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Dynamic recrystallisation of garnet and related diffusion-processes: results from EBSD and EMP investigations on metapegmatite

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The occurrence of garnet with a crystallographic preferred orientation has been described from several eclogite- or granulite facies shear zones, but only recently the first direct evidence of dynamic Grt-recrystallization and subgrain-formation has been reported (Storey & Prior, 2005). New EBSD- and EMP data of garnet-bearing metapegmatites from the Austroalpine Koralpe basement in the Eastern Alps (Austria) evidence the progressive formation of intra- and intercrystalline shear zones in Grt showing a well-developed grain and subgrain microstructure.

Permian pegmatite-emplacement had formed the magmatic assemblage Qtz-Ab-Ms-Grt-And-Kfs and accessory Ap, Xen and Ti-phases. About 10 mm sized idiomorphic Grt grains have nearly pure almandine-spessartine composition but show continuous compositional zoning as well as microstructural, color and sector zoning. Color zoning seems to be a product of the presence/absence of <1 micron sized inclusions (Ap, Ti-phases, Xen), which also reflect sector zoning in Grt. Magmatic growth zoning shows continuously decreasing Mn-, slightly increasing Mg- and Ca-contents (up to 5 mol% pyrope and 1.5 mol% grossular-component) from core to rim.

Cretaceous eclogite facies metamorphism and deformation affected the pegmatites together with the metapelitic host rock at c. 650-700°C/1.4-2.5 ($<$ 2.7) GPa. Rare, about 30-50 micrometer thick Ca-rich garnet overgrowths (containing up to 15 mol% grs) may represent a metamorphic Grt-generation.

EBSD maps reveal continuous lattice distortion patterns within and between coarse grained magmatic garnet-grains (up to 35° lattice rotation from the less distorted area

towards the distinct deformation zones): I) Initial intragranular deformation zones contain a higher density of subgrain boundaries than the rest of the garnet grains. 20-30 micrometer sized new grains have a crystal orientation similar to the host grain. Inclusion-trails of 20-30 micrometer sized Ap and Ky-needles as well as Xen present in these deformation zones are surrounded by colorless Grt-domains.
II) 30-50 micrometer sized new grains from more progressed intragranular deformation zones show a higher scatter around the host orientation. The grains of individual parts of these zones show a nearly random distribution and have a shape preferred orientation (SPO) with a high angle with the deformation zone boundary. III) Intergranular deformation zones follow the common grain boundaries between coarse garnet grains. The new grains (20-50 micrometers) also show a SPO as mentioned with type (II) shear zones. The orientation distribution is random.

The transition between host grains and deformation zones with new grains is often characterized by a subgrain zone. Orientation gradients reveal that many subgrains have misorientation angles less than 2°. The interior of the new grains of all deformation zones is crystallographically rather homogeneous. New grains have slightly higher Ca-content than the host garnet, which is depleted in Ca close to the deformation zones. Still, Ca-variations are below the extent of magmatic zoning ($<$ 1 mol%) indicating the lack of a significant material exchange with the matrix. The individual Grt porphyroclasts record progressive strain accommodation by initial dislocation creep and recovery processes, followed by subgrain rotation recrystallization. We suggest that recrystallized grains, once formed, are able to deform by diffusion accommodated grain boundary sliding. Diffusion processes result in an elevated Ca-content within new grains as well as the crystallization of Ap and Xen accompanying the process of dynamic garnet-recrystallization. Formation of fine-grained Ky within shear zones is therefore interpreted to relate with deformation during the Cretaceous HP event, whereas magmatic Grt-growth occurred at LP conditions in equilibrium with andalusite.

Storey, C.D. & Prior, D.J., 2005. Plastic deformation and recrystallization of garnet: a mechanism to facilitate diffusion creep. J. Petrol., 46, 2593-2613.