Pulverization in a meta-anorthosite of a lower crustal shear zone

*曽田 祐介[1]、奥平 敬元[1]
*Yusuke Soda[1], Takamoto Okudaira[1]

1. 大阪市立大学理学研究科生物地球系専攻
1. Graduate School of Science, Osaka City University

Pulverized rocks, characterized by a very low shear strain and a very high fracture density, have been reported from various crustal-scale faults (e.g., Mitchell et al., 2011; Rempe et al., 2013). Grain size is one of the factor for deformation mechanisms in ductile regime (e.g., Okudaira et al, 2015), however, grain size reduction mechanism at lower crust is still unclear. We report a deformed meta-anorthosite undergoing pulverization at the lower crust.

Studied meta-anorthosite is corrected from a narrow mylonite zone of the Eidsfjord shear zone, Vesterå len, northern Norway (Markl, 1998; Okudaira et al., 2017). The meta-anorthosite has a mylonitic foliation defined by alternating plagioclase and mafic minerals layers in mesoscopic-scale. EBSD measurement parts in this study are mesoscopic-scale plagioclase porphyroclasts, which preserve the outlines of the original grains, making up with a few large relict clasts and many fine microscopic grains. Occurrences of the fine grains are subdivided into equigranular and heterogeneous texture. Later consists of twinned grains with angular grain shape.

Aggregates of fine-grained plagioclase have strong crystallographic preferred orientations (CPO). However, there are no plastic-deformation micro-textures such as subgrain boundaries and bulging in the fine-grained plagioclase grains. Spatial relationship and attitude of CPOs in the relict clast and fine-grained plagioclase preserving original grain, do not show crystal plastic deformation by specific slip system. Misorientation-axis distributions indicate that the grains have rotated randomly so that the misorientation axes are not aligned with either the crystallographic or kinematic axes. The observed microstructures and grain-size distributions in the heterogeneous texture have a fractal dimension D = 1.0, thus suggesting that the fine-grained plagioclase results from the fracturing and fragmentation of the porphyroclast rather than from dynamic recrystallization.

The observed fracturing/fragmentation process occurs without obvious shear deformations, thus indicating that it may be associated with coseismic pulverization. Such pulverization would result in the formation of a zone of fine-grained minerals in the coarse-grained lower crustal rocks, which is followed by a transition in the deformation mechanism from grain-size-insensitive dislocation creep to grain-size-sensitive creep. This process may be critical for the development of localized ductile shear zones in the lower crust.

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