



Strain localization and weakening during eclogite-facies transformation in experimentally deformed plagioclase-pyroxene mixtures

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The rheology of mafic rocks buried at high to ultra-high-pressure conditions remains enigmatic. Minerals stable at these conditions are mechanically very strong (garnet, omphacite, glaucophane, zoisite, kyanite). In the laboratory, they show plastic deformation only at very high temperature (e.g. > 1000°C for pyroxene and garnet). Yet, viscous shear zones in mafic rocks metamorphosed at amphibolite and eclogite-facies conditions are commonly reported in fossil collisional and subduction zones. These shear zones localize and accommodate large amounts of strain by weakening of the host rocks. This weakening is interpreted as being induced by a transition from grain size insensitive to grain size sensitive creep, in particular with the activation of the dissolution-precipitation creep. However, the exact interplay between deformation, mineral reaction and fluid/mass transfer remains poorly-known.

We have conducted a first series of deformation experiments at eclogite-facies conditions on a 2-phase aggregate representative of mafic rocks. Shear experiments were performed in a new generation of Griggs-type apparatus (Univ. Orléans) at 850°C, and 2.1 GPa with a shear strain rate of 10^{-6} s^{-1} . The starting material consists of mixed powders with < 100 µm sized grains of plagioclase and clinopyroxene from an undeformed sample of the Kågen Gabbro in Northern Norway. Experiments have been conducted with 'as is' (dried at 110°C) starting material and with 0.2% added water.

The mechanical data indicate that the samples are first very strong with a peak differential stress at 1.4 GPa. Then, a significant weakening is observed with a stress decrease by 0.5 GPa. The high-strain sample is characterized by a strain gradient increasing toward the center of the shear zone. Metamorphic reactions occur throughout the sample, but the high-strain areas contain

considerably more reaction products than the low-strain areas. The nucleation of new phases leads to a drastic grain size reduction and phase mixing, whose intensities are positively correlated with the strain intensity. The nature, distribution and fabric of the mineral products vary also progressively with the strain intensity.

- In the low-strain areas, dissolution-precipitation processes mainly occur along grain boundaries: plagioclase is rimmed by zoisite and a secondary plagioclase more albitic in composition while clinopyroxene is rimmed by amphibole.
- In the mid-strain areas, dissolution-precipitation processes are more pervasive: amphibole and a secondary more sodic clinopyroxene occurs in pressure shadows of primary clinopyroxene, while primary plagioclase is completely replaced by a fine-grained mixture of zoisite and quartz. Reaction products show a strong shape-preferred orientation parallel to the shear direction.
- In the high-strain areas, dissolution-precipitation leads to the nucleation of a fine-grained mixture of garnet and secondary clinopyroxene, quartz and kyanite. Most reaction products have subhedral shape with no clear preferred orientation. Hydrous minerals (amphibole and zoisite) are not observed.

Our preliminary results indicate that strain at eclogite-facies conditions is preferentially accommodated and localized by dissolution-precipitation processes. Further micro-structural and geochemical analyses are required to quantify the exact interplay between the physical and chemical processes controlling the dissolution-precipitation creep.