MAREANO LEG 3 2023

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TOKTRAPPORT
Nr.9 2024

Tittel (norsk og engelsk):

Mareano leg 3 2023

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Rapportserie:	**År - Nr.:**	**Dato:**
Toktrapport	2024-9	25.04.2024
ISSN:1503-6294		

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Godkjent av: Forskningsdirektør(er): Geir Lasse Taranger
Programleder(e): Frode Vikebø

Toktleder(e):

Distribusjon:

Åpen

Prosjektnr:

15312-03

Antall sider:

25

Samarbeid med

Kartverket

NORGES GEOLOGISKE UNDERSØKELSE

· NGU ·

Sammendrag (norsk):

Cruise Report from Mareano Leg 3, 2023. The objective of the cruise was MAREANO mapping of areas in the outer Oslofjord adn Skagerrak, but also to recover lost equipment owned by the Institute of Marine Research (video rig) and the Norwegian Defence Research Establishment (shellframe). The cruise was greatly affected by bad weather, necessitating alternative mapping areas outside the pre-planned areas of interest on several occasions due to this. Another aim of the cruise was to collect data with an Autonomous Underwater Vehicle (AUV) while conventional cruise activities were ongoing.

Sammendrag (engelsk):

Toktrapport fra Mareano leg 3 2023. Målet for toktet var MAREANO-kartlegging av områder i ytre Oslofjord, men også å redde mistet utstyr eid av HI (videorigg) og FFI (skjellramme). Toktet var meget påvirket av dårlig vær, og måtte ved flere anledninger utføre alternativ kartlegging utenfor de opprinnelige interesseområdene grunnet dette. Et annet mål for toktet var å samle inn data med AUV samtidig som konvensjonell toktvirksomhet pågikk.

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1 - Abbreviations

The following Abbreviations are use throughout this report:

AUV : Autonomous Underwater Vehicle – here it is the Kongsberg Munin +.

CT : Conductivity and Temperature (but not Depth as is normal) – the AUV CT sensor does not collect pressure information that is converted into depth as standard, but it does have an altimeter/depth sensor as part of that navigation system so this data is also available.

CTD : Conductivity, Temperature and Depth sampling rosette

FFI: Forsvarets forskningsinstitutt (Norwegian Defence Research Establishment)

FOH: Forsvarets operative hovedkvarter (Norwegian Joint Headquarters)

HF: Hardanger fjord

HI : Havforskningsinstituttet or the Institute of Marine Research as it is called in English.

MBE : MultiBeam Echosounder

NGU : Norsk Geologiske Undersøkelse or the Norwegian Geological Survey as it is called in English.

SVO : Særlig Verdiful Område – translates to “Especially Valuable Area” and is a Norwegian management region that currently has no protection measures but indicates an area of particular ecological value.

2 - Aims

- Recover the Chimera video rig that was lost during Mareano leg 2 (approximately 7 nm east of TromÃ¸ya.
  - **Achieved**
- Assist FFI in recovering a shell frame from a dumping ground for munitions (post WWII) in the Norwegian Trench.
  - **Achieved**
- Sample (physically and using video) Isidella corals along the slope south of Egersund for studies and gene sequencing.
  - **Achieved**
- Perform full station physical sampling simultaneously with AUV dive.
  - **Achieved**
- Gain experience with the placement and use of different equipment for cruises equipped with AUV, ROV and physical sampling gear.
  - **Achieved**
- Perform various tests related to improving data quality with the AUV Munin+ and evaluate the position accuracy and navigational skills.
  - **Partly achieved**
- Video sample areas in Skagerrak that cannot be mapped with conventional Mareano sampling due to challenging terrains and current conditions (which requires ROV).
  - **Partly achieved**
- Obtain shallow core samples of bottom sedients both inside and outside of intensively trawled areas for studies of carbon storage in sediments.
  - **Partly achieved**
- Complete three previously planned video stations that have not been sufficiently surveyed.
  - **Deferred due to weather**
- Map trawl tracks and investigate the consequences of intensive trawling for seabed conditions, including carbon storage capacity in sediments.
  - **Deferred due to weather**

3 - Areas

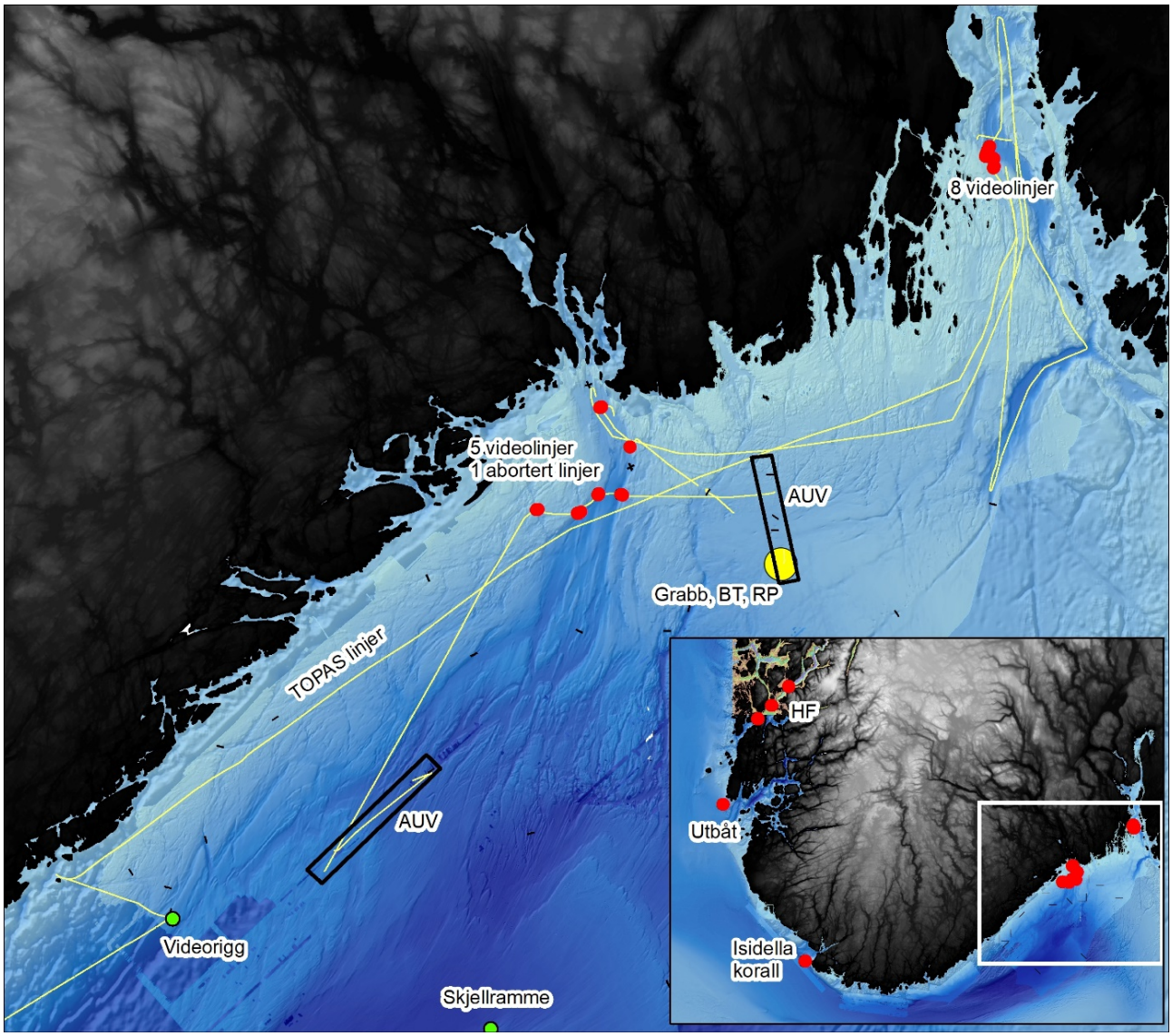


Figure 1: Cruise map. Focus area, Skagerrak, can be seen in the large picture, while other activities are marked on the smaller overview map. (Image: Valérie Bellec)

The cruise was focused on areas with steep or challenging terrain in Skagerrak, where video sampling using a camera rig is not possible. A planning meeting at NGUs offices in Trondheim where we had access to restricted high-resolution bathymetry was carried out before the cruise in order to plan all targeted stations based on 1) terrain and 2) seabed substrate. This resulted in a total of 31 planned stations of priority as well as 18 backup stations of lower priority. We also planned four areas for AUV mapping, and two back-up areas in secluded areas close to land in case of challenging weather conditions. We had applied (and received permission) from FOH for declassification of seabed data in these areas before the cruise. In addition to the main interest area in Skagerrak, we had planned ROV dives south-west of Karmøy on the recently discovered wreck of a WWII U-boat and in the Isidella hot-spot outside Lindesnes. Due to extreme weather conditions we had to plan a new

set of video lines inside the Hardanger fjord. We did not have a suitable declassified area inside the fjord, so AUV missions were not possible to conduct and were therefore not planned. The video stations in the fjord are marked on the inset map (HF).

4 - People

Table 1 : Cruise participants

Name	Surname	Organisation	Role
Valerie	Bellec	NGU	Geologist (video, sampling)
Pål	Buhl-Mortensen	HI	Biologist (video, sampling)
Reidulv	Bøe	NGU	Geologist (video, sampling)
Lene	Christensen	HI	Biologist (video, sampling) + AUV
Martin	Dahl	HI	Instrument technician
Eyvind	Ernstsen	HI	ROV pilot
Barbro Taraldset	Haugland	HI	Biologist (video, sampling)
Kyrre	Heldal Kartveit	HI	Cruise leader
Josefina	Johansson	HI	Biologist (video, sampling)
Yngve	Klungseth Johansen	HI	Biologist (video, sampling)
Aivo	Lepland	NGU	Geologist (video, sampling)
Björn	Löfqvist	Ægir	ROV pilot
Jörn Patrick	Meyer	HI	AUV pilot
Leif Johan	Ohnstad	HI	AUV pilot
Nils	Piechaud	HI	Scientist - AUV
William	Skjold	HI	ROV pilot
Silje	Smith-Johnsen	HI	Data management
Terje	Thorsnes	NGU	Geologist (video, sampling) + AUV

5 - Activities

Priority

- Recover the video rig Chimera (1)
- Finish the two last (grts) video-stations in Skagerrak
- ROV video stations (and physical sampling) in Skagerrak
- Survey trawl marks (AUV + ROV-dives)
- Carbon storage sediment sampling
- Map modelled coral reef with AUV
- Sample Isidella south of Egersund
- Aid FFI in recovery of mussel rig
- Sample a full station simultaneously with AUV-dive

Lower Priority

- Video stations in the southern part of the Norwegian North Sea i SN
- Sample additional full stations in Skagerrak

6 - Collected Data

Information regarding the data collected is shown in the following figures, as well as the overview map (figure 1). More details for each station are available in the day by day overview appendix, on the mareano webpage, or can be given upon request.

Table 2: Station summary

#	Units	Gear	Short description
21	Stations	Ægir6000	ROV video lines for mapping biology and geology
3	Stations	CTD	CTD stations for sound profiles for utilizing AUV with sidescan sonar and multibeam
810	n.miles	Topas	Topas lines for geoogical and sediment mapping.
7	Stations	Small VV grab	7 grabs with small sediment grab for sampling and environmental analysis.
2	Haul	Beam trawl	Two beam trawl hauls at Mareano full-station for collecting benthic fauna. One successful, as the net was not sealed properly on the first try.
1	Haul	Epibenthic sled	One epibenthic sled haul for collecting benthic fauna.
20	Samples	Ægir 6000	20 push core samples for marine geology.
20	Samples	Ægir 6000	20 samples of benthic fauna with ROV manipulator.

Table 3: Complete station list

Equipment	Refstation No	Sample No	Station No	Latitude	Longitude	Bottom Depth	Datetime
CTD	0	472	1	5826.304	917.1973	428.88	09.10.2023 06:11
CTD	0	473	1	5852.423	1011.151	182.35	10.10.2023 06:01
CTD	0	474	1	5915.826	1033.589	192.47	11.10.2023 06:00
Video	3284	3446	1	5905.737	508.5402	169.25	08.10.2023 01:19
Small VV grab	3284	81	1	5905.762	508.5948	167.53	08.10.2023 02:43
Video	3366	3447	1	5850.101	941.5575	126.62	09.10.2023 19:38
Bioboks	3366	3447	1	5850.106	941.552	138.165	09.10.2023 20:01
Bioboks	3366	3447	2	5850.106	941.552	138.165	09.10.2023 20:01
Video	3367	3448	1	5850.111	946.8958	305.13	09.10.2023 22:43
Pushcorer	3367	3448	1	5850.116	946.888	304.996	09.10.2023 23:04
Pushcorer	3367	3448	2	5850.116	946.888	304.996	09.10.2023 23:04
Bioboks	3367	3448	1	5850.09	946.6935	211.105	09.10.2023 23:44
Bioboks	3367	3448	3	5850.09	946.6935	211.105	09.10.2023 23:44
Bioboks	3367	3448	2	5850.09	946.6935	211.105	09.10.2023 23:44
Video	3368	3449	1	5851.346	949.0112	257.16	10.10.2023 01:09
Pushcorer	3368	3449	1	5851.349	948.9837	255.673	10.10.2023 01:24
Video	3369	3450	1	5851.514	951.7833	372.03	10.10.2023 03:02
Pushcorer	3369	3450	1	5851.51	951.7725	405.553	10.10.2023 03:13

Video	3370	3453	1	5915.308	1034.265	318.92	11.10.2023 16:34
Pushcorer	3370	3453	1	5915.313	1034.253	325.715	11.10.2023 16:52
Video	3370	3454	1	5915.207	1034.173	226.09	11.10.2023 17:24
Video	3370	3455	1	5915.113	1034.098	166.77	11.10.2023 17:53
Pushcorer	3370	3455	1	5915.131	1034.115	175.676	11.10.2023 18:08
Video	3370	3456	1	5915.029	1034.044	124.94	11.10.2023 18:31
Pushcorer	3370	3456	1	5915.045	1034.049	137.66	11.10.2023 18:44
Bioboks	3370	3456	6	5914.996	1034.019	105.306	11.10.2023 19:02
Bioboks	3370	3456	2	5914.954	1033.995	88.22	11.10.2023 19:28
Bioboks	3370	3456	5	5914.954	1033.995	88.22	11.10.2023 19:28
Bioboks	3370	3456	1	5914.954	1033.995	88.22	11.10.2023 19:28
Bioboks	3370	3456	7	5914.954	1033.995	88.273	11.10.2023 19:32
Bioboks	3370	3456	4	5914.954	1033.996	87.96	11.10.2023 19:34
Bioboks	3370	3456	3	5914.954	1033.996	87.96	11.10.2023 19:34
Beamtrawl	3371	14	1	5847.769	1011.206	207.49	10.10.2023 08:59
Beamtrawl	3371	15	1	5847.833	1011.563	201.69	10.10.2023 10:03
RP-sledge	3371	28	1	5847.961	1012.783	192.76	10.10.2023 10:48
Small VV grab	3371	82	1	5847.894	1012.308	192.09	10.10.2023 12:51
Small VV grab	3371	83	1	5847.893	1012.309	192.01	10.10.2023 13:20
Small VV grab	3371	84	1	5847.893	1012.309	191.89	10.10.2023 13:48
Small VV grab	3371	85	1	5847.893	1012.309	192.04	10.10.2023 14:14
Boxcorer	3371	86	1	5847.894	1012.308	191.79	10.10.2023 14:49
Small VV grab	3371	86	1	5847.894	1012.308	191.79	10.10.2023 14:49
Small VV grab	3371	87	1	5847.894	1012.308	191.87	10.10.2023 15:18
Video	3372	3451	1	5854.571	952.4534	254.67	10.10.2023 18:58
Bioboks	3372	3451	1	5854.567	952.4639	247.999	10.10.2023 19:10
Pushcorer	3372	3451	1	5854.566	952.4579	247.785	10.10.2023 19:14
Video	3373	3452	1	5856.898	948.394	248.07	10.10.2023 21:46
Pushcorer	3373	3452	1	5856.917	948.3619	239.467	10.10.2023 22:07
Pushcorer	3373	3452	2	5856.92	948.405	239.938	10.10.2023 22:16
Pushcorer	3373	3452	3	5856.936	948.4551	240.063	10.10.2023 22:41
Pushcorer	3373	3452	4	5856.936	948.4551	240.063	10.10.2023 22:41
Pushcorer	3373	3452	5	5856.951	948.5154	240.028	10.10.2023 22:54
Video	3374	3457	1	5914.852	1033.959	161.02	11.10.2023 21:03
Pushcorer	3374	3457	1	5914.858	1033.948	152.671	11.10.2023 21:22
Video	3374	3458	1	5914.75	1033.894	132.65	11.10.2023 21:52
Bioboks	3374	3458	1	5914.723	1033.857	115.409	11.10.2023 22:06

Video	3375	3459	1	5914.577	1034.655	139.21	11.10.2023 23:02
Pushcorer	3375	3459	1	5914.592	1034.651	140.463	11.10.2023 23:10
Bioboks	3375	3459	1	5914.546	1034.868	156.839	11.10.2023 23:42
Video	3376	3460	1	5914.058	1034.996	145.07	12.10.2023 00:22
Pushcorer	3376	3460	1	5914.059	1034.974	137.73	12.10.2023 00:32
Video	3377	3461	1	5807.045	628.5348	344.71	13.10.2023 12:26
Bioboks	3377	3461	1	5807.054	628.5278	338.003	13.10.2023 12:38
Bioboks	3377	3461	2	5807.055	628.5266	337.954	13.10.2023 12:45
Pushcorer	3377	3461	1	5807.055	628.5261	337.963	13.10.2023 12:47
Bioboks	3377	3461	3	5807.13	628.6779	319.125	13.10.2023 13:19
Video	3377	3462	1	5807.124	628.6871	326.96	13.10.2023 13:22
Bioboks	3377	3462	1	5807.238	628.8977	298.098	13.10.2023 13:58
Video	3378	3463	1	5942.077	525.6296	172.31	14.10.2023 06:42
Video	3379	3464	1	5948.478	535.7652	178.56	14.10.2023 10:12
Pushcorer	3379	3464	1	5948.478	535.5481	164.649	14.10.2023 11:08
Bioboks	3379	3464	1	5948.478	535.5482	164.747	14.10.2023 11:10
Video	3380	3465	1	5956.957	547.1453	414.39	14.10.2023 13:47
Pushcorer	3380	3465	1	5956.966	547.1535	414.409	14.10.2023 13:54
Video	3381	3466	1	6020.063	615.7488	857.68	14.10.2023 18:19
Pushcorer	3381	3466	1	6020.06	615.7546	846.454	14.10.2023 18:47

7 - Challenges

We had some major difficulties with weather conditions on the cruise. Waves of op to 12 meters in the North Sea made us withdraw into the fjords for the better part of the cruise. As we had some prioritized operations that demanded fair weather conditions we had to use the small weather windows to complete these at the expense of other activities. We sent an inquiry to end the cruise early due to the demanding conditions, but due to a major surge if ships going in to Bergen Havn and weekend approaching it was not possible to de-mobilise until the pre-planned date we decided to make the best of it and spent the last days surveying the Hardanger fjord.

7.1 - ROV

The Ægir6000 was surprisingly susceptible to wave action and, not least, current conditions. We experienced that a current strength of as little as 2 knots made diving with the ROV challenging. Based on this, we would recommend bringing the TMS if Ægir is to be used on expeditions during the winter season

7.2 - AUV

As somewhat feared in advance, the weather windows for AUV collection were few and short, and as a result, we were not able to use the vessel nearly as much as we wanted. This resulted in two successful dives in the Skagerrak that collected data of apparently good quality. Launch and recovery went well despite challenging weather conditions, which we view as positive.

7.3 - Deck space during the cruise

In one of the Skagerrak's AUV areas, a full station was conducted in parallel with the AUV dive. The deck space for processing samples was effectively resolved in consultation with the trawl boss and bridge. Cleaning and sorting stations on the port side of the trawl deck were well suited for MAREANO's samples. A small “breakwater” (molo) was placed in front of the grate on the stern of the vessel, which worked OK under the prevailing weather conditions, but in rougher seas, the grate should be able to be closed off with a solid plate or the breakwater significantly heightened to secure valuable samples during processing. We envision conducting physical sampling in AUV areas simultaneously where the AUV is operational on upcoming voyages.

8 - Appendix 1 – AUV dive plans

This cruise aimed at carrying out tests on the AUV function and particularly how the different acoustic instruments potentially interfered with each other and how much the AUV drifted throughout the dive by covering the same points at the beginning and end of the dive and with different instrument switched on.

Two divers were carried out and went relatively well and collected good data that will enable the intended tests. However, the weather did not allow further dives after the day 2 of the cruise so only 2 dives took place instead of the 6 intended.

8.1 - Dive 1:

This first dive took place at the a relatively flat 400m deep area in the southwesternmost declassified zone. It aimed at collecting acoustic data over an area where the presence of pockmarks and the general topographic setting led to the suspicion that it contained a lot of mud which could store vast amount of carbon.

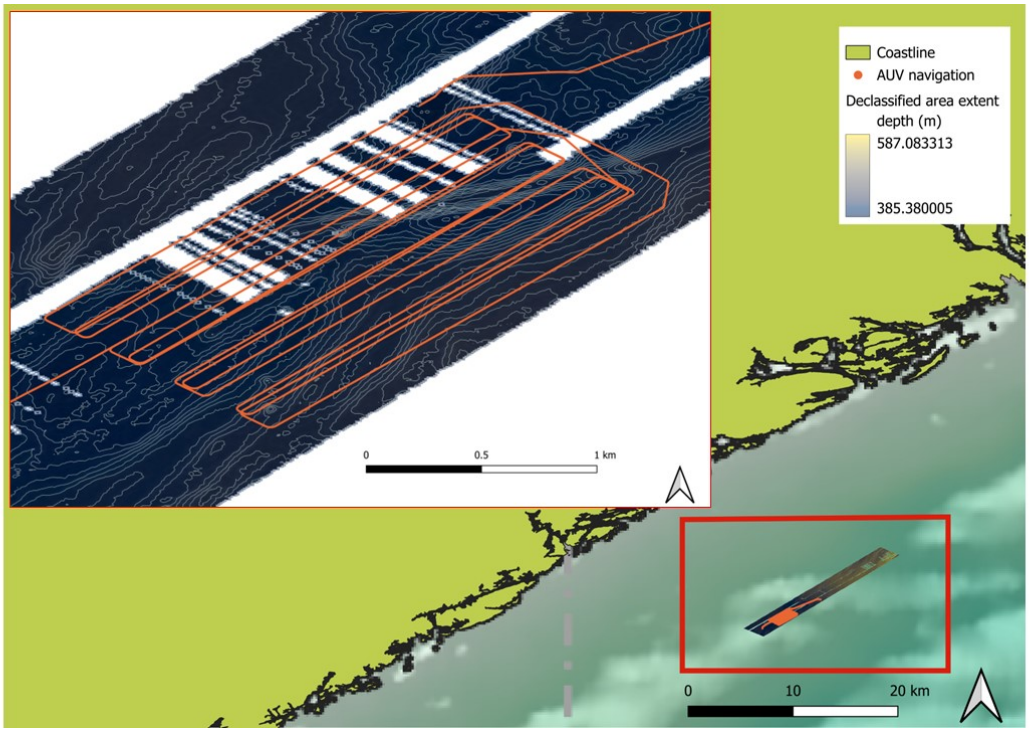


Figure 2: Map showing location of dive 1 and the Path of the AUV over the seabed. The background in the close-up shows the local bathymetric 2m contours.

The AUV used the EM2040 Multibeam while flying at 70m in a grid pattern to provide full bathymetric coverage of the area at <1m resolution.

The Hisas sounder was also used in a grid pattern flying at 20m from the seabed to provide full coverage of the same area at high resolution

Finally a last line was carried out where the vehicle went back over the terrain it had previously surveyed and, particularly, at a noticeable feature that stood out and would be easily identifiable in the resulting surface thus

acting as an ‘anchor’. This repetition will enable a precise measurement of the drift in AUV positioning throughout the mission by calculating the distance between the locations of the anchor feature in both MB lines that went over it. At the last point before the AUV started its ascend, the distance between the internal navigation and the navlab processed navigation was 4.85m. This less than 5m drift over 6 hours is considered low.

8.1.1 - Dive Plan 1

Kongsberg Maritime AUV Mission Plan

Saved 2023-10-09 14:01:19 by hugin

#:Tag Depth Alt DMo Latitude Longitude Course GMo Speed SMo Dur Dist Flags

Speed up

:speed 0.0 30.0 D - - 234.0 H 2.30 S 30 - EMPowerOn

: = = = - - = = = = 30 -

NB: Remember to set Safe 20m and Crit 10m distance in Startup parameters!

: = = = - - = = = = 30 -

Are we waiting enough for payload to boot?

: = = = - - = = = = 1 - EMPowerOn

: = = = - - = = = = 1 - SASPowerOn

: = = = - - = = = = 1 - ETPowerOn

: = = = - - = = = = 1 -

: = = = - - = = = = 1 -

: = = = - - = = = = 1 -

: = = = - - = = = = 1 -

: = = = - - = = = = 1 -

: = = = - - = = = = 10 -

: 0.0 = = - - = = = = 1 -

Start dykk til 50m for aa sjekke at alt er ok, Jump here to repeat dive

:dive 50.0 = = - - = = = = 180 -

: = = = - - = = = = 1 -

: 50.0 = = - - = = = = 180 -

Jump from here to repeat dive, health check here

:health = = = - - = = 2.00 S 20 -

: = = = - - = = = = 1 -

Submerged, vehicle configuration

:config = = = - - = = = = 1 - RollCtrlOn

: = = = - - = = = = 1 - EM400Int

: = = = - - = = = = 1 - Auto

: = = = - - = = = = 1 -

: = = = - - = = = = 1 -

: = = = - - = = = = 1 -

Descent to working depth (100 m / 3 min), Activate HiSAS

:descent 300.0 70.0 D - - = = = = 720 - EMOn

: 400.0 70.0 T - - = = = = 180 -

Lead-in to Survey Pattern

:leadin = = = 58:27.9368N 009:21.4817E (234) = = = - - Auto

:leadin = = = 58:27.8909N 009:21.4018E (222) = = = (57) (115)

: = = = 58:27.8475N 009:21.3591E (207) = = = (45) (91)

:mbline01 = = = 58:26.8607N 009:19.6104E (223) = = = (1250) (2500)

:mbturn = = = 58:26.7903N 009:19.7559E (133) = = = (96) (193)

:mbline02 = = = 58:27.7771N 009:21.5047E (043) = = = (1250) (2500)

:mbturn = = = 58:27.7067N 009:21.6505E (133) = = = (96) (193)

:mbline03 = = = 58:26.7199N 009:19.9013E (223) = = = (1250) (2501)

:mbturn = = = 58:26.6494N 009:20.0468E (133) = = = (96) (193)

:mbline04 = = = 58:27.6362N 009:21.7961E (043) = = = (1250) (2501)

:mbturn = = = 58:27.5658N 009:21.9418E (133) = = = (96) (193)

:mbline05 = = = 58:26.5790N 009:20.1922E (223) = = = (1250) (2501)

:mbturn = = = 58:26.5085N 009:20.3377E (133) = = = (96) (193)

:mbline06 = = = 58:27.4954N 009:22.0874E (043) = = = (1250) (2501)

:mbturn = = = 58:27.4249N 009:22.2331E (133) = = = (96) (193)

:mbline07 = = = 58:26.4381N 009:20.4831E (223) = = = (1250) (2501)

:mbturn = = = 58:26.3677N 009:20.6285E (133) = = = (96) (193) SASMode1

:mbline08 = = = 58:27.3545N 009:22.3787E (043) = = = (1250) (2501) SASHighPower

:em_stop = = = 58:27.4676N 009:22.4003E (006) = = = (105) (211) EMOff

HISAS - set depth and altitude

:hisas_st 400.0 = = 58:27.5095N 009:22.3245E (317) = = = (53) (107) SASOn

: = = = 58:27.5476N 009:22.2459E (313) = = = (52) (104) CritHeight6

: = = = 58:27.5817N 009:22.1826E (316) = = = (44) (88) SafeDist10

: = 20.0 = 58:27.8194N 009:21.6825E (312) = = = (328) (657)

Lead-in to Survey Pattern

:leadin = = = 58:27.7928N 009:21.4667E (257) = = = (107) (216) ETOn

:l01 = = = 58:26.8000N 009:19.7455E (222) = = = (1245) (2490)

: = = = 58:26.7692N 009:19.8103E (132) = = = (42) (85)

:l02 = = = 58:27.7620N 009:21.5316E (042) = = = (1245) (2490)

: = = = 58:27.6787N 009:21.7072E (132) = = = (115) (230)

:l03 = = = 58:26.6858N 009:19.9858E (222) = = = (1245) (2491)

: = = = 58:26.6551N 009:20.0506E (132) = = = (42) (85)

:l04 = = = 58:27.6479N 009:21.7721E (042) = = = (1245) (2491)

: = = = 58:27.5647N 009:21.9476E (132) = = = (115) (230)

:l05 = = = 58:26.5718N 009:20.2261E (222) = = = (1245) (2491)

: = = = 58:26.5410N 009:20.2909E (132) = = = (42) (85)

:l06 = = = 58:27.5339N 009:22.0125E (042) = = = (1245) (2491)

: = = = 58:27.4506N 009:22.1880E (132) = = = (115) (230)

:l07 = = = 58:26.4577N 009:20.4664E (222) = = = (1245) (2491)

: = = = 58:26.4269N 009:20.5312E (132) = = = (42) (85)

:l08 = = = 58:27.4198N 009:22.2529E (042) = = = (1245) (2491)

MB check

: = = = - - = = = = 1 - SASOff

: 400.0 70.0 = 58:27.6712N 009:21.9254E (042) = = = 1 - EMOn

:em_leadi 400.0 70.0 = 58:27.7069N 009:21.6522E (284) = = = (136) (274)

:mb_check = = = 58:26.6496N 009:19.7760E (223) = = = (1340) (2681)

: = = = 58:26.0763N 009:18.7772E (222) = = = (720) (1442) Ascent

8.2 - Dive 2

The second dive took place over a relatively flat 200m deep zone in the easternmost declassified area.

The aim wsa to cover as much surface as possible during a short window of weather suitable for recovery of the AUV. The whole dive could not be carried out and had to be aborted after 4h 50m to ensure safe recovery on board. Hisas data was collected in a grid pattern flying at 20m altitude to offer a high resolution view of the seabed so small objects could be visually detected Initial inspection of the hisas data also revealed large number of trawlmarks. Sub-bottom profiler was also switched on during the dive for an assessment of the sensor by geologists.

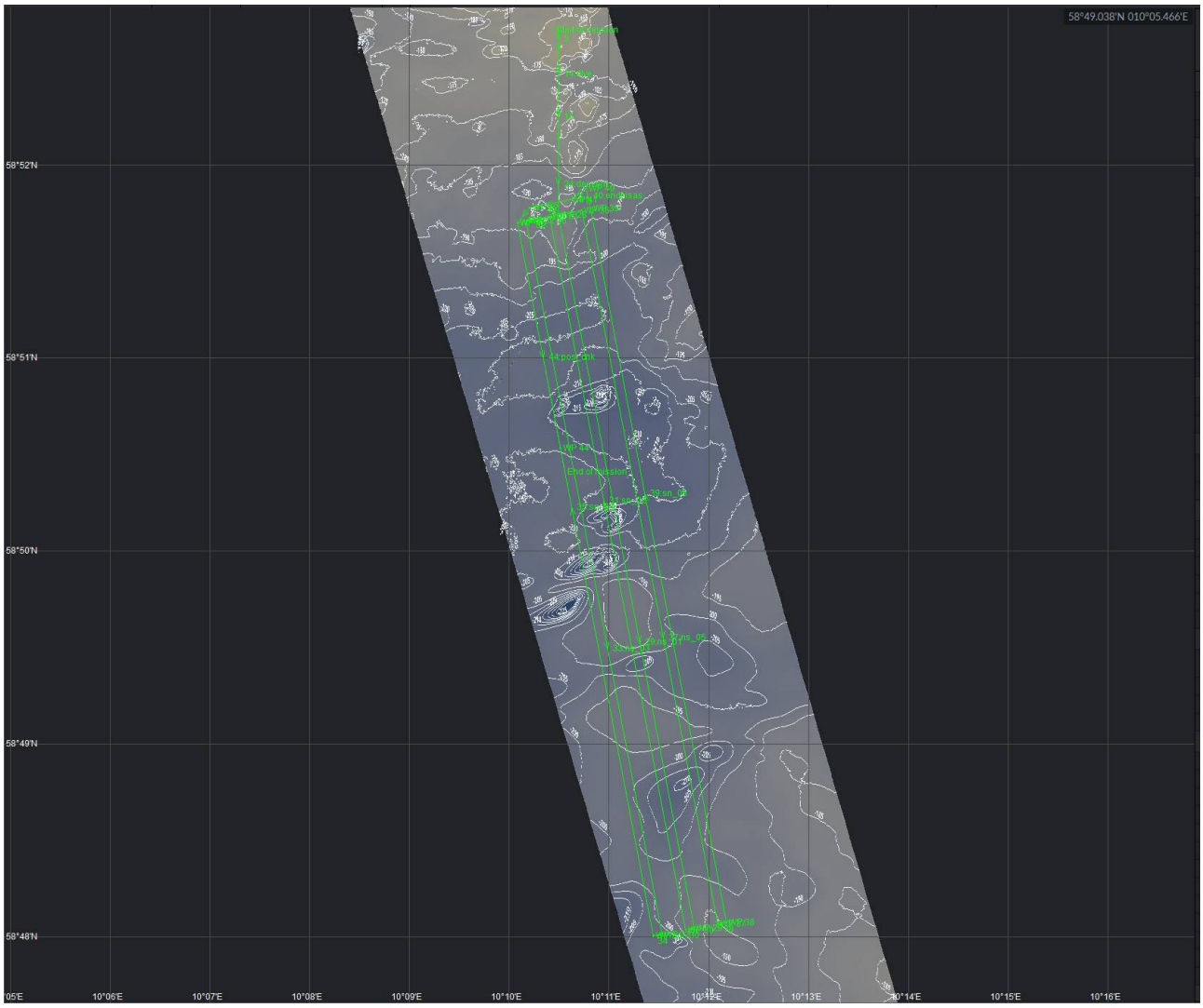


Figure 3: Dive plan of Dive 1 and the bathymetry in the eastern AUV area. The the local bathymetric contours are 5m.

8.2.1 - Mission plan Dive 2

Kongsberg Maritime AUV Mission Plan

Saved 2023-10-10 06:21:14 by hugin

#:Tag Depth Alt DMo Latitude Longitude Course GMo Speed SMo Dur Dist Flags

Speed up

:speed 0.0 20.0 D - - 180.0 H 2.30 S 30 - EMPowerOn

: = = = - - = = = = 60 - SASPowerOn

NB: Remember to set Safe 20m and Crit 10m distance in Startup parameters!

: = = = - - = = = = 1 - ETPowerOn

Are we waiting enough for payload to boot?

: = = = - - = = = = 1 - SafeDist10

: = = = - - = = = = 1 - CritHeight6

: = = = - - = = = = 1 -

: = = = - - = = = = 1 -

: = = = - - = = = = 1 -

: = = = - - = = = = 1 -

: = = = - - = = = = 1 -

: = = = - - = = = = 1 -

: = = = - - = = = = 1 -

: 0.0 = = - - = = = = 1 -

Start dykk til 30m for aa sjekke at alt er ok

:dive 100.0 = = - - = = = = 180 -

: 100.0 = = - - = = = = 180 -

Jump from here to repeat dive, health check here

:health = = = - - = = 2.00 S 20 -

: = = = - - = = = = 1 - Auto

Submerged, vehicle configuration

:config = = = - - = = = = 1 - RollCtrlOn

: = = = - - = = = = 1 -

: = = = - - = = = = 1 -

: = = = - - = = = = 1 - SASHighPower

: = = = - - = = = = 1 - SASMode1

: = = = - - = = = = 1 - ETOn

Descent to working depth (100 m / 3 min), Activate HiSAS

:descent 195.0 = T - - 180.0 = = = 360 - SASOn

: = = = - - = = = = 1 -

: = = = - - = = = = 1 -

:setalt = 20.0 = - - = = = = - -

Lead-in to Survey Pattern

:leadin = = = 58:51.7434N 010:10.4904E (180) = = = - -

:ns_01 = = = 58:48.0441N 010:11.8531E (169) = = = (3495) (6992)

: = = = 58:48.0356N 010:11.7662E (259) = = = (42) (85)

:sn_02 = = = 58:51.7344N 010:10.4041E (349) = = = (3495) (6991)

: = = = 58:51.7111N 010:10.1688E (259) = = = (115) (230)

:ns_03 = = = 58:48.0122N 010:11.5316E (169) = = = (3495) (6991)

: = = = 58:48.0039N 010:11.4437E (260) = = = (43) (86)

:sn_04 = = = 58:51.7012N 010:10.0822E (349) = = = (3494) (6988)

: = = = 58:51.7660N 010:10.7268E (079) = = = (315) (632)

:ns_05 = = = 58:48.0673N 010:12.0882E (169) = = = (3495) (6991)

: = = = 58:48.0758N 010:12.1750E (079) = = = (42) (85)

:sn_06 = = = 58:51.7747N 010:10.8139E (349) = = = (3495) (6991)

:endhisas = = = 58:51.8795N 010:10.7705E (348) = = = (99) (199)

position check

: = = = 58:51.8200N 010:10.6035E (235) = = = (97) (195)

: = = = 58:51.7808N 010:10.2052E (259) = = = (194) (390)

: = = = 58:51.7013N 010:10.0824E (219) = = = (94) (189)

position check?

:pos_chk = = = 58:50.5320N 010:10.5133E (169) = = = (1105) (2210)

: = = = - - = = = = - 50 Ascent

9 - Appendix 2 – Biology summary

Location	P No	R no	VL	Notes
KB-Utsira	P36	3284	3446	Ikke logging. test ROV ved ubåt HMS Thistle.
Skagerrak	P37	3366	3447	Biology: Plukket: porifera branched dense. Over en kløft. Fjellvegg ned og opp dekket i novocrania, viftesvamp(VME sponge garden), serpulidae. Mixed sediments på bunn av kløft, og siste del på toppen av vegg , munida, stichastrella,Bonellidae og noe viftesvamp.
Skagerrak	P38	3367	3448	Climbing up a steep wall. Rich fauna. Sponge garden all the way(Axinellidae). Dense population of basketstars in the beginning. Lots of lost fishing gear. Nephrops eating Myxine in the start. 2 cores in the start. Rock with porifera picked by ROV.
Skagerrak	P145	3368	3449	Seapen garden with funiculina and sponge garden with Porifera branched dense, Phakellia, Axinella, Axinellidae alternating VMEs
Skagerrak	P44	3369	3450	Svamphager (geodial, Porifera branched dense). Pandalider.
Skagerrak	P41	3372	3451	Virularidae red sampled at start. Station aborted 19:25 due to weather.
Skagerrak	P50	3373	3452	Pandalidae, Myxine, Trisopterus, Pollachius virens Lost 4k rec after 17min.
Skagerrak	P51	3370	3453	Cerianthidae bottom. Pandalidae. cerianthus lloydi. Biology:
Skagerrak	P52	3370	3454	Pandalidae. pseudamussium septemradiatum. (P-51)
Skagerrak	P53	3370	3455	Biology: Pandalidae. parastichopus. calocarides and possible juveniles swimming in hole.
Skagerrak	P54	3370	3456	Parastichopus, Trisopterus,virgularia, kophobelemnon, Seapen garden bedrock at the end. Rich fauna. Sampled two rock with rich fauna at the end
Skagerrak	P55	3374	3457	parastichopus,Pandalidae,cerianthus lloydii, Trisopterus, virgularidae red, Myxine.
Skagerrak	P56	3374	3458	Seapen garden. Sampling stylatula cf
Skagerrak	P57	3375	3459	cerianthidae bottom, burrows. sampling stylatula cf
Skagerrak	P15	3376	3460	opp to små vegger med acesta, svamp, og novocrania. VME sjøfjærbunn siste halvdel med kophobelemnon, funiculina og virgularia. også en del parastichopus, munida og pandalidae.
Utenfor Lista	P15	3377	3461	VME seapen garden hele veien, kophobelemnon, funiculina, og noe virgularia. VME koraallhage med isidella i flekker alle årsklasser. Flekker medgracilechinus og noe thenea. plukker 3 isidella. en god del knekt funiculina
Utenfor Lista	Extra	3377	3462	VME seapen garden hele veien. Noe VME korallhage med isidella, alle årsklasser, mye små individ mot slutten. Sjøfjær dominert av kophobelemnon og funiculina. flekker med mye garcilechinus. OBS transekt utvidet med 100m (300m totalt). plukket en liten isidella.
Hardanger	P53	3378	3463	Lophelia reef, madrepora. små paramuricea, noen paragorgia, clavularia borealis og anthothela grandiflora. Mye geodia, forskjellige arter og mycale. munida, asteroidea og cerianthidae i korallgrusen. Healthy reef.
Hardanger	P54	3379	3464	VME hydrocoral hard bottom, dominated by stylaster and paramuricea. seastar collected. Sponge garden VME dominatedby geodia species and mycale. Lots of murida and lithodes. Live Lophelia reef, clavelaria borealis. patches of madrepora before reef. Litter.
Hardanger	P55	3380	3465	parastichopus, Munida, pandalidae, Thenea. Some seapens, Funiculina, virgularia, spisskate (Dipturus oxyrinchus). eptmopterus spinax.
Hardanger	P56	3381	3466	Brisinga,anthomastus, asconema . sampled brisinga and asconema

10 - Appendix 3 – Geologic summary

P nb	R nb	Video	Back-scatter	Video	Grab/Push core	Quality	Notes
Utsira							
submarine dive + grab		VL3446			sandy mud, gravelly sandy mud, MSGC	good	Test dive at the submarine area, 2 surface samples taken from a grab, one for HI, one for NGU.
Skagerrak							
P36	R3366	VL3447	strong	BCB/SGCB, GSM, exp bedrock,	-	good	line through 50 m deep bedrock fracture, GCB/SGCB on both sides of fracture, exposed bedrock on slopes, gravelly sandy mud mainly at the bottom of fracture, no PC taken due to very coarse sediments
P37	R3367	VL3448	strong	sandy mud, exposed bedrock	sandy myd	good	Line starting arouund 309 m in sandy mud. Steep climb up bedrock slope towards the west to ca. 200 m depth. 2 push cores from sandy mud and 2 bedrock samples from cliff. Sandy mud in hand sample from push core. Crystalline bedrock (gneis/mica schist) in bedrock sample.
P38	R3368	VL3449	medium	sandy mud, bedrock, MSGCB	sandy mud/mud	good	Mud with very minor sand and gravel in beginning and end of line (in video described as sandy mud), short interval of bedrock and long interval of MSGCB in the middle of line, PC taken from beginning
P145	R3369	VL3450	strong	sandy mud, exposed bedrock	sandy mud	good	Sandy mud alternating with exposed bedrock I steep cliff. Bedrock partly layered, probably Cambrosilurian. Massive bedrock may be larvikite.
P44	R3372	VL3451	weak	mud		good	mud at landing site, line aborted shortly after lift off due to bad weather
P41	R3373	VL3452	weak	mud	mud	good	5 push cores for carbon analyses. 1: slighktly outside TM, 2: in old TM, 3: in fresh TM, 4: in very fresh TM, 5: outside TM, lost core 2 during retrieval
P50	R3370	VL3453	-	sandy mud	mud	good	sandy mud with burrows, push core for hand sample
P51	R3370	VL3454	-	sandy mud		good	sandy mud with burrows, a few TMs, a few cobbles
P52	R3370	VL3455	-	sandy mud	mud	good	push core for hand sample
P53	R3370	VL3456	-	sandy mud	mud	good	push core for hand sample
P54	R3374	VL3457	-	mud	mud	good	mud and burrows throughout, many TMs towards the end of line, push core for hand sample
P55	R3374	VL3458	-	mud, exposed bedrock		good	mud in the beginning of the line, intervals of bedrock in the middle and mud with scattered cobbles and boulders in the end, bedrock is often covered with thin layer of mud
P56	R3375	VL3459	-	mud	mud	good	mud with burrows, one push core

P57	R3376	VL3460	-	mud, exsposed bedrock	mud	good	Mud, but two intervals of exposed bedrock. Many TMs in the beginning. Push core in bottom of old TM at beginning of line.
P15	R3377	VL3461	-	mud	sandy mud	good	mud with burrows, a few gravelly areas, one push core. Change to sandy mud in the logger
P15	R3377	VL3462	-	mud	-	good	mud with burrows, a few MSGCB areas. Change to sandy mud in the logger
extra VL	R3378	VL3463	-	bioclastic sediments	-	good	Coral reef alternating live coral mounds, dead coral mounds, coral rubble dominated by sandy gravel. One little bedrock exposure. Fishing gears.
extra VL	R3379	VL3464	-	G/GCB/bioclastic sediments	sandy gravel	good	Mostly coarse sediments, with G(SG) and GCB(SGCB) for more than half of the line, some bioclastic sediments (shell and tube fragments) at the surface, comet marks. Bioclastic sediments (coral rubble, coral block and live lophelia) on the last third of the line. Sample taken with ROV spade.
extra VL	R3380	VL3465	-	mud	mud	good	mud and abundant burrows throughout,
extra VL	R3381	VL3466		mud/exposed bedrock	mud	good	wreck at the beginning of the line. Line started with mud with burrows, then long exposed bedrock cliff with here and there some mud cover and burrows. 1 pushcore. Long line (c. 3h record, splitted in 2)

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