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An SEM-EBSD analysis of plagioclase crystallographic fabrics in the Pankenushi gabbro in the Hidaka metamorphic belt

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The mylonitization of the Pankenushi gabbro in the Hidaka metamorphic belt along its western margin is inferred to have occurred under granulite-facies conditions shortly after the emplacement of the gabbro (Toyoshima, 1994; Toyoshima et al., 1997). With increasing mylonitization of the gabbro, plagioclase (An48-66) becomes crystal-plastically deformed and finer grained due to dynamic recrystallization. We have measured crystallographic orientations of plagioclase grains in the gabbro using the electron backscatter diffraction (EBSD) method, and revealed a change in plagioclase crystallographic fabric with increasing mylonitization.

The Pankenushi gabbro contains 48-73 mode% plagioclase. With increasing deformation of the gabbro, plagioclase develops undulatory extinction, deformation twins and subgrains indicative of crystal plastic deformation. In mylonites, plagioclase develops ribbons which are composed mainly of dynamically recrystallized grains having a shape preferred orientation oblique to the ribbon orientation, and in which remaining porphyroclasts exhibit a core-and-mantle structure surrounded by subgrains and dynamically recrystallized grains. Plagioclase grains in ultramylonites are rather homogeneously mixed with other constituent mineral grains, and also show a shape preferred orientation oblique to foliation. This oblique shape preferred orientation indicates a dextral sense of shear in both mylonites and ultramylonites.

We have collected orientation data of plagioclase grains from 5 samples, i.e. an undeformed sample, a weakly deformed sample, a strongly deformed sample, a mylonite sample and an ultramylonite sample, using an HKL Channel 5 EBSD system recently installed at Chiba University, with an accelerating voltage of 17 kV, a beam current of 8 nA, a working distance of 23 mm, and a specimen tilt angle of 73 degrees. A reflector file for anorthite was used to index diffraction patterns of plagioclase. A specimen coordinate of X axis parallel to lineation, Y axis normal to lineation and parallel to foliation, and Z axis normal to foliation was used. In the undeformed and weakly deformed samples, plagioclase grains exhibit preferred orientations of (100), (010) and (001) normal to the Z, X and Y axes, respectively. Plagioclase grains in the strongly deformed sample exhibit similar but weak preferred orientations. In contrast, plagioclase grains in the mylonite and ultramylonite samples exhibit preferred orientations of (010) 10-30 degrees clockwise away from the XY plane and [001] 10-40 degrees clockwise away from the X axis.

The crystallographic fabric of plagioclase in the undeformed sample likely represents a primary fabric formed by either magmatic flow or crystal settling in the magma chamber. This primary plagioclase fabric has not significantly been modified by crystal plastic deformation in the weakly and strongly deformed samples, although it has been weakened in the strongly deformed sample. In contrast, the primary plagioclase fabric has been completely modified in the mylonite and ultramylonite samples. The preferred orientations of (010) subparallel to foliation and [001] subparallel to lineation in these samples imply the dominance of (010)[001] slip system which is known to be active at medium- to high-grade metamorphic conditions (Ji and Mainprice, 1988). Although the homogeneous mixture of constituent mineral grains in the ultramylonite sample suggests activation of grain boundary sliding, the developed crystallographic fabric of plagioclase indicates that dislocation creep was the dominant deformation mechanism of plagioclase in this sample. The preferred orientations of plagioclase (010) and [001] clockwise oblique to foliation and lineation, respectively in the mylonite and ultramylonite samples indicate a dextral sense of shear which is consistent with that deduced from the oblique shape preferred orientation of plagioclase in these samples.