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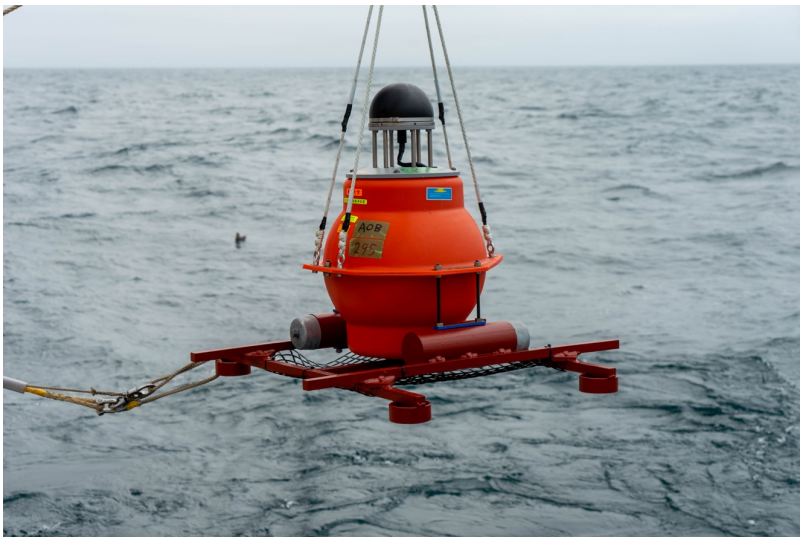
RV Shinsei-maru “Cruise Report”
KS-19-12

Investigation of preparation process for the huge interplate earthquake along the southwestern Kuril Trench based on the multiple sea-floor geodetic observation



Northern part of Sanriku-Oki,
Tokachi-Oki and Nemuro-Oki

July 03, 2019 － July 13, 2019

Joint Usage/Research Center for Atmosphere
and Ocean Science (JURCAOS)

Japan Agency for Marine-Earth Science and Technology
(JAMSTEC)

1. Cruise Information

Cruise ID: KS-19-12

Name of vessel: RV Shinsei-maru

Title of cruise:

Investigation of preparation process for the huge interplate rathquake along the southwestern Kuril Trench based on the multiple sea-floor geodetic observation

Chief Scientist [Affiliation]

Yusaku Ohta (Graduate School of Science, Tohoku University)

Cruise period

July 3-13th, 2019

Ports of departure / call / arrival

Departure: Hakodate

Arrival: Ishinomaki

Research area

Northern part of Sanriku-Oki, Tokachi-Oki and Nemuro-Oki. Area of the surrounding by following points [39°00'N,143°30'E],[41°46'N,143°30'E],[43°03'N,145°56'E],[41°29'N,146°41'E], [40°26'N,145°00'E],[39°00'N,145°00'E].

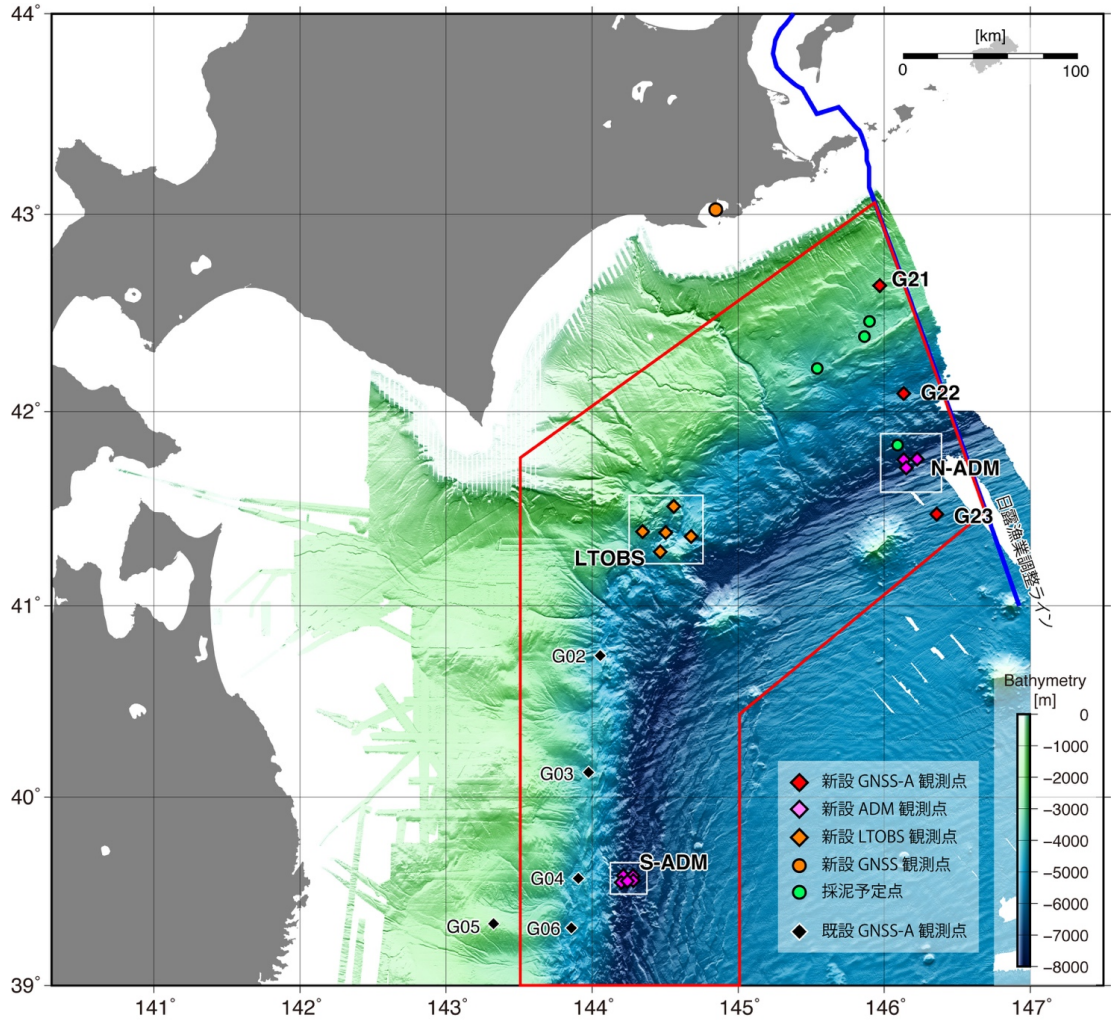


Figure 1. Observation map for the KS-19-12 cruise.

Research map (Cruise track):

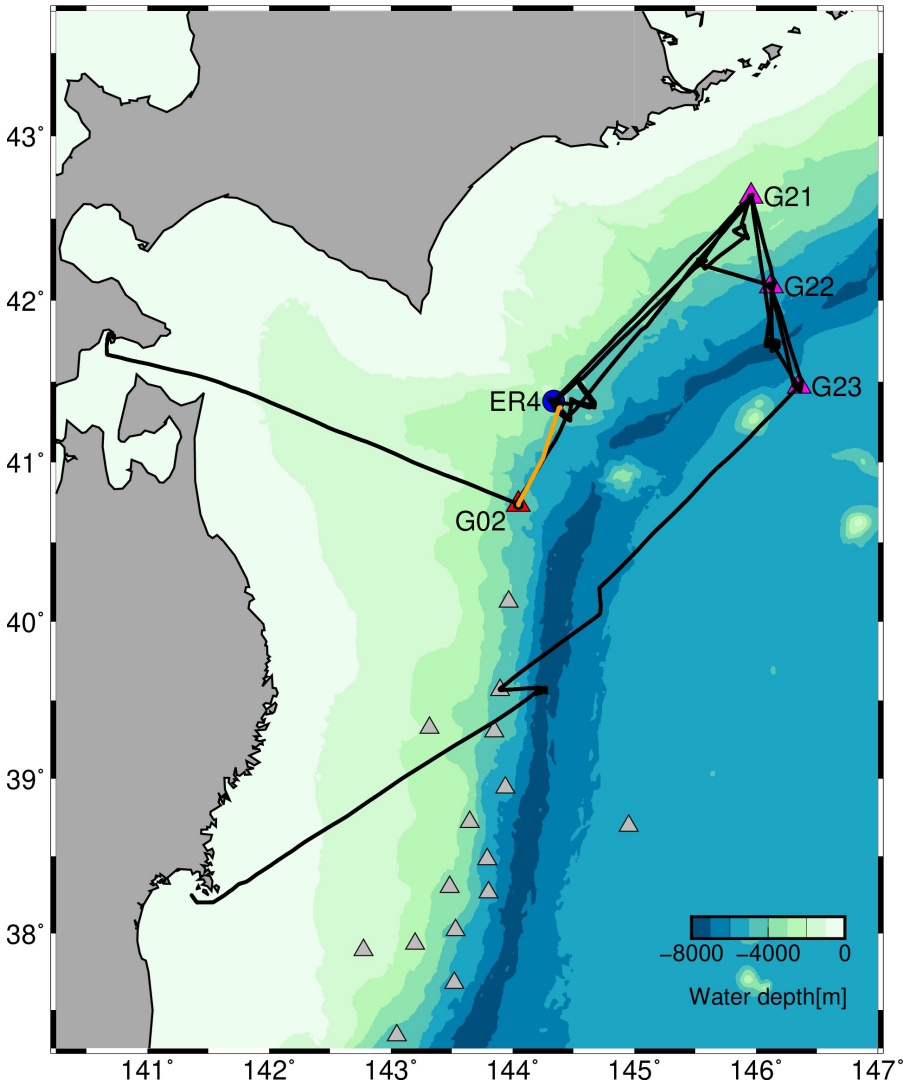


Figure 2. Entire ship track of the KS-19-12 cruise. Black line denotes the ship track of the Shinsei-maru. Orange line between the G02 and ER4 denoes the tack of the Wave Glider.

2. Research Proposal and Science Party

Title of proposal

Investigation of preparation process for the huge interplate earthquake along the southwestern Kuril Trench based on the multiple sea-floor geodetic observation

Representative of Science Party [Affiliation]

Yusaku Ohta [Graduate School of Science, Tohoku University]

Science Party (List) [Affiliation, assignment etc.]

Yusaku Ohta	[RCPEVE, Graduate School of Science, Tohoku University] onboard
Toshiya Kanamatsu	[JAMSTEC] onboard
Motoyuki Kido	[IRIDES, Tohoku University] onboard
Ryosuke Azuma	[RCPEVE, Graduate School of Science, Tohoku University] onboard
Makiko Sato	[RCPEVE, Graduate School of Science, Tohoku University] onboard
Ryusuke Yamamoto	[RCPEVE, Graduate School of Science, Tohoku University] onboard
Hidenobu Takahashi	[RCPEVE, Graduate School of Science, Tohoku University] onboard

Yukiho Kimura	[RCPEVE, Graduate School of Science, Tohoku University] onboard
Hideto Otsuka	[RCPEVE, Graduate School of Science, Tohoku University] onboard
Kan-Hsi Hsiung	[JAMSTEC] onboard
Fumiaki Tomita	[JAMSTEC] onboard
Mako Ohzono	[ISV, Graduate School of Science, Hokkaido University] onboard
Kazumi Okada	[ISV, Graduate School of Science, Hokkaido University] onboard
Yuki Aota	[ISV, Graduate School of Science, Hokkaido University] onboard
Hiroshi Matsunaga	[Marine Works Japan] onboard
Hiroshi Fujii	[Marine Works Japan]
Takeshi Iinuma	[JAMSTEC]
Ryota Hino	[RCPEVE, Graduate School of Science, Tohoku University]
Masanao Shinohara	[ERI, University of Tokyo]
Tatsuya Fukuda	[JAMSTEC]
Iwao Ueki	[JAMSTEC]
Hiroaki Takahashi	[ISV, Graduate School of Science, Hokkaido University]

3. Research/Development Activities

(a) Installation and observation of the GNSS-Acoustic site in Nemuro-Oki

- Responsible personnel

  Yusaku Ohta and Motoyuki Kido [Tohoku University]

- Background and research purpose

  The 2011 Tohoku-Oki earthquake clearly showed the large coseismic slip in the shallowest part of the subducting plate interface. It is truly important to know that such characteristic slip behavior is universally existing phenomena or not. Ioki and Tanioka (EPSL, 2016) pointed out the possible M9 class earthquake along the most southern part of the Kuril Trench based on the numerical tsunami simulation with the tsunami deposit record. They pointed out if the tsunami deposit record requires the large slip in the shallowest part of the subducting plate interface. In contrast, there is no sea-floor geodesy network in the region. Based on these background, we installed three GNSS-Acoustic (GNSS-A) arrays to understand the strain accumulation process in this region.

- Activities

  We installed three GNSS-A arrays in the Nemuro-Oki region (Figure 1). Each GNSS-A array is composed of three or four precision acoustic transponders (PXPs). In this cruise, we install four PXPs for G21 and G22, and three PXPs for G23 site. Installation is the simple free-fall from the research vessel.

  After installation, we conducted the two different types of the observation, which were the point survey and moving survey. The point survey conducted for the estimation of the position of the array center. The moving survey conducted to determine the position of the each PXPs.

- Methods and Instruments

  To measure the distance between the research vessel and PXPs, we adopted the ship-equipped transducer. As the PXPs, we installed the simple mirror transponder (Figure 3).

- Results

  We succeeded to keep the enough time to determine the initial position of each PXPs by the moving survey. Figure 4 shows the ship track which contain both moving survey and point survey.

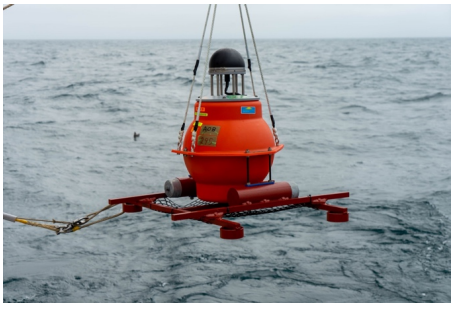
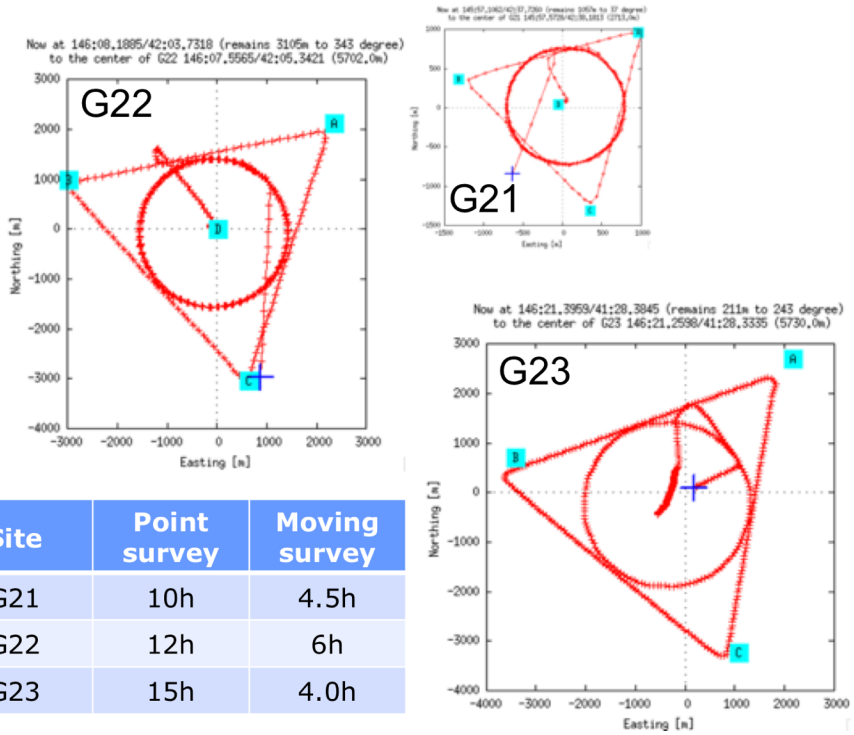


Figure 3. Photo of the PXPs for the GNSS-A observation.



Site	Point survey	Moving survey
G21	10h	4.5h
G22	12h	6h
G23	15h	4.0h

Figure 4. Ship track during the GNSS-A observation for G21, G22 and G23 site. Table denoted the approximately observation time in each site by the KS-19-12 cruise.

- Next plan

  We will continue the observations more frequently than annually to understand the strain accumulation process in this region.

(b) Installation of the equipment for the Acoustic Distance Measurement

- Responsible personnel

  Motoyuki Kido and Ryota Hino [Tohoku University]

- Background and research purpose

  Direct distance measurement between the incoming plate and continental plate is extremely important to understand the strain accumulation process in the shallowest portion of the subducting plate interface. Tohoku University is developing the direct acoustic distance measurement (ADM) equipment. In the KS-19-12 cruise, we installed the developed system in the Nemuro-Oki and northern part of the Sanriku-Oki.

- Activities

  We installed the three ADM in the Nemuro-Oki. We also insallted the four ADM in the northern part of the Sanriku-Oki. Furthermore, we also tried to install Indirect Path Ranging (IPR) unit for the Sanriku-Oki.

- Methods and Instruments

  To measure the direct path distance between

Figure 5. Photo of the ADM unit before the installation in the Nemuro-Oki.

the two ADM, we should select the installation point carefully because we need to consider the topography effect. Thus, we used the winch of the Shinseimaru for the installation. Figure 5 shows the ADM unit before the installation.

- Results

  We successfully installed the three ADM unit in the Nemuro-Oki. We also confirmed that each ADM unit successfully sent and received the other ADM unit signal.

  We also successfully installed the four ADM unit in the northern part of the Sanriku-Oki. We also tried to install the IPR unit. However, the IPR unit failed to install in this time.

- Next plan

  We will try to recover these ADM unit in the future, and try to investigate the strain accumulation process in the shallower portion of the subducting plate interface.

(c) Sea-trial of the Wave Glider for the GNSS-A observation

- Responsible personnel

  Fumiaki Tomita, Takeshi Iinumua [JAMSTEC],
  Motoyuki Kido and Yusaku Ohta [Tohoku University]

- Background and research purpose

  In the current time, GNSS-A observation basically require the research vessel. Thus, the cost and manpower are the problems. To reduce the cost and man power, JAMSTEC and Tohoku University currently are developing the system for the GNSS-A observation using the Wave Glider.

- Activities

  We installed the Wave Glider in G02 which is the one of the GNSS-A site of the Tohoku University. The developed system was worked well. We succeeded to conduct the GNSS-A measurement automatically by the Wave Glider.

- Methods and Instruments

  We adopted the Wave Glider SV3 for the plat home of the GNSS-A measurement. Figure 6 shows the recovered Wave Glider system in this cruise.

- Results

  We successfully conducted the GNSS-A measurement using Wave Glider. It was the first time result of the GNSS-A observation using the Wave Glider.

- Next plan

  We will continue the development of the system for the GNSS-A observation using the Wave Glider.

Figure 6. Photo of the Wave Glider for the GNSS-A observation after the recovery.

(d) OBS measurement near the Erimo Sea-mount

- Responsible personnel

  Ryosuke Azuma [Tohoku University]

- Background and research purpose

  Near the Erimo Sea-mount, the activity of the Very Low Frequency Earthquake (VLFE) is very active. To understand the spatial and temporal relationship between the ordinary earthquake and VLFE, we installed the five Ocean Bottom Seismometer (OBS) near the Erimo Sea-mount.

- Activities

  We installed five OBS as the array near the Erimo Sea-mount.

- Results

  We successfully installed the all OBS and we also determined the each OBS position by the acoustic ranging.

- Next plan

  We will recover the installed equipment next year and try to investigate the spatial and temporal relationship between the ordinary earthquake and VLFE.

(e) Sea-trial of the "A-0-A" OBP prototype system

- Responsible personnel

  Yusaku Ohta and Ryota Hino [Tohoku University]

- Background and research purpose

  Ocean bottom pressure gauge (OBP) can continuously observe the vertical crustal deformation on the seafloor. The long-term sensor drift of pressure sensors equipped with OBPs has been a serious and long-standing problem for detection of the slow crustal deformation. One of the approaches to reduce the long-term drift from OBP record is so-called "A-0-A" method. The method uses atmospheric pressure in the housing as the reference pressure (Kajikawa et al., 2014) instead of using the pressure standard, such as a dead-weight tester (Sasagawa and Zumberge, 2013), to monitor the sensor drift. Based on these backgrounds, we developed a prototype of OBP with "A-0-A" function, which can be deployed to deep (~ 6,500 m) sea environment (Figure 7). In the KS-19-12 cruise, we conducted the sea-trial of the developed system.

- Activities

  We installed the developed "A-0-A" system near the center of the G21 GNSS-A observation array. After four days experiment, we recovered the system.

- Results

  We confirmed the developed system successfully obtain the both the inside and outside pressure data.

- Next plan

  We will continue the development the system.

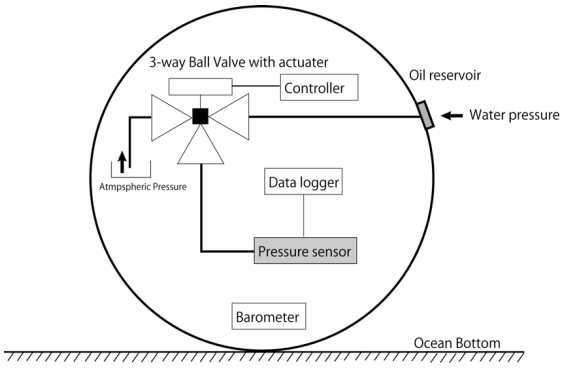


Figure 7. Schematic of the developed "A-0-A" system.

(f) Sampling the deep-sea using a piston corer system

- Responsible personnel

  Toshiya Kanamatsu [JAMSTEC]

- Background and research purpose

  The sampling the deep-sea sediment is extremely important to understand the past large earthquake history. Thus, we conducted the deep-sea sediment sampling using a piston corer system.

- Activities

We conducted two piston coring in the Nemuro-Oki. Before the piston coring, we also conducted sub-bottom profiling to investigate the characteristic of the sediments and rock under bodies of water.

- Results

We succeeded to obtain the core. The length of core for the KS-19-12 PC01 and PC02 were 5.25m and 4.39m, respectively.

- Next plan

We will analysis the obtained sample and investigate the past large earthquake history in Nemuro-Oki region.

4. Cruise Log

Time was denoted by local time (JST).

July 3th, 2019

14:00	Depart from Hakodate

July 4th, 2019

05:00	Arrived at the G02 site
05:00-08:30	Conducted moving survey for the GNSS-A observation at the G02
08:50	Installed the Wave Glider for the GNSS-A observation at the G02
09:00	Conducted XBT measurement at the G02
09:12-12:00	Conducted moving survey for the GNSS-A observation at the G02
12:00	Started moving to the ER3
15:43	Installed LTOBS at the ER3 by free fall
16:50	Installed LTOBS at the ER4 by free fall
17:47	Installed LTOBS at the ER0 by free fall
18:39	Installed LTOBS at the ER2 by free fall
20:55-23:30	Conducted the position measurement of the LTOBS (ER4 and ER3)
23:30	Started moving to the the G21

July 5th, 2019

08:30-10:30	Installed the 4 PXPs in the G21 by free fall
10:05	Installed A-0-A OBP prototype near the G21
13:40-15:22	Installed the 4 PXPs in the G22 by free fall
18:35-20:00	Installed the 3 PXPs in the G23 by free fall
	Started moving to the G22
23:00	Conducted XBT measurement at the G22

July 6th, 2019

00:00-06:00	Conducted moving survey for the GNSS-A observation at the G22
06:00	Started moving to N-ADM
08:00-10:32	Conducted the installation of the N-ADM1 by the intermediate size winch
10:32	Tear off the equipment by the releaser at 1,800m water depth
	Finished to install the N-ADM1
12:00-13:51	Conducted the installation of the N-ADM1 by the intermediate size winch
13:51	Tear off the equipment by the releaser at 2,500m water depth
14:30-16:39	Conducted the installation of the N-ADM1 by the intermediate size winch
16:39	Tear off the equipment by the releaser at 1,800m water depth
17:53	Conducted XBT measurement at the N-ADM
18:14-20:50	Conducted the measurement of the N-ADM positions
20:50	Started moving to the G21

July 7th, 2019

01:50-06:00	Conducted moving survey for the GNSS-A observation at the G21
06:00	Started moving to KS-19-12 PC01
07:10	Conducted SBP observation around the KS-19-12 PC01

09:40	Finished the SBP observation
09:40-13:20	Conducted the piston coring at KS-19-12 PC01
13:20	Started moving to KS-19-12 PC02
15:20-17:00	Conducted SBP observation around the KS-19-12 PC02
	Started moving to the ER1
22:30	Started to measure the ER1 and ER2 position

July 8th, 2019

03:48	Finished to measure the ER1 and ER2 position
	Started moving to the ER4
07:45-09:15	Conducted recovery of the Wave Glider
10:30	Started moving to the G21
20:24	Started point survey at G21
20:24-22:15	Conducted the CTD measurement at G21

July 9th, 2019

06:50	Finished point survey at G21
08:20	Recovered A-0-A OBP prototype near the G21
	Started moving to the KS-19-12 PC02
11:00-14:30	Conducted the piston coring at KS-19-12 PC02
14:30	Started moving to the G22
17:20	Started point survey at the G22
17:30-21:50	Conducted the CTD measurement at the G22

July 10th, 2019

04:00	Conducted XBT measurement at the G22
06:00	Finished point survey at the G22
	Started moving to N-ADM
08:00-08:48	Conducted the data recovery via acoustic communication at N-ADM
10:40-15:53	Conducted the first point survey at the G23
10:40-15:15	Conducted the CTD measurement at the G23
15:53-18:50	Conducted moving survey at the G23
19:09	Started second point survey at the G23

July 11th, 2019

00:00	Conducted XBT measurement at the G23
06:00	Finished the second point survey at the G23
	Started moving to the G04
22:30	Started point survey at the G04

July 12th, 2019

02:30	Finished point survey at the G04
	Started moving to the S-ADM array
04:00	Started installing four S-ADMs and one IRP
04:00-06:38	Conducted the installation of the S-ADM1 by the intermediate size winch
06:38	Tear off the equipment by the releaser at 2,300m water depth
08:10-08:50	Conducted the installation of the S-ADM3 by the intermediate size winch
08:50	Tear off the equipment by the releaser at 2,000m water depth
10:10-10:51	Conducted the installation of the S-ADM4 by the intermediate size winch
10:51	Tear off the equipment by the releaser at 2,000m water depth
12:38-13:27	Conducted the installation of the S-ADM2 by the intermediate size winch
13:27	Tear off the equipment by the releaser at 2,300m water depth
13:27-15:30	Conducted the installation of one IPR at center of the S-ADM array
15:30	Finished to install one IPR at center of the S-ADM array
16:20	Identified the unexpected floating of the IPR by acoustic ranging
18:20	Successfully recovered the IPR
	Started to moving to Ishinomaki

July 13th, 2019

10:00 Arrived at Ishinomaki

5. Notice on Using

This cruise report is a preliminary documentation as of the end of cruise.
This report is not necessarily corrected even if there is any inaccurate description (i.e. taxonomic classifications). This report is subject to be revised without notice. Some data on this report may be raw or unprocessed. If you are going to use or refer the data on this report, it is recommended to ask the Chief Scientist for latest status.
Users of information on this report are requested to submit Publication Report to Cooperative Research System Office.

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