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Study on the installation method for long-term observatory: Causes and characteristics of vibration under strong current

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In the Nankai Trough Seismogenic Zone Experiment (NanTroSEIZE) project, a series of long-term borehole observatories that combine elements of CORKs (e.g., ODP Leg 196 in the Nankai Trough) and NEREID (ODP Leg 186 at Japan Trench), will be installed into the three holes along the NanTroSEIZE transect offshore the Kii Peninsula of southern Honshu, Japan (Sites C0002, C0 009 and C0010) to investigate fault mechanism and seismogenesis along subduction megathrusts. One of the primary challenges in realizing these long-term borehole observatories is to install high-precision, sensitive sensors into the borehole without damaging them. In particular, strong vibration can damage sensors during the lowering on drill pipe through the water column and the drifting to the hole, especially in areas of strong ocean currents such as Kuroshio.

JAMSTEC Long Term Borehole Measurements (LTBMS) group has been studying the causes and characteristics of the vibration based on the result from the field test. During IODP Expedition 319 from May - August 2009, we simulated the installation of the planned f borehole sensor system at Site C0010. Accelerometer was attached to the Instrument Carrier at the bottom of the sensor tree which includes four joints of 3-1/2" Tubing. The sensor tree was attached to the end of the drill pipe. Acceleration was recorded at 500 Hz during the lowering the sensor trees to the depth of ~1700 mbsf and the drifting to the Site with the ship speed of 1 knot. Spectral analysis of the collected acceleration data represents the drill pipe vibration and resonance of the Instrument Carrier during the drifted in the sea current. The amplitude of the resonance was much larger than the drill pipe vibration. The vibration mode at the lower frequency seems to correlate with the drifting rate, whereas the higher frequency mode seems to correlate with the current speed.

We are considering the two ways to prevent any vibration damage which can affect the performance of the sensors. 1) Establish the installation method which does not cause any vibration and which reduce the propagation of the vibration. The suppression of vortex induced vibration (VIV), consideration of the tubing size, configuration of a string of drill pipes, tubing and Instrument Carrier, and the structure of the Instrument Carrier has been studied. 2) Improve robustness of the sensors and instruments to the vibration during the installation. The vibration tests of electronic boards, individual instruments and the measurement system will be conducted to evaluate and improve vibration resistance. In addition, we are planning to conduct the field test to check the validity during the D/V CHIKYU test cruise in next March 2010. During next dummy run test, four accelerometers are attached to the drill pipe and the tubing as well as the Instrument Carrier. The acceleration data will be measured under the current speed of 2 to 4 knot. The collected acceleration data give us an opportunity to quantify the VIV and its propagation of the drill pipes, and the resonance and its generation of the Instrument Carrier. We will examine the further modification points by considering the results to establish the installation method under the strong current.

Keywords: Long-term borehole measurement, Seismogenic zone, Nankai trough, Vibration, Sensor development, Subduction zone