
Strain localization in the Quiberon detachment zone (South Armorican Massif, Brittany, France) : from micro to macroscale

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Résumé

Strain localization processes in late-orogenic granitoid rocks are key to understand the rheological behavior of the continental crust in settings of crustal thinning. In several extensive geological settings, progressive strain localization occurs during exhumation and is expressed in clear deformation gradients at the macroscale. In the Quiberon granitic massif (South Armorican Domain, Brittany, France), exhumed along a detachment zone, instead, viscous strain appears heterogeneously distributed from the kilometric to the metric scale. This questions the factors controlling strain distribution other than decreasing temperature conditions. To address this issue, this study combines detailed mapping of macroscopic shear zones with petrographic observations at the microscale, quantitative textural analyses of quartz by electron backscatter diffraction (EBSD), hyperspectral cathodoluminescence imaging (CL) and thermobarometric estimates on phyllosilicates and quartz. Structural analyses reveal the existence of two deformation phases at the kilometric scale within the Quiberon granite, showing opposite senses of shear. Top-to-the-E shear zones formed at conditions from $\sim 550^{\circ}\text{C}$ to $\sim 450^{\circ}\text{C}$, 1 kbar. They appear crosscutted by late top-to-the-W shear zones formed at $450\text{-}350^{\circ}\text{C}$, < 1 kbar. Both deformation events result in diffuse and localized deformation within the granite. Microscopic analyses reveal that at high temperature conditions, top-to-the E deformation was distributed in the rock volume except along phyllosilicate-rich shear bands formed on former fractures opening in an overall ductile regime. With decreasing temperature conditions, strain preferentially localized along suitably oriented inherited lithological discontinuities (dykes). In their absence, strain appears distributed at the mesoscale but localized at the microscale along a dense network of anastomosed fine-grained, phase mixed, mm-size shear bands. These shear bands formed by : (i) dynamic recrystallization of quartz (ii) fractured-induced and reaction-induced grain size reduction in presence of water and (iii) phase nucleation. Grain-boundary sliding largely operated in these shear bands, further promoting phase nucleation and mixing that favoured strain localization at small scale. Hence, diversity in the mechanisms of strain localization at the microscale due to the heterogeneity of fluid percolation and distribution of reactions resulted in differences in the style of deformation at the mesoscale during the two-stage exhumation of the Quiberon massif.

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Mots-Clés: Strain localization, detachments, metagranitoids, metamorphic petrology, quartz microstructures, deformation mechanisms, inherited structures