



R/V Kaimei Cruise Report
KM19-E01

Investigation for the survey protocols for
submarine hydrothermal ore deposits

Okinawa Trough

February 1 to 14, 2019

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

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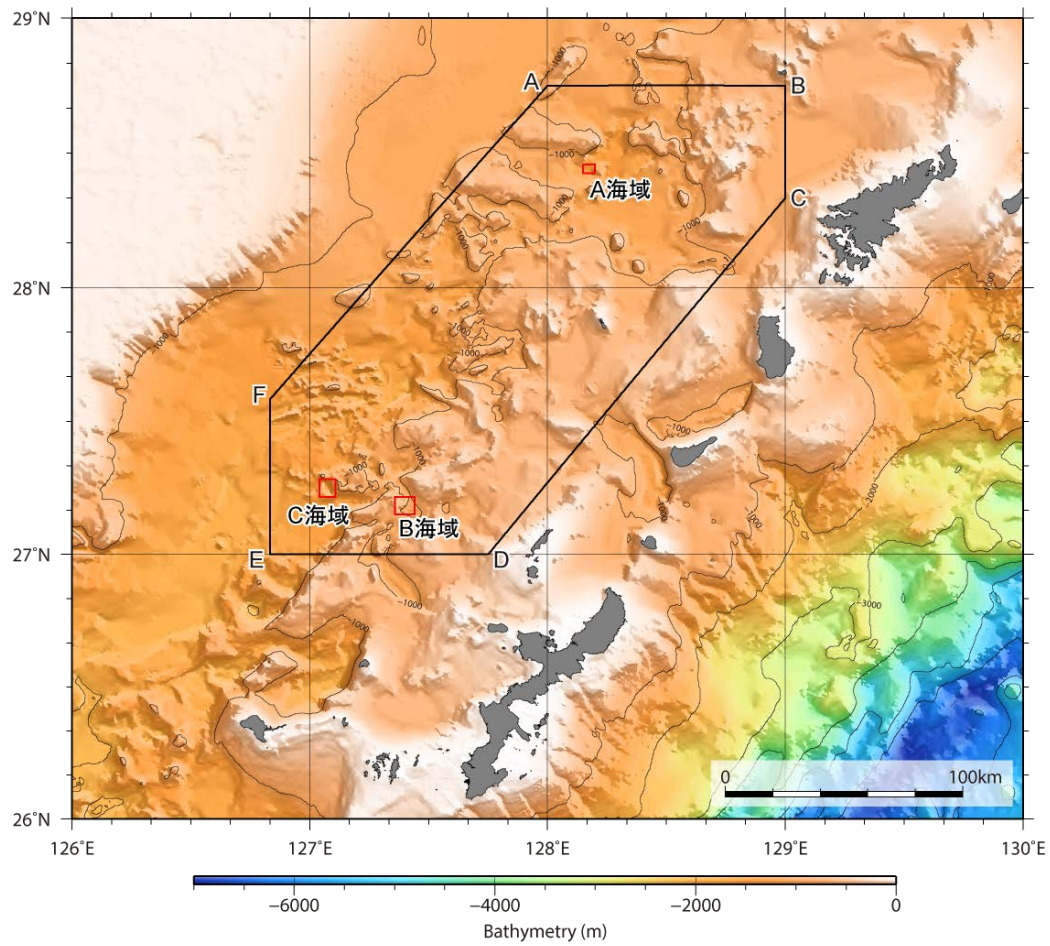
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1. Cruise Information

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- Name of vessel R/V Kaimei
- Title of the cruise
Investigation for the survey protocols for submarine hydrothermal ore deposits
- Title of proposal: Project research on hydrothermal system
- Cruise period February 1 to 14, 2019
- Ports of departure / arrival Yokosuka / Yokosuka
- Research area Okinawa Trough
- Research Map



2. Research party

- Chief Scientist:
Hidenori KUMAGAI JAMSTEC
- Associate Chief Scientist:
Hideaki MACHIYAMA JAMSTEC
- Representative of the science party:
Eiichi KIKAWA JAMSTEC
- Science party
Hirofumi YAMAMOTO JAMSTEC
Koichi IJIMA JAMSTEC
Shinsuke KAWAGUCCI JAMSTEC
Junji KANEKO JAMSTEC
Yoshinobu NAMMBU JAMSTEC
Erina MOMOI JAMSTEC
Shuhei TOTSUKA JAMSTEC
Yusuke OHTA JAMSTEC
Shohei TOMITA JAMSTEC

(Marine Technician)

Mitsuteru KUNO	NME
Katsuhisa MAENO	NME
Michiyasu KATAGIRI	NME
Takahiro KUBO	NME

BMS/ROV Operation Team

Operation Manager	MIURA Atsumori
1st Submersible Tech Staff	OHNO Yoshinari
1st Submersible Tech Staff	KONDOH Tomoe
2nd Submersible Tech Staff	ISHIDUKA Tetsuya
2nd Submersible Tech Staff	CHIBA Katsushi
2nd Submersible Tech Staff	TAKENOUCHI Atsushi
2nd Submersible Tech Staff	KUMAGAI Shinnosuke
2nd Submersible Tech Staff	IHARA Shota
2nd Submersible Tech Staff	GOTO Takuma
2nd Submersible Tech Staff	TORIGOE Mitsuru
3rd Submersible Tech Staff	SUGIURA Shuya
3rd Submersible Tech Staff	KOGUMA Atsushi
3rd Submersible Tech Staff	SATO Naoki
(Drill Advisor: JDC)	OKAYAMA Harutaka
	OIKAWA Atsushi
(Engineering Member: Cellula)	Scott BAUER
	Antony KINGAN
	Breanna HAYTON
	Thomas DEATON

R/V KAIMEI CREW

Captain	Rikita YOSHIDA
Chief Officer	Yasuhiko SAMMORI
2nd Officer	Tetsuo SHIRAYAMA
3rd Officer	Yuki ITO
Chief Engineer	Minoru TSUKADA
1st Engineer	Shinichi IKUTA
Jr. 1st Engineer	Kazuhiko KANEDA

2nd Engineer	Yoichi YASUE
3rd Engineer	Takamasa OCHIAI
Chief Electronic Operator	Yosuke KOMAKI
2nd Electronic Operator	Takatomo SHIROZUME
3rd Electronic Operator	Yohei SUGIMOTO
Jr. 3rd Electronic Operator	Misato TAKI
Boat Swain	OHATA Masanori
Seaman	YANAGITANI Daisuke
Seaman	SAITO Akira
Seaman	HIRAI Saikan
Seaman	KOJIMA Shinya
Seaman	TOKUNAGA Takuma
Seaman	OHJIRI Yuta
No.1 Oiler	OISHI Hiroyuki
Oiler	SATO Ryo
Oiler	KAWANO Motohiro
Oiler	SUZUKI Ryota
Chief Steward	HIRAYAMA Kazuhiro
Steward	HIRAI Tatsuya
Steward	YAMAMOTO Yoshitaka
Steward	KASHIWAGI Koichiro

3. Research/Development Activities

3.1. Research overview

This cruise was planned as the evaluation of "the survey protocol for submarine massive sulfide deposits" by a pair of (shallow) drilling by BMS (boring machine system) at active hydrothermal areas with and without SP anomaly found in 2017. This cruise is an adjunctive one to complement the previous scientific BMS drilling at hydrothermal site, KM18-08C scheduled in September 2018 (chief scientist: T. Kasaya) because not only severe weather/sea condition but also the severe troubles on hardware, e.g. winch or cable, inhibited the drilling. The main targeted area was western off Amami-Oshima and second target area was eastward from Izena Hole. Here, SP anomaly has been utilized as the middle step criteria to cut less promising area off in the protocol. The sequence proposed in the protocol as below: large scale area survey – micro bathymetric and Self Potential (SP) survey – marine CSEM or its variation as the detailed survey and final confirmation by drilling to confirm. In addition, pre- and post-drilling survey around the holes by ROV, MBES bathymetric survey, shallow sub-seafloor structural survey by SBP, gravity and geomagnetic survey were also planned.

Respective 44.2m and 10.8m of penetration in drilling was achieved in western off Amami-Oshima. At the first hole in the area with clear SP anomaly, several mineralization veins ranging 21-24mbsf and 31-34mbsf were found. On the other hand, at the second hole in the area without SP anomaly but in the vicinity of the active vents, little mineralization as veins were found. Cores obtained were logged by MSCL, half-cut and taken images followed by visual core description, pore water and discrete sampling, and electrochemical measurement. Further, the post drilling survey for Hole 01H and pre drilling survey for Hole 02H were also carried out by KM-ROV, respectively.

3.2. BMS drilling

Hidegori Kumagai, Hideaki Machiyama, and Shuhei Totsuka

In order to investigate the origin of the SP anomaly mapped by surface ships and towed- or autonomous- vehicles, both the area with and without SP anomalies were targeted. In this cruise, a couple of shallow drilling using a seabed drilling apparatus were conducted, of which planned target depth was approx. 60 mbsf. Due to the hole condition or limitation of time, the respective penetration of the hole was significantly shallow, approx. 44.2m for Hole 01H and 10.8m for Hole 02H. The specification of BMS is listed in Appendix B.

●Drilling information

BMS #9

Date: February 4 - 5, 2019

Location: Higashi-Ensei Hydrothermal Field, Hole: KM19-E01 BMS01H

Position: 28°26.386'N, 128°10.354'E, 1235 mWD (1230m by BMS depth meter attached to elevated position), at the foot of an active hydrothermal mound. In a local depression approx. 15m in diameter. By a post drilling ROV-dive, two ROV-event markers were deployed (92-1 and 92-2): one is at the rim of the drilled hole, the other is on a shallow point a few meters away from the hole.

Bottom of the Hole: 44.215mbsf

Assembly: H-type bit, 62mm liner, no casing

Description:

This hole targeted to investigate the origin of SP anomaly observed by AUV Jinbei as well as JAMSA/J-MARES survey as in the part of SIP "Next-generation technology for ocean resources exploration." The drilled point was set on the polarity boundary of vertical electric field (Ez) parallel to the trends of hydrothermal mounds; south of where the values of Ez showed negative values. Such an inflection points of Ez probably associates the position of the source of anomaly beneath the sea floor (e.g. Kawada and Kasaya, 2017). At least lower half of the hole, high temperature in the hole was observed indicated by blackened thermographic labels on the top of core barrel: higher than 160°C. Regardless of the blackening of the labels, only one inner polycarbonate tube was melt; the core #21 was irregularly settled more than 1.5 hours at the bottom of the hole. Blocks of massive sulfides were found in the tenth and from twelfth to fourteenth cores, which clearly responds as the electric nature in on-board electromagnetic measurement. Both upper and lower lithologies of the

above described sulfide enriched part were to be a hydrothermal clay dominated formation with and without scattered sulfides.

BMS #10

Date: February 10 - 11, 2019

Location: Higashi-Ensei Hydrothermal Field, Hole: KM19-E01 BMS02H

Position: 28°26.571'N, 128°10.462'E, 1233 mWD. On a saddle point of local ridge 40m northeastward away from a trend of active hydrothermal vents.

Bottom of the Hole: 10.813mbsf

Assembly: H-type bit, 62mm liner, no casing

Description:

Contrasting to the previous drill site, the drilled point has no anomaly of electric field observed by AUV based electromagnetic survey. Any temperature anomaly were not observed at drilling also.

The uppermost, core 1 (mud line – 1.1 mbsf), was hydrothermally altered volcanoclastics similar to the top of KM19-E01 BMS01H sample. The lower part mainly consists of volcanoclastics that looks like fresh lava, associating with hyaloclastite.

Core processing for BMS drilling

Hideaki Machiyama and Koichi Iijima

The drilled cores were firstly retrieved from the BMS system itself as in the steel sampler called as "inner tubes" with steel- or plastic-made container, "core liners." In this cruise, such liners are made of polycarbonates 62mm OD of which limit of operation temperature is 120°C. After the retrieval of samples into "core liners", they were processed according to the sample processing protocols shown in Appendix A.

3.3. Survey by KM-ROV

Hidenori Kumagai, Shinsuke Kawagucci and Hideaki Machiyama

In this cruise, we performed two dives, KM-ROV #92 and 93 to observe seafloor and sampling sediments and hydrothermal fluids in Higashi-Ensei hydrothermal field. The former one, dive #92 was the post-drilling survey for the BMS #9 drilling; the latter one is pre-drilling survey for the BMS #10 drilling. Both the drilling is to contribute to access the influences of developing marine resources against marine environments; we should know the prior environments including biodiversity and geochemical background, e.g. meiofauna, fluid chemistry of hydrothermal vents. The specification of MK-ROV is listed in Appendix C.

●Dive information

KM-ROV Dive #92

Date: February 6, 2019

Location: Higashi-Ensei Hydrothermal Field

Area: 28°26.30'-26.43'N, 128°10.32 – 10.42'E, 1243 – 1192 m WD

Payloads: WHATS-3 (for hydrothermal fluid sampling) w/ thermometer, H-type push corer (2 sets), sample box, SAHF, Around View Camera (AVC), ROV marker.

Description:

This dive is performed to observe the drilled site as BMS#9 finished on February 5, at the northern flank of a large hydrothermal mound having tall and big chimney complex with numbers of large flange structure. Two ROV event markers were deployed for future convenience; one is at the rim of the drilled hole (92-1), the other is on a shallow point a few meters away from the hole (92-2).

After the investigation of the vicinity of the drilled hole with reference seawater sampling, the vehicle moved to the active vents. Two localities were set to fluid sampling; one on a foot of large and tall dead chimney where simmering of 70°C in temperature was recorded, but not found in a few tens of minutes search. Contrasting to that, the sampling at the other point, set the tall and big chimney complex with numbers of large flange structure, was successful. The recorded maximum fluid temperature was 308.5°C and a piece of flange as well as two rocks were sampled.

KM-ROV Dive #93

Date: February 7, 2019

Location: Higashi-Ensei Field

Area: 28°26.38'-26.63'N, 128°10.35' – 10.50'E, 1238 – 1129 m WD

Payloads: WHATS-3 (for hydrothermal fluid sampling) w/ thermometer, H-type push corer (2 sets), sample box, scoop (kumade in Japanese), AVC, ROV marker

Description:

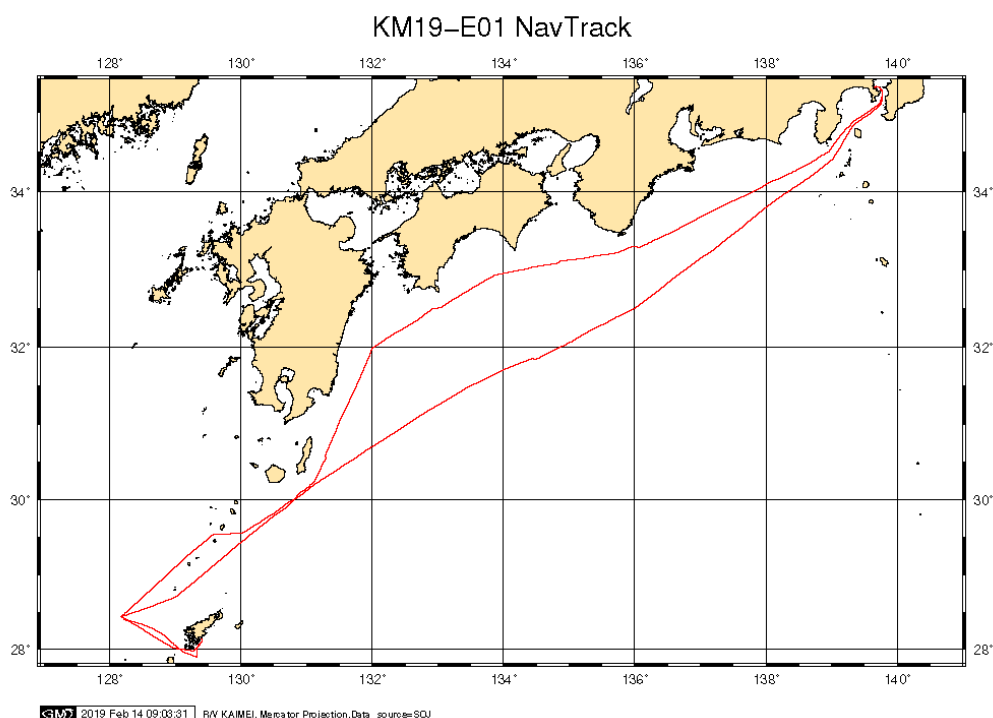
The vehicle touched down again in the vicinity of the BMS#9 drilled hole. Firstly, the exotic sediment covering around the hole was sampled by a scoop (KM-ROV#93 KD). Then, the vehicle directed to the planned next drill hole via cone-shaped local topographic high at the mid-point of traverse. It was actually active hydrothermal mound of which fluid and rock fragment were sampled. The highest temperature recorded was 309°C. Another hydrothermal simmering area was also found associating with a local ridge 100m away from the mounds, then marker #93-1 was deployed for future convenience. Commencing the box survey from the southwestern apex of the area, an ROV marker (#93-2) was deployed to bound the area surveyed. Similarly, markers #93-3 and #93-5 were also deployed at southeastern and northeastern apexes, respectively. At the northwestern edge of the grid survey area, an active hydrothermal mound found previously (w/ marker: 79-3) was observed and sampled its chimney fluid (max T = 299°C). The hydrothermal area seems to extend much upper part of the slope, indicated by a color-changed seabed and a colony of *S. crosnieri*. A few trends of the vent or simmering area

3.4. Surface geophysical survey: magnetic and gravity field

Hidenori Kumagai

We conducted a suite of a standard magnetic and gravity surveys aboard the R/V Kaimei. Magnetic field data were collected by a shipboard three-component magnetometer (STCM, Tierra Tecnica SFG-2015). The STCM data contain the effects of ship's magnetic field, which is required to be corrected in order to derive the real geomagnetic field. In this cruise, no 360° rotation maneuver was carried out. Gravity field data were obtained from a shipboard gravimeter (MGS-6, Micro-g LaCoste). The gravity field data measured by the portable gravimeter (CG-5 AUTOGRAV gravity meter, Scintrex) at the pier of the JAMSTEC Yokosuka HQ were used to correct the data drift.

4. Cruise Log



Date	Local Time	Description	Position / Weather / Wind, Sea condition (Noon)
Fri. 01.Feb	08:00	Scientists party onboard R/V KAIMEI	Northward of IZU-OSHIMA
	09:00	Let go all shore line & left JAMSTEC	34-56.7N, 139-26.6E
	10:00	Onboard lecture for evacuation and onboard life	Cloudy
			NNE-4 (Moderate breeze)
			3 (Sea Slight)
			2 (Low Swell Long)
			Visibly: 8'
Sat. 02.Feb	11:00	Meeting for BMS drilling plan and operation	South-Eastward of MUROTO-MISAKI
	13:00	Briefing about BMS from chief of operation team	33-04.3N, 134-47.0E
	18:30	Scientists meeting	Fine but Cloudy
			NE-3 (Gentle breeze)
			2 (Sea Smooth)
			1 (Low Swell Short or Average)
			Visibly: 8'
Sun. 03.Feb	18:30	Scientists meeting	Southward of TANEGA-SHIMA
			30-03.8N, 130-51.3E
			Fine but Cloudy
			South-6 (Strong breeze)
			4 (Sea Moderate)
			2 (Low Swell Long)
			Visibly: 8'
Mon. 04.Feb	07:08	XBT observation	Westward of AMAMI-OSHIMA
	12:28	BMS launched and started Dive#9	28-26.2N, 128-11.7E
	17:29	BMS landed on the bottom (D=1,230m)	Overcast
	17:46	BMS started drilling	North-5 (Fresh breeze)
			4 (Sea Moderate)
			3 (Moderate Short)
			Visibly: 6'
Tue. 05.Feb	16:38	BMS finished drilling	Westward of AMAMI-OSHIMA
	17:38	BMS started recovering drill rod	28-26.4N, 128-10.4E
	20:59	BMS left the bottom (D=1,230m)	Rain
	21:50	Recovered BMS	East-3 (Gentle breeze)
			3 (Sea Slight)
			2 (Low Swell Long)
			Visibly: 8'

Wed. 06.Feb	10:18	KM-ROV launched and started Dive#92	Westward of AMAMI-OSHIMA
	11:04	KM-ROV landed on the bottom (D=1,237m)	28-26.4N, 128-11.9E
	16:09	KM-ROV left the bottom (D=1,210m)	Fine but Cloudy
	17:03	Recovered KM-ROV	NNE-4 (Moderate breeze)
	18:30	Scientists meeting	4 (Sea Moderate)
			3 (Moderate Short)
			Visibly: 8'
Thu. 07.Feb	08:14	KM-ROV launched and started Dive#93	Westward of AMAMI-OSHIMA
	08:56	KM-ROV landed on the bottom (D=1,232m)	28-26.6N, 128-10.5E
	14:07	KM-ROV left the bottom (D=1,129m)	Fine but Cloudy
	14:54	Recovered KM-ROV	SSE-5 (Fresh breeze)
	17:54	Carried out MBES & SBP observation	3 (Sea Slight)
	19:24	Finished MBES & SBP observation	1 (Low Swell Short or Average)
	19:25	Proceeded to Amami-Oshima because rough sea condition	Visibly: 8'
	22:00	Arrived at South ward of Amami-Oshima and started waiting recovery sea condition	
Fri. 08.Feb	18:30	Scientists meeting	Southward of AMAMI-OSHIMA
			28-08.4N, 129-24.6E
			Overcast
			NNW-3 (Gentle breeze)
			2 (Sea Smooth)
			1 (Low Swell Short or Average)
			Visibly: 8'
Sat. 09.Feb	18:00	Scientists meeting	Southward of AMAMI-OSHIMA
			28-08.4N, 129-24.6E
			Overcast
			NNW-3 (Gentle breeze)
			2 (Sea Smooth)
			1 (Low Swell Short or Average)
			Visibly: 8'
Sun. 10.Feb	10:00	Proceeded to research area	Southward of AMAMI-OSHIMA
	18:16	BMS launched and started Dive#10	28-00.9N, 129-00.2E
	19:28	BMS landed on the bottom (D=1,213m)	Overcast
	19:39	BMS started drilling	NNW-4 (Moderate breeze)
			3 (Sea Slight)
			3 (Moderate Short)
			Visibly: 8'

Mon. 11.Feb	06:51	BMS finished drilling	Off North west of AMAMI-OSHIMA
	06:54	BMS started recovering drill rod	28-30.2N, 128-15.2E
	07:31	BMS left the bottom (D=1,230m)	Overcast
	08:15	Recovered BMS	NNW-6 (Strong breeze)
	11:30	Finished KM19-E01 cruise, proceeded to Yokosuka-port	5 (Sea Rough)
	18:30	Scientists meeting	3 (Moderate Short)
			Visibly: 6'
Tue. 12.Feb		Proceeded to Yokosuka-port	Southward of ASHIZURI-MISAKI
	18:30	Scientists meeting	31-22.0N, 133-14.4E
			Fine but Cloudy
			NNW-4 (Moderate breeze)
			3 (Sea Slight)
			2 (Low Swell Long)
			Visibly: 8'
Wed. 13.Feb		Proceeded to Yokosuka-port	Southward of OMAWE-ZAKI
			34-02.4N, 138-24.6E
			Cloudy
			NW-6 (Strong breeze)
			4 (Sea Moderate)
			3 (Moderate Short)
			Visibly: 7'
Thu. 14.Feb	09:00	Arrived at YOKOSUKA-port	

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.

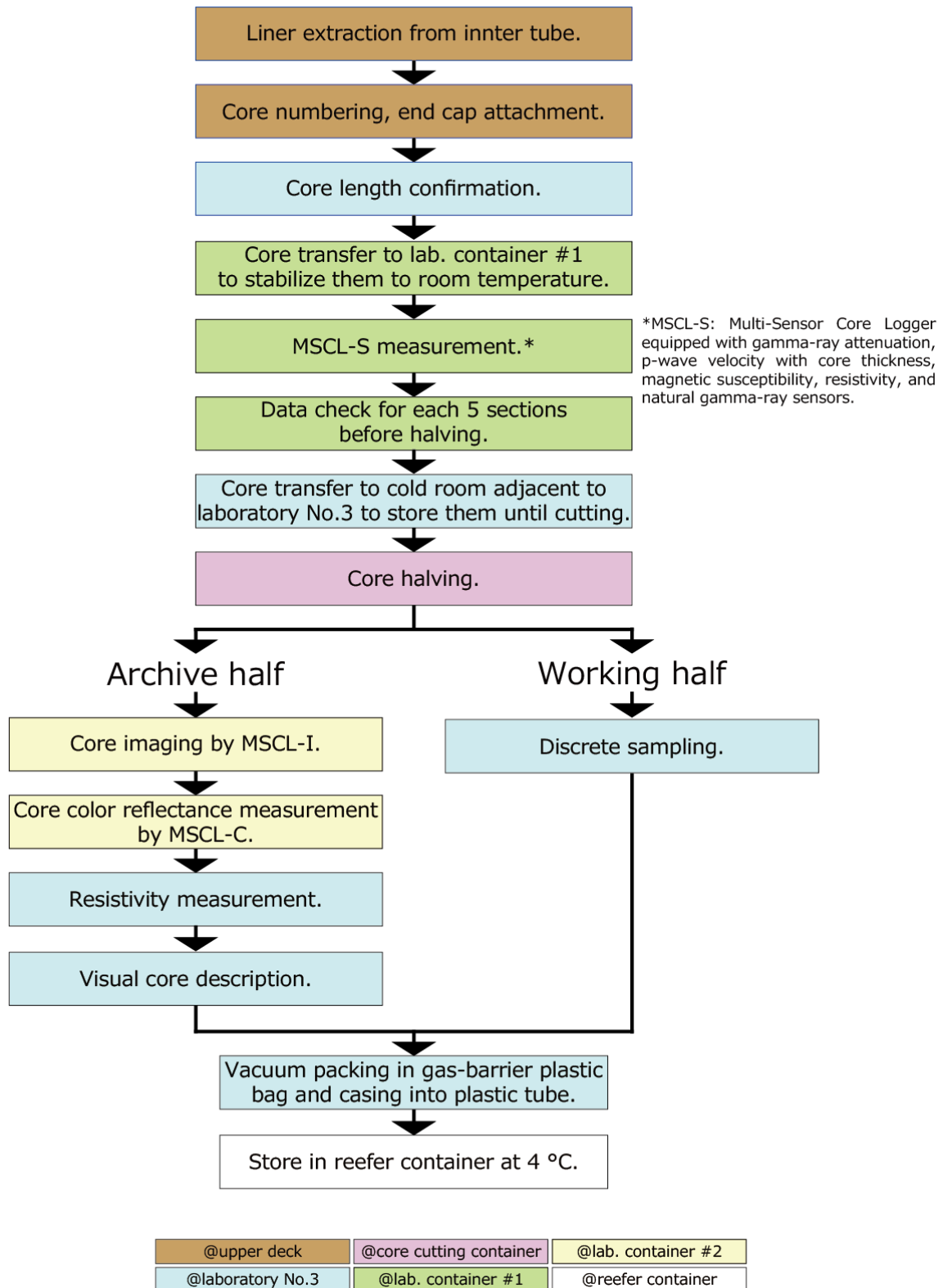
Users of information on this report are requested to submit Publication Report to JAMSTEC.

<http://www.godac.jamstec.go.jp/darwin/explain/1/e#report>

E-mail: submit-rv-cruise@jamstec.go.jp

Appendix A: core processing scheme for BMS sample
KM19-E01 BMS core-flow

2019. 2. 3 r1



Appendix B: specification and description of JAMSTEC BMS



General Description of BMS

Length : 3.1m
Width : 3.1m
Height : 5.7m
Weight : 7.0t (including drilling tool)
Weight : 12.0t (including drilling tool & MUD)
Maximum operation depth :3000m

Drilling tool

H-size(ϕ :60mm) : maximum penetration : 66m
※core length :1.5m /1core
T146(ϕ :146mm) : maximum penetration : 7.5m
※core length :1.5m /1core
 ϕ 450mm Drilling tool(ϕ :450mm):
maximum penetration : 0.4m
※ core sample is unavailable

Manufactured by CELLULA ROBOTICS Ltd.

Appendix C: specification and description of KM-ROV



General Description about KM-ROV

UBC

- cable length : 3500m(Φ 28.5mm)
- cable weight : 8855kg (in air, 2530kg/km)
6580kg (in water, 1880kg/km)

TMS

- length : 2.2m
- width : 1.9m
- weight : 2600kg (in air)
1580kg (in water)
- cable : 425m(Φ 28mm)
- cable weight : 675kg (in air)
45kg (in water)

ROV

- length : 2.6m
- width : 1.7m
- height : 2.0m + 0.5m (height of skid)
- weight : 3900kg(air),
- No. of thruster : 4(horizontal), 3(vertical)
- Manipulator :
ORION (7P Dual Manipulator System)
- No. of camera : NTSC:3 , HDTV:1
- No. of Light : 10(LED)