Geological and rheological conditions of subduction plate boundary between the seismogenic zone and the ETS zone in warm-slab environments

*Kohtaro Ujiie[1], Kazuya Noro[1], Norio Shigematsu[2], Ake Fagereng[3], Naoki Nishiyama[1], Christopher Tulley[3], Haruna MASUYAMA[1], Yasushi Mori[4]

1. Graduate School of Life and Environmental Sciences, University of Tsukuba, 2. Research Institute of Earthquake and Volcano Geology, National Institute of Advanced Industrial Science and Technology, Japan, 3. Cardiff University, 4. Kitakyushu Museum of Natural History and Human History

In subduction zones particularly under warm-slab environments, the transition zone between the locked seismogenic zone and the deeper, stably sliding zone is the site of slow earthquakes such as episodic tremor and slip (ETS) and long-term slow slip events (L-SSEs). Exhumed subduction mélanges on Kyushu Island, Japan, were deformed at depths of ~15–30 km and temperatures of ~370–500 ˚C under warm-slab environments and thus provide an invaluable opportunity to examine geological and rheological conditions that may responsible for slow earthquakes. The mélanges record low-angle thrust sense, viscous shear associated with metasomatic reactions. The metasomatism is caused by the infiltration of sodium-bearing fluid between pelitic schist and mafic to ultramafic rocks, resulting in albitization of pelitic schist. Microstructural observations and electron backscatter diffraction analysis show that viscous shear was accommodated by dislocation creep, mechanical rotation, and possible diffusion creep, resulting in dynamic recrystallization of quartz, strong shape and crystal preferred orientations of actinolite and chlorite, and random orientation of albite, respectively. Strain rate of viscous shear zones, estimated from the recrystallized grain size piezometer and flow law for quartz, increases with depth from ~$10^{-13}s^{-1}$to ~$10^{-10}s^{-1}$. The upper value of strain rate is consistent with the strain rate of L-SSEs in subduction zones, when the thickness of viscous shear zone is orders of 10–100 m, compatible with our field observation. Lattice-preferred orientation patterns of quartz c-axes also changes with depth from Type I crossed girdle to c-axis maximum subparallel to shear direction, showing a shear sense consistent with low-angle thrust faulting. Albitized pelitic schist formed by metasomatic reactions and associated viscous shear zones are absent in the mélange deformed at temperatures less than ~330 ˚C. In total, viscous shear associated with metasomatic reactions may account for strain rate, kinematics, and lower limit temperature of L-SSEs zone.

Keywords: subduction mélange, metasomatism, viscous shear

