Deformation microstructures and rheological evolution of granulite-facies shear zones in the Main Zone, Hidaka, Hokkaido

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The microstructure of the gabbros of the Hidaka Metamorphic Belt, an island-arc crustal section exhumed on Hokkaido, Japan (Komatsu, 1980; Komatsu et al., 1979), enables to study the rheological evolution, as well as the stress conditions of deforming crust in collision zones. The strong dextral shear deformation (Jolivet and Huchon, 1989; Jolivet and Miyashita, 1985; Toyoshima, 1991; Toyoshima et al., 1994, 1997), localized within 10m-wide shear zones cutting through undeformed and unlayered gabbro composed mainly of large pyroxenes embedded within a plagioclase matrix, 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), with [100] parallel to lineation and [001] perpendicular to foliation, attesting to their deformation by dislocation creep (Toyoshima, 1991). 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 formation of the small pyroxenes is achieved by rotation and subgrain formation on the rim of the large pyroxenes deforming by dislocation creep, but that once formed, these small grains start deforming 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 first enables us to assess the deformation conditions. Additionally, such a switch in deformation mechanisms indicates that rheological softening accompanied deformation. Such a deformation-weakening process is probably responsible for the localization of the deformation and the mylonitization observed in the Main Zone gabbros.

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