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2011 年東北沖地震の震源域海底で起こったこと:海底長期観測の成果と展望
What long-term seafloor observations told us about the 2011 Tohoku-Oki Earthquake

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A number of important aspects of the 2011 Tohoku-Oki earthquake (Mw 9.0) were clarified by the seafloor observation above the rupture area of the earthquake. The most important observations were the extraordinarily large coseismic displacements, putting strong constraint on the processes of the fault rupture and tsunami generation. Continuous monitoring of ground motion using seismometers and pressure gauges clarified that gradual acceleration of the aseismic slip took place not only in the vicinity of the hypocenter of the eventual mainshock but also in the updip side of it. In addition, the seafloor instruments detected several unexpected phenomena associated with the earthquake. One of the instruments was displaced by about 1 km and detected large pressure and temperature excursions beginning three hours after the mainshock occurrence. These observations gave a strong evidence for the occurrence of tsunami-generated turbidity current in the area. Sediments trapped by the outer-shells of these instruments also helped to identify the origin and path of the flow. Including these non-seismological/geodetic ones, pre- co- and post-seismic observations are invaluable to characterize the massive and infrequent event and are still under careful inspection.

We continued seismological and geodetic observation after the earthquake to know postseismic activity. The obtained data indicate that the postseismic crustal deformation field show very complex spatial pattern as compared to those observed by the onshore network. The complexity is caused by large viscoelastic relaxation induced by the huge coseismic slip and makes it difficult to identify the elastic deformation associated with the afterslip along the megathrust, although it is the most important information to understand the behavior of the fault. The situation requires us to enhance the abilities of seafloor monitoring to detect the slip activities on the fault. Detecting slow-slip transient slips is one of the solutions and we started an array of arrays observation including broad-band seismographs to detect and locate slow-slip events and low-frequency tremors, which can happen in the transient process regaining interplate coupling. Another observation we started is direct-path acoustic ranging across the trench axis. Slip rate of the shallow fault can be measured by monitoring the change in distance between the benchmarks on the incoming and overrding plates.

Keywords: 2011 Tohoku-Oki Earthquake, ocean bottom seismology, seafloor geodesy, temperature monitoring