Observation of seafloor crustal deformation by the Tokyo University of Marine Science and Technology training ship Shioji Maru

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The Tokyo University of Marine Science and Technology (TUMSAT) build the training ship “Shioji Maru” in October 2021, which is installed a bottom transducer for seafloor crustal deformation observation. In this presentation, we will report the outline of the first observation of seafloor crustal deformation conducted by the Shioji Maru in January 2022 off the coast of Ibaraki and the quality of the acquired data.
The Japan Trench is one of the most active seismogenic zones in the world. The most recent of which occurred on March 11, 2011, when the tsunami triggered by the 2011 off the Pacific Coast of Tohoku Earthquake caused extensive damage along the Pacific coast of eastern Japan. Subduction-zone earthquakes, such as the Tohoku earthquake, occur when strain accumulates at the plate boundary due to the movement of the subducting oceanic plate, and the strain is released. In order to estimate the strain rate at the shallow part of a plate boundary, it is important to understand the movement of the seafloor. Therefore, seafloor crustal deformation observation has been vigorously conducted on the Pacific side of the Japanese islands by the GNSS-Acoustic (GNSS-A) observation, which combines GNSS observation and acoustic ranging. In general, to measure the seafloor crustal deformation data, it is necessary to conduct campaign observations by observation ship and so on, which incurs very large financial and human costs. In the case of Tohoku University, most observation points can only be conducted observations once a year, and some observation points have not been observed for many years. It is necessary to increase the frequency of observations in order to grasp the situation of sticking and sliding at plate boundaries with high accuracy and high temporal resolution over a wide area. In recent years, unmanned autonomous observers propelled by waves have been developed to reduce the labor required for observations, but the observation method is limited due to the slow speed of navigation, and the operation itself is difficult in waters with fast currents, so observations by ships are essential. In this study, we report on the observation of seafloor crustal deformation at the Tohoku University observation point G20(depth:2742m) off the coast of Ibaraki, which has not been observed since 2018 due to the Kuroshio and Oyashio currents are mixed and currents of about 4 knots can occur depending on the path of the Kuroshio. The observations were conducted from 0:23 to 14:10(JST) on January 13, 2022, for a total of 13 hours and 57 minutes. The first observation was fixed point observation at the center of the array of submarine stations for 8 hours, followed by three rounds of moving observations on the circumference of the array (about 4 hours), and finally the fixed-point observation for about 2 hours. In order to understand the maneuverability and acoustic noise level of the new ship, the first fixed-point observation was conducted by manual operation, and the second fixed-point observation was conducted by The Dynamic Positioning System. In addition to the acoustic observations, a total of five XCTD observations and one XBT observation were conducted. At this stage, we have confirmed the recorded acoustic waveforms and the correlated waveforms for runtime detection. Furthermore, we have confirmed that the Shioji Maru can acquire acoustic waveform data comparable to that of the R/V Shinsei Maru of the Japan Agency for Marine-Earth Science and Technology, which is also equipped with a ship bottom. We plan to conduct detailed analysis such as actual runtime detection, GNSS data analysis, hull attitude correction, and confirmation of consistency with measured sound velocity.
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