Serpentinite dehydration in subduction shear zones formed at source depths of slow earthquakes

*Yasushi Mori[1], Miki Shigeno[1], Kohtaro Ujiie[2], Kazuya Noro[2], Tadao Nishiyama[3]

1. Kitakyushu Museum of Natural History and Human History, 2. University of Tsukuba, 3. Kumamoto University

Long-term slow slip events (L-SSEs) and episodic tremor and slip (ETS) occur along the subduction plate boundary at depths of 30–45 km (Obara, 2002; Shelly et al., 2006). These deep slow earthquakes are probably induced by high pore-fluid pressure. Based on geological study, we propose that the high pore-fluid pressure can be produced by metasomatic dehydration of serpentinite in subduction shear zones at source depths of deep slow earthquakes.

The Nishisonogi metamorphic rocks in Kyushu, Japan, are part of a Late Cretaceous subduction complex metamorphosed at $P \approx 1$ GPa and $T \approx 470$ °C. The *P*-*T* conditions are close to those of source depths of deep slow earthquakes. Serpentinite mélanges intercalated with the metamorphic rocks contain blocks of metabasite, metapelite and albitite. The mélange matrix consists of chlorite-actinolite schist (CAS), talc schist and schistose serpentinite. Intense shear deformation is concentrated in the CAS, and the serpentinite mélanges have the characteristics of anastomosing shear zones.

Bulk chemical composition of the rocks suggests that the CAS is the metasomatized mixture of serpentinite and metabasite. In addition, chemical mass balance indicates considerable dehydration during the CAS formation, along with a slight increase of solid volume. These findings suggest that the CAS formation involves the build-up of pore-fluid pressure. The high pore-fluid pressure results in the concentration of shear deformation into the weakened CAS.

Dehydration of serpentinite probably plays a key role in deep slow earthquakes (Poulet et al., 2014; Okazaki and Katayama, 2015). Thermal dehydration of serpentinite occurs at ~600 °C along the subduction plate boundary (Auzende et al., 2006), which is much higher temperature than that of source depths of deep slow earthquakes. In contrast, metasomatic dehydration of serpentinite described here could occur at source depths of deep slow earthquakes.

Auzende, A-L., et al., 2006, EJM, 18, 21–33. Obara, K., 2002, Science, 296, 1679–1681. Okazaki, K., Katayama, I, 2015, GRL, 42, 1099–1104. Poulet, T., et al., 2014, JGR, 119, 4606–4625. Shelly, D.R., et al., 2006, Nature, 442, 188–191.

Keywords: serpentinite mélange, shear zone, dehydration, pore fluid pressure, Nishisonogi metamorphic rocks, deep slow earthquakes

