Mechanisms of weakening during ductile deformation of rock
Summary

• Phase changes: reaction softening
• Phase changes: crystallization of weaker phases
• Introduction of water
• Development of anisotropy
• Dynamic recrystallization:
  ▪ Decrease of dislocation density
  ▪ Relaxation of von Mises criterion through grain boundary sliding
  ▪ Transition to grain-size sensitive creep
Shear zone in granite, Laghetti, Swiss Alps
Phase changes: reaction softening
Eclogitic shear zone in granulite-facies gneiss, Holsnøy, Norway
Eclogitic shear zones in granulite-facies gneiss, Holsnøy, Norway
Granulite blocks in eclogite, Holsnøy, Norway
Granulite blocks in eclogite, Holsnøy
Granulite blocks in eclogite, Holsnøy
Granulite blocks in eclogite, Holsnøy
Phase changes: crystallization of weaker phases
Development of anisotropy
Ribbon quartz, Peloritani massif, Sicily
Crystallographic preferred orientation in quartz

PW37b-Qua-pf.ai

(HKL) = 001
N = 186216

Contours (x uni.)
15.68

Max. Density = 15.68
Min. Density = 0.00
Lower hemisphere
Non-Polar data
p.f.I = 7.29  Xs = 270.0

2-10
N = 186216

Contours (x uni.)
9.41

Max. Density = 9.41
Min. Density = 0.01
Lower hemisphere
Non-Polar data
p.f.I = 3.50  Xs = 270.0
Dynamic recrystallization

- Decrease of dislocation density
- Relaxation of von Mises criterion through grain boundary sliding
- Transition to grain-size sensitive creep
Dynamic recrystallization in olivine by grain-boundary bulging
Dynamic recrystallization in olivine by subgrain rotation
Dynamic recrystallization in quartz by subgrain rotation
Quartz porphyroclasts in dynamically recrystallized matrix
Olivine porphyroclast with dynamically recrystallized tail
Dynamic recrystallization in quartz, Betic Cordillera, Spain
Stress–grainsize plot for olivine

Black line shows predicted grainsize for dislocation creep.

Arrows show possible rock evolution.

From De Bresser et al. 2001