The role of fracturing in the formation of lower crustal shear zones

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Plagioclase-rich rocks are major constituents of the lower crust, and then understanding the rheological properties and deformation processes of plagioclase-rich rocks is key to evaluating the strength and mechanical behavior of the lower crust. Investigating grain size reduction and possible subsequent grain-size-sensitive (GSS) deformation in plagioclase-rich rocks is particularly important because a transition to GSS creep would result in significant rheological weakening. Dynamic recrystallization is a common grain-size reduction mechanism in plagioclase aggregates deformed by grain-size-insensitive (GSI) dislocation creep under conditions of the amphibolite to granulite facies. Empirical relationships between stress and recrystallized grain size have been proposed for plagioclase aggregates. If such stress and grain size relations transect the boundary between GSI and GSS creep fields, grain size reduction by dynamic recrystallization can lead to a transition from GSI dislocation creep to GSS creep. However, in the GSS creep field the applicability of the empirical piezometer is problematic owing to a potential lack of driving force for recrystallization. Dynamic recrystallization may represent a balance between grain size reduction and crystal growth processes set up in the boundary region between the GSI and GSS creep fields, and then recrystallized grain size and stress balance near the GSI–GSS field boundary. Thus, major weakening in localized natural deformation zones is unlikely to be caused by dynamic recrystallization. Fracturing and/or comminution are dominant grain-size reduction mechanisms at low temperatures because the critical resolved shear stress may not be reached in plagioclase, and recovery and recrystallization are limited. However, even under high-temperature conditions where plagioclase undergoes plastic deformation, fracturing and nucleation of new grains as small fragments has been identified in naturally and experimentally deformed rocks. Zones of very fine grains that result from fracturing and/or comminution would deform by GSS creep and then would develop as ductile shear zones in the lower crust. In this study, we summarized the *P*–*T* conditions of dynamic recrystallization and fracturing in the lower crustal plagioclase-rich rocks, and will discuss the formation and development of shear zones in the lower crust.

Keywords: Rheology, Lower crust, Shear zone, Fracturing, Dynamic recrystallization, Plagioclase

