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Deformation microstructures and rheological evolution of granulite-facies shear zones in Hokkaido, Japan

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The microstructure of the gabbros of the Hidaka Metamorphic Belt, an island-arc crustal section exhumed on Hokkaido, Japan, enables to study the rheological evolution, as well as the stress conditions of deforming crust in collision zones. The strongly localized dextral shear deformation (Jolivet and Miyashita, Tectonics, 1985) leads to the formation of granulite-facies layered mylonites composed of alternating fine grained (50 microns) plagioclase layers and asymmetric elongated (few mm) pyroxenes linked to each others by fine layers of very fine pyroxenes (10 microns) starting from their tips.

The large pyroxenes show strong shape and crystallographic preferred orientation (CPO) attesting to their deformation by dislocation creep (Toyoshima, The Island Arc, 1994). In contrast, the very small pyroxene grains show the same strong CPO when they are located on their rims of the large pyroxenes, but no preferred orientation when located in the fine layers far from the large pyroxenes. We propose therefore that the small pyroxenes, formed as rotated subgrains on the rim of the large pyroxenes, deform by diffusion accommodated grain boundary sliding, leading to the observed random crystallographic fabric. This transition from dislocation creep to a grain size dependent mechanism resulting from the large grain size drop enables to assess the deformation conditions.

Additionally, mapping of the crystal orientation within the large pyroxenes shows high internal deformation, whose length scale depends on the shape ratio of the elongated pyroxenes. The systematic study of the geometry of this deformation, as well as its modelling using models of beam bending, also enable to precise the stress conditions.