Coupled fluid-mineral reactions and rock deformation

Andrew Putnis[1,2], Hiroki Mukai[1,3], Håkon Austrheim[4]& Christine V. Putnis[1]

1. InstitutfürMineralogie, University of Münster, 48149 Münste, Germany
2. The Institute for Geoscience Research (TIGeR), Curtin University, Perth, Australia
3. Department of Earth and Planetary Sciences, University of Tokyo, Japan
4. Department of Geosciences, University of Oslo, Norway

ABSTRACT

Fluid infiltration into dry, granulite rocks of the Bergen Arcs, western Norway results in deformation and the formation of shear zones on a range of spatial scales. These allow a detailed study of the relationships between fluid- mineral reactions, the evolution of microstructure and deformation mechanisms. A sequence of rocks from the relatively pristine granulites into a shear zone has been studied by optical microscopy, electron microprobe microanalysis (EMPA), scanning electron microscopy (SEM), electron backscatter diffraction (EBSD) and transmission electron microscopy (TEM), focusing on the progressive development of microstructure in the plagioclase feldspars, leading up to their deformation in the shear zone. At the outcrop scale, fluid infiltration into the granulites is marked by a distinct colourchange in the plagioclase from lilac-brown to white.This is associated with the breakdown of the intermediate compositionplagioclase (An50) in the granulite to a complex intergrowth of Na-rich and Ca-rich domains. EBSD analysis shows that this intergrowth retains the crystallographic orientation of the parent feldspar,but that the Ca-rich domains contain low-angle grain boundaries. Within the shear zone, this complex intergrowth coarsens by grain boundary migration, annihilating these grain boundaries but retainingthe Na-rich and Ca-rich zoning pattern. Analysis of nearest neighbourmisorientations of feldspar grains in the shear zone demonstrates that local crystallographic preferred orientation (CPO) is inherited from the parent granulite grain orientations. Random pair misorientation angle distributions show that there is no CPO in the shear zone as a whole, nor is there significant shape preferred orientation (SPO) in single grains. These observations are interpreted in terms of fluid-induced weakening and deformation by dissolution-precipitation (pressure solution) creep.