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An EBSD study of the textural development of feldspars in a shear zone

Hiroki Mukai (1), Håkon Austrheim (2), and Andrew Putnis (1)

(1) Münster University, Institut für Mineralogie, Münster, Germany, (2) Physics of Geological Processes, University of Oslo, 0316 Oslo, Norway

The numerous eclogite and amphibolite facies shear zones of Caledonian age (∼420My) that transect the older granulite facies gabbroic anorthosites (∼930My) of the Bergen Arc in western Norway provide an opportunity to study in detail the textural and chemical changes from the relatively unaltered granulites which retain the high grade mineralogy and texture, through to highly strained and hydrated minerals within the shear zones. The involvement of fluids has been well documented by the mineral reactions and reaction textures in the vicinity of these shear zones. We have studied the textural evolution of large plagioclase (∼An50) grains (several mms in size) within the gabbroic anorthosites by SEM and EBSD. The first stage of microstructural evolution within these plagioclases is a phase separation forming a network of Na-rich (∼An25) domains separated by thinner zones of Ca-rich (∼An65) domains. This results in a large number of new domain walls which contribute to the weakening of the rock. The Ca-rich domains contain a much higher density of sub-grain boundaries than the Na-rich domains which are relatively homogeneous on an SEM scale. EBSD of this intergrowth shows that both the Na and Ca-rich regions retain the crystallographic orientation of the parent An50 plagioclase crystals. Despite the large number of new domain walls the spread of orientations is very small.

In the next stage of shear-zone formation, recrystallisation of the two-phase intergrowth results in a crystal mosaic of grains up to 100μm in size. EBSD shows that the recrystallisation primarily involves the annihilation of the domain structure within the Ca-rich regions which surround the Na-rich cores. Thus each grain in the polygonal texture retains aspects of the chemical zoning from the intergrowth i.e. the crystals have a Na-rich core with a more Ca-rich rim. The resulting texture in the shear zone has a strong shape-preferred orientation made up from polygonal grains with abundant 120° triple junctions.

EBSD of 1136 grains from the polygonal texture within one rock thin section taken from the shear zone shows a random distribution of orientations i.e. no crystallographically preferred orientation (CPO). However a more detailed EBSD study of local areas where it is possible to locate the boundary between the two-phase feldspar of stage 1 and the feldspar in the shear zone shows a strong correlation between the crystallographic orientation of groupings of adjacent grains within the shear zone and the Na-rich, Ca-rich intergrowth from which it is derived. In other words, it is possible to trace the crystallographic orientation of a single large crystal of plagioclase from the gabbroic anorthosite, through its phase separation to the Na- and Ca-rich intergrowth and finally to those parts of the polygonal texture which were derived from the original plagioclase crystal. The fact that feldspar in the original gabbroic anorthosite has no CPO means that taken over the whole shear zone the feldspars have no CPO, while small areas appear to have a CPO because it is inherited from the original parent crystal.

The development of the textures in the feldspars is consistent with deformation by fluid-induced dissolution-precipitation creep.