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Olivine tablets in peridotite xenoliths: Evidence for a static, foliation-producing recrystallization mechanism operative in the strained, fluid-bearing mantle

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The term "olivine tablet" is used for elongated, (sub-)idiomorphic, strain-free crystals of olivine with well developed parallel crystal faces, usually found in peridotite xenoliths. While only rarely occurring in basalt-hosted xenolith suites, such peculiar grains are relatively common in specific kimberlite-hosted peridotite xenoliths and often explained as a result of fluid-assisted recrystallization in xenoliths after their entrainment in host magma. Extremely well developed olivine tablets are common in some peridotite xenoliths from Pliocene Lutynia basanite (South Poland). These were studied in detail focusing on their crystallographic orientation and chemical composition in relation to their host grains, in order to learn more about their origin.

The tablets are restricted to grain boundary regions of olivine(I) and enstatite or occur pervasively, in some cases constituting more than half of the rock volume. Together with strain-free mosaic grains they form a second generation of olivine growing at the expense of older and larger, strained olivine(I) grains. The tablets are typically 0.1-1 mm (up to 3 mm) long having typical aspect ratios of 2-3 (up to >10) and exhibit a strong shape preferred orientation at local scale or in the whole sample, in the latter case forming a distinct foliation in peridotite xenoliths. Tablet grains usually exhibit a lattice preferred orientation (LPOs) similar to the host olivine(I), suggesting that their orientation is inherited, likely by selective exaggerated growth of small grains at the margins of host grains (dynamically recrystallized grains were not observed directly). In some cases oriented growth of tablets along microcrackss, or planar sliding surfaces, is suggested by the microstructures. Traces of prominent tablet faces mostly correspond to (010) planes of tablet grains, while correlation to crystallographic orientations of host grains is poor.

Compositional profiles across tablet/host grain boundaries (EMPA, long counting times) show Ca-enrichment (from 0.02-0.03 to 0.06-0.09 wt% CaO) in $\leq$50 μm wide rims both in tablets and host grains, and, in some cases a non-identified Al-rich phase at the grain boundary itself. However, the Ca-profiles are symmetric with respect to grain boundaries and therefore this enrichment is assumed to post-date the tablet growth, probably being linked to infiltration of components from the xenolith host magma (which is observed independently as pockets with alkali feldspar, a second generation of clinopyroxene and a third, high-Ca generation of olivine). Compositions in the cores of tablets and olivine(I) are virtually identical within the resolution of conventional EMPA. Trace element composition, analyzed by LA-ICP-MS in several tablet/host grain pairs, shows systematically and significantly higher P and Li contents in tablets relative to host grains: (P: 30-40 ppm in olivine(I) vs. 76-87 ppm in tablets; Li: 4.6-5.7 ppm in olivine(I) vs. 7.6-10.0 ppm in tablets). Preliminary polarized micro-FTIR spectra show generally low water contents in olivine, mostly below 10 ppm of H_2O.

The observed microstructural and compositional features suggest formation of tablets by fluid-assisted static recrystallization which took place in-situ in the upper mantle interacting with P- and Li-rich, Ca- and Fe-poor agents. This recrystallization resulted in the formation of a foliation in peridotite by parallelization of grain boundaries in recrystallized domains with the (010) plane of the original LPO pattern. Although such observations are relatively uncommon, they might document a poorly sampled but widespread process potentially important for shear localization and the acceleration of fluid migration in the mantle.