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Development of seafloor and seafloor borehole observatory network in the Nankai Trough for monitoring earthquake and slo

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A seafloor seismo-geodetic observation network using a submarine cable called ”DONET” (Dense Ocean-floor Network for Earthquake and Tsunamis) is currently under development in and around the epicenter of the Tonankai earthquake in the Nankai Trough. The purpose of the observation system development is to study mechanism of seismogenesis of large earthquakes in subducting oceanic plate.

Observation of ground deformation and earthquake above the seismogenic plate interface in the Nankai Trough seafloor should give a very important data to model the system of the coupling at the plate interface in the seismogenic cycles. In the development of the DONET, observation of seafloor ground deformation is important target. We planned ground deformation observation in the DONET in two methods, one using a seafloor height measurement based on the seafloor pressure data, and the other using geodetic sensors installed in a seafloor borehole where the surrounding media is more consistent and stable with less effect from oceanographic disturbances.

Our installation of the DONET seafloor observation network started in March 2010 with seafloor seismometer and seafloor pressure gauges, completing in July 2011 with 20 seafloor observatory in the seafloor. In the installation of the seafloor seismometers, we took care to bury the seismometer in the seabed using a caisson penetrated into the sediment to minimize effect from current flow in the seafloor for broadband wide-dynamic range seismic observation. In February 2013, we further improved the installation by filling the gap between the seismometer and the caisson with sand. After filling sand, we confirmed improvement in the seismic background noise level in many of the observatories.

In observing long-term ground deformation with seafloor pressure measurement, instrumental drift of the pressure gauge can be larger than the pressure change expected from seafloor deformation. Our measure on the instrument drift is to implement repeated calibration of the pressure gauges in the seafloor. We had an experimental calibration of the seafloor pressure gauge in January 2013 by JAMSTEC R/V Kaiyo.

Development of seafloor borehole observation network was planned as a part of IODP scientific drilling in the Nankai Trough. We successfully constructed the first long-term seafloor borehole seismogeodetic observatory in IODP C0002G hole in December, 2010. After confirming the proper function of the borehole instruments in 2011-2012 periods, we finally connected DONET cable to the borehole observatory in January 24, 2013. Currently we perform continuous real-time observation with the borehole observatory in IODP C0002G hole connected to the DONET. Observed records of the borehole strainmeter, tiltmeter, pore-fluid pressure gauges, and broadband seismometer showed clear signature of ground deformation from oceanic tide, tsunami, and long-period ocean gravity waves. We continues observation with the combined seafloor and seafloor borehole observation systems to analyze earthquakes and slow slip phenomena in the seismogenic plate boundary in the Nankai Trough.

Keywords: the Nankai Trough, seismic observation, ground deformation monitoring, borehole, seafloor pressure, seafloor cable