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Clash of garnets - Mechanical interaction of porphyroblasts

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The presence of porphyroblasts in metamorphic rocks has a strong influence on the microstructures that develop during deformation. Valuable as gauges for the sense of shear, single isolated porphyroblasts and -clasts have attracted enormous attention and vigorous discussion in the geological community. However, nature does not always provide samples fulfilling this criterion, therefore the understanding of multi-porphyroblast interaction is of great significance.

We use amphibolite-facies garnet mica schists from the Upper Austroalpine Wölz Complex for a case study. The microstructure of mm-cm sized, densely distributed garnet porphyroblasts indicates interference of the blasts. Microstructural and chemical investigation have been performed using optical and electron microscopy as well as an electron microprobe. The observed finite deformation is compatible with general shear. Blasts are subjected to convergence parallel to the instantaneous shortening axis, causing (i) accumulation and deformation of strain caps, (ii) fracturing of the garnets and (iii) dissolution at garnet-garnet interfaces. Parallel to the instantaneous stretching axis, (i) wedge-shaped strain shadows are linked between neighbouring garnets and (ii) separation of garnet clusters occurs preferably. Despite the existence of a non-coaxial strain component, strain shadows do not develop a monoclinic symmetry, owing to the interference of adjacent blasts.

The proximity of garnets determines (i) the formation of microstructures dependant on the direction of the instantaneous stretching axes, as well as (ii) the disturbance of these fabrics. Thus, dense populations of stronger objects in a weaker deforming matrix cause complex heterogeneous strain patterns, which demand a thorough investigation of the deformation history of a rock. Finally, when they are close enough, garnets interact and deform, and thus cannot be considered as rigid.