Depth profile of frictional properties inferred from cuttings obtained at the Nankai trough C0002 drilling site

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Nankai megathrust earthquakes has occurred repeatedly, and has caused great damage historically (e.g., Ando et al., 1975). To understand the process of Nankai megathrust earthquakes, Nankai Trough Seismogenic Zone Excavation Project (NanTroSEIZE) has been conducted as part of the IODP since 2007 to 2019. Friction experiments were performed using core samples collected at the Nankai Trough Seismogenic Zone Excavation Project (Ikari and Saffer, 2011 and Takahashi et al., 2014), however, depth variations were limited in these previous experiments because cores were retrieved from limited depth intervals. In order to make a continuous depth profile of frictional properties, we carried frictional experiments using cuttings samples collected at every 50 m over the interval from 860 to 3000 mbsf in the ultra-deep riser hole, Site C0002 .

Frictional tests were conducted by biaxial frictional machine at Hiroshima university under saturated conditions (brine,0.5 mol/L) at in-situ effective normal stress (σe = 9–34 MPa). The cuttings samples were ground and the grain size was adjusted to less than 106 μm. The gouge sample was sandwiched by gabbro blocks in double–direct configuration. After slip behavior reached a steady state at 3 μm/s, velocity was changed stepwise between 0.3, 3, and 33 μm/s. In this test, frictional coefficient at a steady state and the velocity dependence defined by the rate- and sate-dependent friction constitutive law were examined. All tests were conducted in water tank filled with brine. The relationship between friction properties and clay minerals were investigated by comparing the total clay mineral content and smectite content of cuttings samples reported by the IODP 348 Expedition data report.

Frictional coefficient at the drilling Site C0002N are ranging from 0.472 to 0.575. There is no relationship between depth and frictional coefficient. Frictional coefficient was slightly decrease with increasing smectite content, which is consistent with the pervious study (Takahashi et al., 2014). The smectite content of samples collected at a deeper depth decrease, and therefore we expect future increasing coefficient of friction of these samples in the future measurements of deeper samples. Velocity dependence of friction(a-b) were ranging from -0.009 to 0.020. In most cases, velocity strengthening was observed, but the neutral of velocity-dependence was characteristically appeared at depths around 1100–1800 mbsf. Although Takahashi et al. (2014) has reported velocity strengthening in all experiments at the Site C0002, velocity dependence might be influenced by effective normal stress. Since the occurrence of slow earthquake is possibility related to a neutral sate of velocity dependence (e.g., Ikari and Saffer, 2011), the observed neutral dependence might attribute to the shallow very low-frequency earthquakes observed in the Nankai accretionary prism.

Keywords: friction, Nankai trough, clay minerals, accretionary prism

