Deformation mechanisms related to olivine megacrysts in mantle dunite

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In the Western Gneiss Region of Norway, pods of ultramafic, mantle-derived rocks occur as tectonic emplacements within a predominantly ortho- and paragneiss host rock terrane. One of these ultramafic pods, the Almklovdalen dunite-peridotite body, was exhumed from depths of ≥120 km during the Caledonian Orogeny. In the Åheim quarry, chlorite-bearing highly depleted dunites contain rare decimetric-sized olivine crystals surrounded by recrystallised material.

Microstructural and EBSD analysis of the Åheim olivine megacrysts and the adjacent and/or enclosed recrystallised grains reveal a record of multi-stage deformation: (1) A high-temperature episode under low deviatoric stress is suggested by [100](010) fabrics, consistent with an upper mantle setting; (2) A lower-temperature deformation event with an inferred higher deviatoric stress is indicated by analysis of the olivine subgrains, suggesting the activation of [100](001) slip. Our data further indicate that the olivine slip system activation in the recrystallised domains correlates with position relative to the megacryst: the closer to the megacryst, the more likely the activation of [100](001) in the recrystallised material.

In addition to providing further constraints on the deformation history of the Western Gneiss Region, the Åheim dunites provide an opportunity to observe the deformation processes involved in the recrystallisation of coarse-grained material and raise questions about the mean grain-size of the upper mantle.