Flow acceleration due to a flow mechanism transition in mylonites as a possible origin of slow earthquakes

Kyuichi Kanagawa[1]

[1] Dept. Earth Sci., Chiba Univ.

Last year, I showed three examples of superplastic flow of fine-grained (smaller than 50 microns) polymineralic aggregate derived from reactions in mylonites. Among them, fine-grained polymineralic aggregate makes up 50~60% and forms stress-supporting framework of the granite ultramylonite along the Hatagawa Shear Zone in the Abukuma Mountains and the Uenzaru peridotite mylonite in the Hidaka metamorphic belt. The rheology of these mylonites is hence controlled by the fine-grained polymineralic aggregate.

All these mylonites have matrix composed of monomineralic aggregate and fine-grained polymineralic aggregate. The monomineralic aggregate is composed of dynamically recrystallized quartz and olivine grains in the granite and peridotite mylonites, respectively. These grains exhibit both shape and crystallographic preferred orientations, indicating their crystal plastic flow by dislocation creep. The fine-grained polymineralic aggregate in the granite mylonite is composed of plagioclase, K-feldspar, quartz and biotite grains mainly derived from a myrmekite-forming reaction, while that in the peridotite mylonite is composed of olivine, plagioclase, spinel, orthopyroxene and clinopyroxene grains derived from the phase transformation reaction from spinel peridotite to plagioclase peridotite. The majority of these constituent grains exhibit neither shape nor crystallographic preferred orientations, suggesting their superplastic flow by grain boundary sliding.

Since the fine-grained polymineralic aggregate increases in amount with reaction progress, it should be minor in amount at an early stage of reaction progress, and hence the rheology of these mylonites at that stage is likely controlled by the monomineralic quartz or olivine aggregate flowing crystal plastically. Increasing amount of fine-grained polymineralic aggregate with reaction progress would result in a transition in dominant flow mechanism in mylonites from crystal plastic flow to superplastic flow, leading to a dramatic increase in strain rate, i.e., flow acceleration. Such flow acceleration in a mylonite zone possibly triggers a slow earthquake.