

## Precise aftershock distribution by urgent seafloor observation in the eastern source region of the 2024 Noto-Hanto earthquake using ocean bottom seismometers

\*Masanao Shinohara<sup>1</sup>, Yoshio Murai<sup>2</sup>, Ryota Hino<sup>3</sup>, Yusaku Ohta<sup>3</sup>, Ryosuke Azuma<sup>3</sup>, Toshinori Sato<sup>4</sup>, Hajime Shiobara<sup>1</sup>, Kimihiro Mochizuki<sup>1</sup>, Takehi Isse<sup>1</sup>, Tomoaki Yamada<sup>1</sup>, Takeshi Akuhara<sup>1</sup>, Shinichi Sakai<sup>9,1</sup>, Eiji Kurashimo<sup>1</sup>, Kazuo Nakahigashi<sup>5</sup>, Hisatoshi Baba<sup>6</sup>, Yoshihiro Ito<sup>7</sup>, Yusuke Yamashita<sup>7</sup>, Hiroshi Yakiwara<sup>8</sup>, Yukihiro Nakatani<sup>8</sup>, Shuichi Kodaira<sup>10</sup>, Koichiro Obana<sup>10</sup>, Gou Fujie<sup>10</sup>, Tsutomu Takahashi<sup>10</sup>, KH-24-JE01 and KH-24-JE02C shipboard scientists

1. Earthquake Research Institute, University of Tokyo, 2. Faculty of Science, Hokkaido University, 3. Graduate School of Science, Tohoku University, 4. Graduate School of Science, Chiba University, 5. Tokyo University of Marine Science and Technology, 6. Undergraduate School of Marine Science and Technology, Tokai University, 7. Disaster Prevention Research Institute, Kyoto University, 8. Research Field in Science, Science and Engineering Area, Kagoshima University, 9. Interfaculty Initiative in Information Studies, University of Tokyo, 10. Japan Agency for Marine-Earth Science and Technology

The 2024 Noto-Hanto earthquake with a Japan Meteorological Agency (JMA) magnitude of 7.6 occurred in the Noto peninsula on January 1st, 2024. The mainshock has a source mechanism of reverse fault type with compression axis of NW-SE direction. In the Noto peninsula, an earthquake swarm has been observed since December 2020, and migration of fluids in the crust was estimated to relate to the swarm activity. In contrast to the swarm activity, a source region of the mainshock extends to a marine area. Therefore, we decided to conduct an urgent marine seismic observation in the source region using a spatially dense network of free-fall pop-up type ocean bottom seismometers (OBSs) to obtain precise aftershock activity.

From January 20th 2024, we started deployment of 34 OBSs using the R/V Hakuho-maru. The spatial interval of 10 km for OBSs should be comparable to depths of events to locate the event precisely. The deployment was completed on January 22nd. We use three type of OBSs; Short-period OBS (SPOBS) with 4.5 Hz seismometers, Long-Term OBS (LTOBS) with 1 Hz seismometers and long recording period, and BroadBand OBS (BBOBS) with broadband seismometers. Data were stored in digital storages such as silicon memory card. We recovered 26 SPOBSs and newly deployed LTOBSs to continue the seafloor observation by the R/V Hakuho-maru from 19th to 28th February 2024. We processed the data from recovered 26 SPOBSs and obtained precise hypocenter distribution and focal solutions for aftershocks. The time of the records obtained by each SPOBS was adjusted using GNSS timing. The data from 25 OBSs and 23 land stations were available. We picked up the arrival times of the P- and S-waves manually from the records on a computer display based on the event list determined by the JMA. The events with a magnitude greater than 2 were selected for data processing. Approximately 570 events were selected within the observation period from the JMA catalog. For large events, we also read the polarities of the first arrivals to determine the focal mechanism of the events. An exact velocity structure is important for the location with spatial high resolution. We estimated a simple, one-dimensional seismic wave velocity structure from the results of the marine seismic surveys around the region (Nakahigashi et al., 2012, Sato et al., 2018). The velocity and thickness of the uppermost layer should have varied beneath each seismic station. Therefore, a compensation of calculated travel time for the location (Station correction) was introduced during a location with absolute travel times. We first located hypocenters of the aftershock using the location program with absolute travel times and the maximum-likelihood estimation technique (Hirata and Matsu'ura, 1987). Next, we relocated the hypocenter using the double-difference (DD)

method (Waldhauser and Ellsworth, 2000) to obtain more precise positions of the aftershocks. The depth of the aftershocks located by the OBS ranged from 0.5 to 16 km and become shallow compared to those in the JMA catalog (Figure). In the western part of the source region in the marine area, the activity of the aftershocks was limited in depths shallower than 12 km. The events with depths greater than 12 km occurred in the eastern part of the source region in the marine area. The deepest event occurred in the easternmost source region. From information of seismic structure, the aftershock activity seems to be limited in the upper crust. Earthquake source faults were modeled in the observation area. Aftershock activities were generally consistent with the source fault models. The focal mechanisms of some aftershocks were estimated using the program of Reasenberg and Oppenheimer (1985) by the first arrival polarity. Most of the aftershocks had a focal mechanism related to the NW–SE compressional stress. Although there are many focal mechanisms of reverse fault, some aftershocks had a strike–slip fault type focal mechanism.

Keywords: The 2024 Noto-Hanto earthquake, Seafloor seismic observation, Free-fall pop-up Ocean Bottom Seismometer, Aftershock distribution

