Microstructural, compositional and textural inheritance in deformed mafic amphibolites

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Résumé

This study investigates the scales of compositional equilibria and role of early hydration in mineral fabric development of mafic amphibolites, deformed along a major transpressional tectonic plate boundary (Hokkaido, Japan). We studied a range of microstructures, from fractured domains with no or incipient viscous deformation to mm/cm-thick shear bands and meter-scale shear zones. In all microstructures, water percolation and hydration reactions were observed to occur at grains boundaries and in fractures formed coevally with viscous deformation, from 850 to 580○C, 4-5 kbar. From fractured to viscously deformed rocks, element, cathodoluminescence mapping and thermodynamic modelling show that the scale of compositional equilibrium was of 100-200 μm, inherited from local reactional domains. Fabrics and grain size were also mainly acquired during local, hydration reactions, whose extent was partly decoupled from viscous strain. In fractured domains, amphibole grew in pseudomorphs after igneous pyroxene and olivine, in microfractures aligned parallel to the main shear zone and in symplectites. In these microstructures, amphibole developed strong crystallographic preferred orientation (CPO) and aspect ratio that was preserved in shear zones. Further amphibole dissolution, nucleation and oriented growth then led to increase in amphibole grain size, but only slightly modified the amphibole crystallographic fabric in a way that (001) axes transpose into the stretching lineation. The crystallographic fabric of plagioclase, whose reaction was incomplete in fractured domains, continued instead to weaken with increasing strain and coeval reaction progress, mainly by fracturing-induced dissolution-reprecipitation. Phase distribution in shear zones also appears to be inherited from protolith and local reactional domains. Intimate phase mixing during viscous strain localization was indeed only achieved where fracture-induced hydration led to the formation of symplectites thus indicating that high strain alone could not produce phase-mixed layers. Fracturing precursors and symplectite formation before and during viscous strain were instead key to initiate and further promote grain-size sensitive creep leading to strain localization. The heterogeneous distribution of fractures controlled the distribution of fluid from the earliest stages of hydration, creating positive feedback between fluid-induced reactions and further localization of viscous strain and mass transfer.

Mots-Clés: mafic middle crust, shear zones, local equilibria, deformation, inheritance, dissolution, reprecipitation, fracturing, phase mixing, fracturing

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