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SSS30-06 Room:Main Hall Time:April 28 11:15-11:30

Large shallow slip during the 2011 Tohoku-Oki earthquake: New insights from JFAST and high-velocity friction experiments

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The Japan Trench Fast Drilling Project (JFAST), Integrated Ocean Drilling Program (IODP) Expeditions 343 and 343T were conducted to understand the coseismic deformation mechanisms and dynamics of large shallow slip during the 2011 Tohoku-Oki earthquake. The drill site is located at the toe of the frontal prism near the Japan Trench axis. Observations and analyses of recovered core samples as well as logging-while-drilling data indicate that the plate-boundary fault is highly localized in pelagic clay less than 5 m-thick. The smectite content in pelagic clay is ˜78%. The deformations in the plate-boundary fault are marked by distributed shear along anastomosing scaly foliations and localized slip along the boundary between red-brown and dark-brown scaly clays with different fabric orientations. On the microscopic scale, injection structures and mixing of clays of different colors without shear surfaces are observed along the localized slip zone, suggesting fluidization during the localized slip. High-velocity (1.3 meters per second) friction experiments on core samples taken from smectite-rich clay of the plate-boundary fault, show a small stress drop with very low peak and steady-state shear stress. The very low shear stress can be attributed to the abundance of smectite and thermal pressurization effects. Steady-state shear stress is independent of normal stress, and the microstructures after the experiments show evidence for fluidization. These features suggest that the fault material behaved like a fluid during high-velocity shearing due to thermal pressurization of pore fluid. Our results indicate that large shallow slip resulted from coseismic fault lubrication, and the similarity of microstructures between natural and experimental shear zones may represent the fluidization of fault material during earthquake faulting. Seismic slip could be promoted even in plate-boundary faults at shallow depths, as the slip propagates through the smectite-rich fault material.