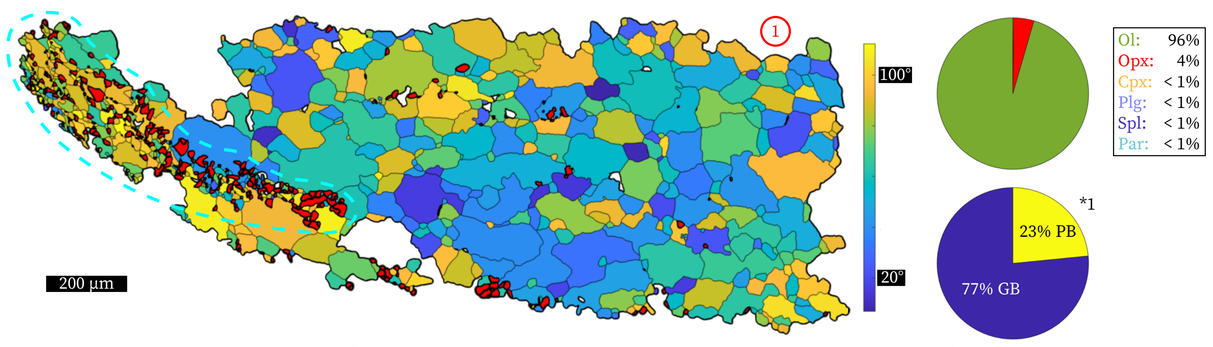

Fig. 1: ± monomineralic rxs tail of a dynRXS ol porphyroclast colored in misorientation angle from host clast (1). Note opx (red)-ol mixing spatially restricted to clearly defined area (dashed line) with significant smaller grain sizes and mixing impulse from outside the ol rxs tail.

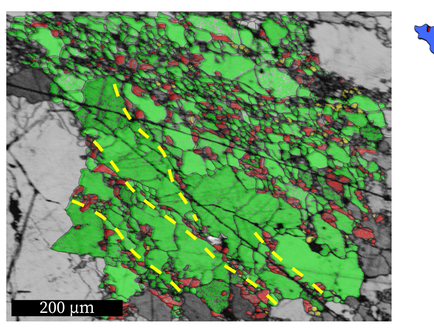

Fig. 2: . Grain boundary alignments (GBA, dashed lines) crosscutting ol rxs tail. Note significantly smaller grain size of ol & opx neoblasts and spatial defined phase mixing along GBA's.

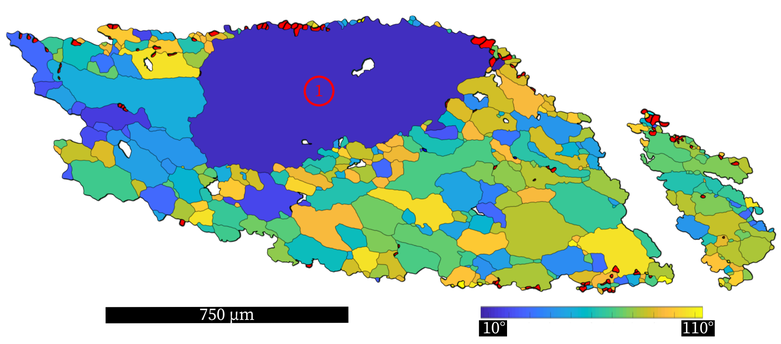

Fig. 3: . DynRXS ol porphyroclast colored in misorientation angle from host clast (1). Note ± monomineralic phase assemblage and low mixing intensity. Red colored, fine grained opx grains are concentrated at the rxs tail-matrix boarders.

Clinopyroxene

Clinopyroxene porphyroclasts recrystallize from porphyroclastic textures onwards forming an instant mix of cpx (~61 area%, ~21µm) and ol (~31 area%, ~18µm) in mylonites (1). Cpx generally displays bigger grain sizes and higher abundances than opx in ol+opx assemblages. Mixing intensities are explicitly high (66% phase boundaries). Recrystallization sides isolated from the ol-bearing matrix show a significant lower amount of phase mixing (2).

Recrystallized cpx porphyroclasts isolated from ol-bearing matrix

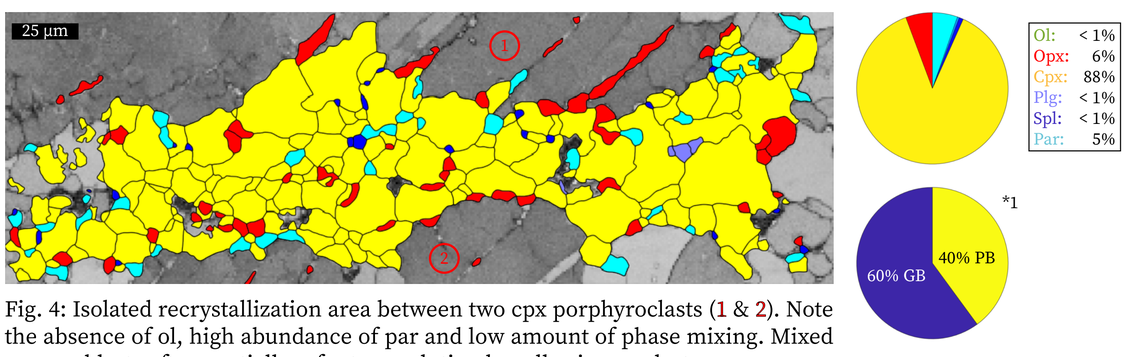

Fig. 4: Isolated recrystallization area between two cpx porphyroclasts (1 & 2). Note the absence of ol, high abundance of par and low amount of phase mixing. Mixed opx neoblasts often spatially refer to exsolution lamallae in cpx clasts.

Recrystallized cpx porphyroclasts in contact to ol-bearing matrix

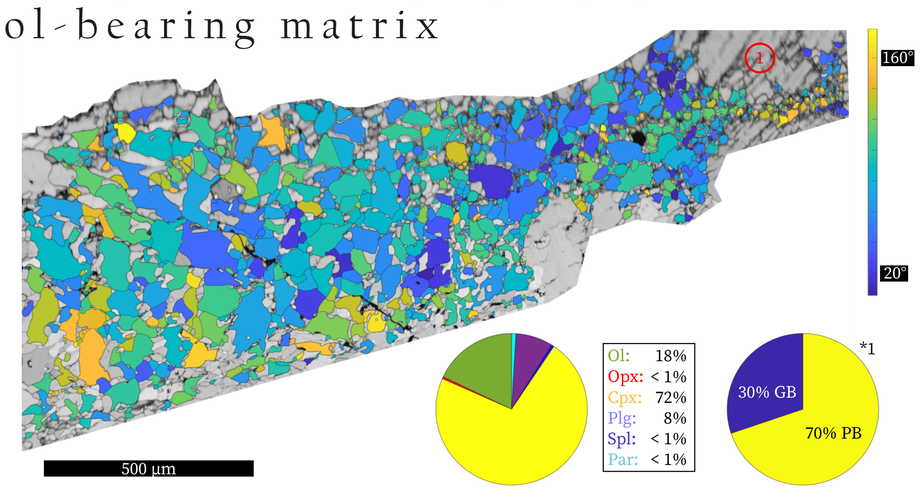

Fig. 5: Detailed map of cpx rxs tail shown in fig. 6 colored in misorientation angle from host clast (1). Note the high abundances of ol and plg and the explicitly high phase mixing intensity. Cpx neoblasts display a highly irregular grain shape.

*1: Mixing intensity depicted by percentages of grain (GB) and phase boundaries (PB) in relation to total boundary length.

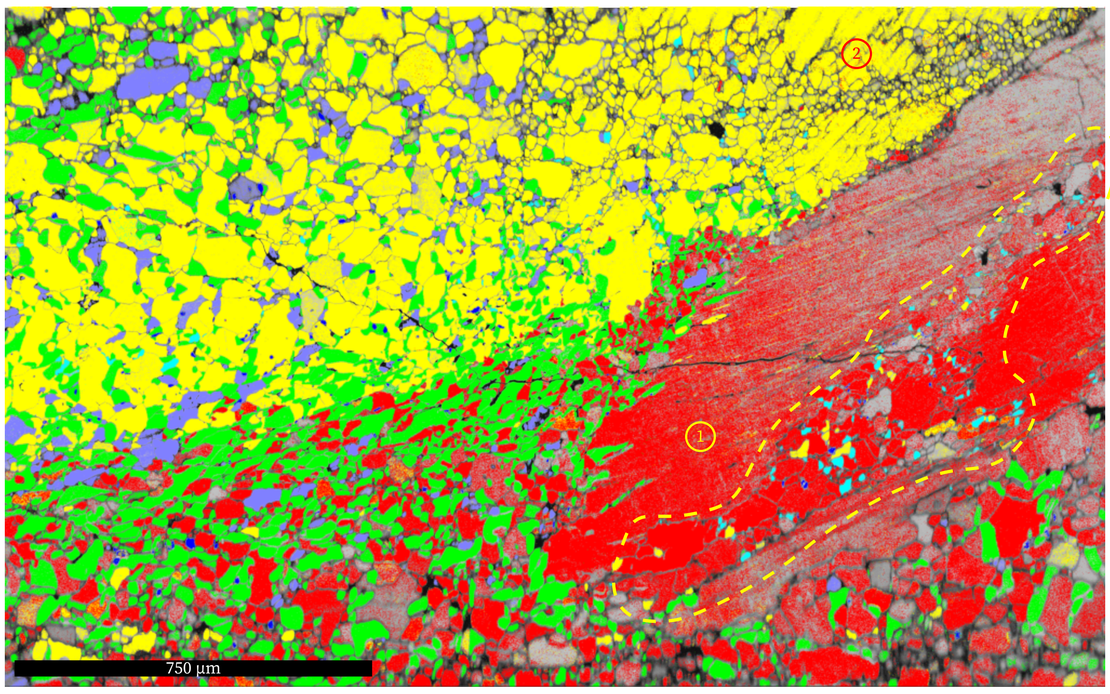

Fig. 6: Rxs tails of neighboring opx band (1) and cpx clast (2). Note the instant phase mixing explicitly at opx porphyroclast grain boundaries. The straight boundary of cpx+ol and ol+opx mixing areas shows little interaction between both rxs areas. High abundances of plg are present. Misorientation maps and phase abundances are shown in fig.5 (cpx) and fig.9 (opx). Grain internal rxs area (dashed line) is further investigated in fig.8.

Orthopyroxene

Up to mylonitic textures orthopyroxene occurs as ±equiaxial porphyroclasts and bands. In mylonites both recrystallize, forming an instant fine-grained mixture of ol (~56 area%, ~13µm) and opx neoblasts (~37 area%, ~14µm)(1). The phase mixing intensity is exceptionally high (63% phase boundaries). Clast internal (2) and matrix- isolated (3) recrystallization display a significantly lower intensity of phase mixing.

Recrystallized opx porphyroclasts isolated from ol-bearing matrix

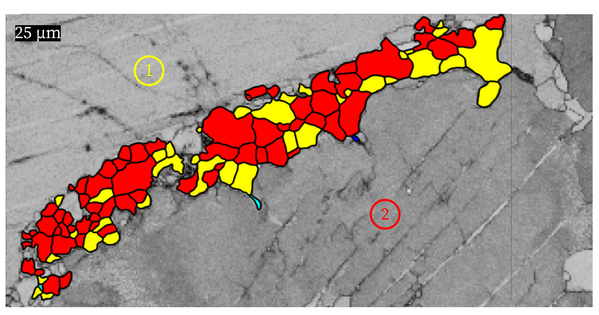

Fig. 7: . Rxs area at opx (1) and cpx (2) clast interface. Note the ± bimodal phase assemblage and the low mixing intensity depicted by clustering of opx/ cpx.

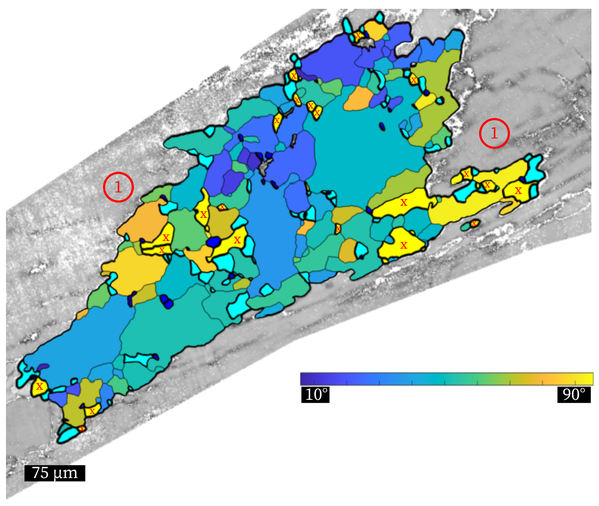

Fig. 8: . Misorientation map of internal opx rxs area from fig. 6 in dependence of opx band orientation (1). Attention cpx is colored yellow marked with red x and Par in cyan. Note the small misorientation angles of opx neoblasts and high abundances of opx and par (!). Ol is nominantly absent. The phase mixing intensity is low.

Recrystallized opx porphyroclasts in contact to ol-bearing matrix

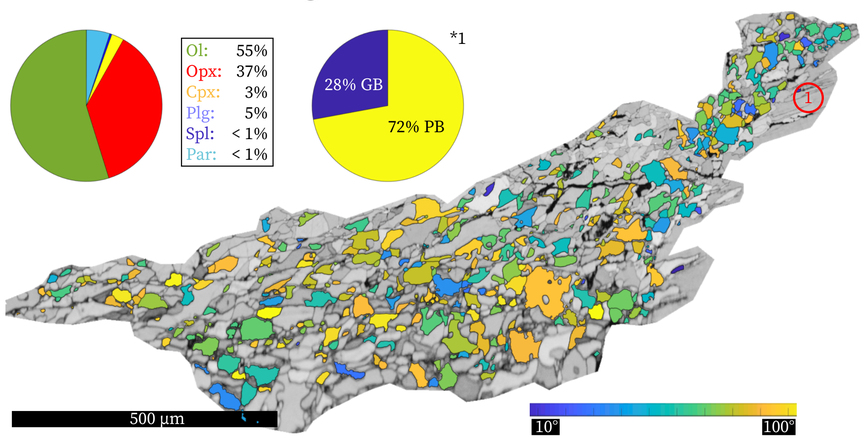

Fig. 9: . Detailed map of opx band rxs tail shown in fig. 6, colored in misorientation angle from host clast (1). Note the high abundances of ol and plg and the explicit high phase mixing intensity. Ol neoblasts are present adjacent to opx clast rxs grain boundary. Opx neoblasts display a highly irregular and elongated grain shape.

Conclusion:

- Recrystallization mechanism, mixing intensity and neoblast assemblage dependent on recrystallized phase and its microstructural position.
- Phase mixing is simultanous to recrystallization of opx and cpx porphyroclasts in contact to ol-matrix.
- Ol porphyroclasts recrystallize by dynamic recrystallization with minor amounts of mixing by GBS.
- This study highlights the importance of neoblast nucleation for phase mixing; Mechanical mixing solely by grain boundary sliding is neglectable in the investigated Lanzo shear zone.

Contact

Sören Tholen (PhD student) tholen@geo.uni-frankfurt.de
Jolien Linckens (PhD) linckens@em.uni-frankfurt.de
Stuctural Geology +49 (0) 69 798 40194
Goethe University Frankfurt