

JFAST: Drilling to the Plate Boundary to Investigate the Large Slip of the 2011 Tohoku-oki Earthquake

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The 2011 Tohoku-Oki earthquake produced the largest fault slip ever recorded for an earthquake, up to 50 meters on the shallow portion of the subduction megathrust. This region of the plate boundary was not expected to have large slip during earthquakes, so the huge co-seismic displacements and resultant devastating tsunami were a shocking surprise to the seismological community. In response to the earthquake, the Integrated Ocean Drilling Program (IODP) rapidly planned and carried out Expedition 343 (JFAST) to investigate the rupture mechanisms and physical conditions that produced the large slip. During April/May and July 2012, three boreholes located at a site close to the Japan Trench about 90 km east of earthquake epicenter, successfully reached the plate boundary fault at depths of about 820 meters below seafloor. These boreholes enabled geophysical logging, core sampling and installation of a temperature observatory in the vicinity of the fault zone.

Analyses of core samples obtained from the plate boundary decollement show a narrow zone (less than 5 meters) of highly deformed fabric in a clay layer. The pronounced localization of deformation within this material suggests coseismic weakening during past earthquakes. Estimates of the level of dynamic friction during the recent earthquake are expected from the temperature monitoring that was installed during the expedition. Also, laboratory experiments on the retrieved core samples will give estimates of the frictional properties of the fault rocks. Combining investigations of the physical, chemical, and mechanical properties of the fault zone along with determinations of the local stress state from borehole breakouts, will provide information to help explain the very large slip that occurred during the earthquake.

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