プレート沈み込み帯に持ち込まれる生物起源堆積物の摩擦強化に関連した剪断の局所化

Shear localization related to frictional strengthening of the biogenic sediments entering subduction zone

*並木 由香[1]、堤 昭人[1]
*Yuka Namiki[1], Akito Tsutsumi[1]

1. 京都大学大学院理学研究科
1. Graduate School of Science, Kyoto University

In subduction zones, various seismic activities such as large earthquakes, episodic slow slip events, or silent earthquakes are observed. This variation likely reflects spatial variations in frictional properties along the seismogenic portion of plate-boundary megathrusts (e.g., Bilek and Lay, 1998). The frictional properties of materials entering subduction zones are probably different among various materials. Hence, the frictional properties of main oceanic sediments should be revealed.
A number of studies revealed frictional properties of clay sediments collected from the Nankai Trough (e.g., Brown, 2003). However, studies on the frictional properties of biogenic sediments are limited (e.g., Ikari et al., 2013; Namiki et al., 2014). In this study, we investigated the frictional properties of the biogenic sediments, and performed a series of friction experiments on silicic to calcareous ooze. To understand what controls the mechanism, we observed the shear structure in the samples by SEM. The samples tested in this study were collected offshore Costa Rica (Site U1381) during IODP expedition 334 and 344.
Frictional properties of the silicic to calcareous ooze were different from those of the clay sediments (Namiki et al. 2014). The friction coefficient of the ooze at a constant slip velocity of 0.28 mm/s showed an initial peak at 0.4 to 0.6 and subsequent minor decrease, followed by a gradual increase to attain a constant friction value at 0.6 to 0.8.
For friction experiments a rotary-shear friction-testing machine was used with various slip rates according to the radius of the shear area. The slip rate at the center is zero, and the slip rate on the outside is the fastest. In cross-sections near the outside of shear areas, two types of shear structures were observed: (1) shear localized zone (about 50 to 100 μm thick) mainly composed of fine rounded particles which forms parallel to the shear zone and (2) shear distributed zone, in which the silicic and calcareous shells show preferred orientation inclined to the shear zone at an angle within a range of about 30 degrees. Both of the structures were observed in samples, which have slipped until 0.4 rotations or more. A shear distributed zone could only be observed in samples slipped within 0.02 rotations. The particles in the shear localized zone decreased in grain size with larger displacement.
In cross-sections through the center of shear areas, a preferred orientation of particles in the shear distributed could not be observed as the analyzed cross-sections are vertical to the slip direction. The shear localized zone was observed only in the outer region of samples, which have slipped until 0.4 rotations. For samples slipped until 3.3 rotations, the shear localized zone could also be observed in the inner region.
From these results, displacement is a significant factor to develop shear localization. The observation of cross-sections through the center of shear areas suggests that duration of slip and slip rate seldom affect shear localization. The shear localized zone has formed while the friction coefficient attained a steady-state value after strengthening. The shear localized zone and preferred orientation in the shear distributed zone might correspond to Y-shear and P-shear of Riedel shear, respectively. Thus, Y-shear

likely develops with frictional strengthening, and continues to develop during a period while the friction coefficient maintains steady-state value.

キーワード：摩擦実験、剪断組織、珪質・石灰質軟泥、CRISP
Keywords: frictional experiment, shear structure, silicic to calcareous ooze, CRISP