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Domain structure and texture in fine grained symplectite from garnet breakdown in peridotite xenoliths (Zinst, Bavaria, Bohemian Massif)

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Lherzolite xenoliths entrained in Oligocene basanite at the locality of Zinst (Bavaria, western Bohemian Massif) contain rare fine-grained symplectites forming about 5 millimeter sized patches comprising several microstructurally and chemically distinct concentric zones. The symplectites reflect a complex reaction history of lherzolite during decompression and interaction with melt.

Here we focus on ultra-fine grained symplectite with an integrated bulk composition expressed in terms of garnet end-member component percentages as Prp(69-71)Alm(11-13)Grs(2.5-5)And(7.5-10)Uvr(4). According to the composition and the microstructural occurrence in lherzolite the ultra-fine grained symplectite is interpreted as a product of isochemical garnet breakdown, although the precursor phase is not preserved.
Under cross polarized light patches with similar extinction show a domain microstructure in symplectite. BSE images reveal an intimate intergrowth of orthopyroxene, spinel and plagioclase. All phases have a shape preferred orientation within distinct domains, whereas discontinuous SPO changes occur at microstructural domain boundaries.

Three types of symplectite were microstructurally discerned: The most pristine type A occurs in a 10-30 micrometers wide zone along the symplectite margin. Spinel forms several tens of nanometers wide rods or lamellae within Opx, whereas Pl and Opx represent the symplectite matrix. All phases show a strong SPO with the maximum elongation perpendicular to the symplectite boundary. At edges of this interface, the SPO of the symplectite phases changes accordingly. Discontinuities in SPO may coincide with changes in crystallographic orientation. EBSD data showed that symplectite phases have strict crystallographic orientation relations with Opx(100)//Spl(111) and Opx(010)//Spl(110). Whereas the initial lattice orientation is controlled by adjacent phases at the symplectite boundary, the crystallographic orientation within symplectite domains changes continuously along subdomain boundaries and perpendicular to the grain elongation.
Type B symplectite has the same phase content and topotactic relations as type A, but the aspect ratio of the grains is smaller, and straight phase boundary segments occur. Furthermore, changes in lattice orientations differ from symplectite A. The crystallographic orientation of Opx and Spl shows a discontinuous scatter around the elongation (=growth) direction. Besides there is a continuous lattice orientation change in growth direction. Changes in crystallographic orientations have significantly larger rotation angles than the SPO changes within a single domain.
In type C symplectite the Pl content is increased at the expense of Opx. Plagioclase has a higher albite component indicating that these domains had interacted with fluid or melt. Spinel displays rounded grain shapes and occurs both within Opx and Pl. All phases recrystallized with isometric grain shapes.
Whereas symplectite A and B reflect reaction microstructures of garnet breakdown, symplectite C is a retrogression product of precursor symplectites A and B.

The changes in crystallographic orientation along and across the SPO are interpreted as due to plastic deformation during symplectite growth. The formation of Opx + Pl + Spl from garnet has a positive reaction volume of about 10%. As the area of the reaction front is supposed not to change during a reaction increment, this volume increase leads to a mechanically driven outward flow of symplectite material. It is hypothesized, that reaction induced strain may have led to plastic deformation and modulation of the crystallographic orientation during propagation of the reaction front.