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Demonstration of in-situ environment in laboratory – For precise observation by BPRs

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JAMSTEC involves various technologies of long-term seafloor or borehole observatories in the seismogenic zone, in which real-time measurement by BPRs (Bottom Pressure Recorders) can contribute to early tsunami detection, slow-slip seismic event monitoring, or possibly crustal deformation's measurement etc. JAMSTEC developed the ocean-bottom borehole temperature and pressure simulator in 2009, which became one of key facilities to promote our technological development related to BPRs. This simulator consists of an oil operated piston gauge system (dead weight mounted on piston-cylinder module), an automated hydraulic pressure controller/calibrator, and low/high thermal oil chambers which can control constant temperature up to 180 °C. This composition allows us to demonstrate seafloor to borehole if the configuration of pressure and temperature can be defined accordingly. In this presentation, we introduce some recent applications by using our unique simulator.
At the beginning of the simulator operation, we evaluated the initial response of BPRs to be installed as a part of DONET observatories which is a seafloor network deployed in the Nankai Trough, SW Japan. In this experiment, 20 MPa of hydrostatic pressure (i.e. 2000 meters water depth) is applied to the BPRs under a constant temperature of 2 °C, for a duration of one month. Although some difficulties are found in the early stage of the experiment, as a result, sensor's stability and repeatability could be confirmed before deployment.
Recent experiment demonstrates that sensor's stability of mechanically different BBRs, i.e. Bourdon tube, TSMR (Thickness Shear Mode Resonator), and silicon resonant pressure transducers are examined. The Bourdon tube and TSMR pressure transducers use quartz crystals, whereas the silicon resonant transducer uses silicon oscillator manufactured by MEMS (Micro Electro Mechanical System) technology. Under the similar condition to DONET observatories, drift curves could be obtained after 38 days continuous pressure loading. This knowledge contributes to clarify the characteristics of stability of each pressure sensor.
Other applications by using the simulator are, for examples, sensor calibration to a mobile calibration system for the in-situ BPRs of DONET or the initial evaluation of pore fluid pressure measurement instrument to be used at IODP borehole observatory. Our unique facility that can demonstrate in-situ environment is used for BPRs' evaluation and development.