DANMARKS OG GRØNLANDS GEOLOGISKE UNDERSØGELSE **RAPPORT 2023/53**

Survey report for marine raw material mapping for the Danish Environmental Protection Agency 2023

Vibrocoring in Danish waters

Thomas Vangkilde-Pedersen, Luna Holland Winther,
Henrik Jønsson Granat, Lisbeth Lyngkjær Pedersen & Lis Allaart

GEOLOGICAL SURVEY OF DENMARK AND GREENLAND
DANISH MINISTRY OF CLIMATE, ENERGY AND UTILITIES

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Content

1. Summary

GEUS has carried out fieldwork for the Danish Environmental Protection Agency (Miljøstyrelsen, MST) as part of their marine raw material mapping in 2023 in Danish waters.

The investigations started September 16 and was completed September 28. The survey will hereafter be referred to as the MST 2023 survey. The MST 2023 survey included 32 so-called 'Fællesområder' and 'Potentielle Fællesområder' as well as three raw material interest areas.

The survey activities were carried out using the survey vessel Fortuna Crane and included two legs of vibrocoring.

Mobilization of the vessel and equipment took place on August 14 in Esbjerg prior to another GEUS survey. In total 15 MST cores were taken during the other GEUS survey as this was logistically beneficial for both projects, and the specific MST-cores were collected on September 3, 5, 6, 14 and 15. Four of the cores were collected in inner Danish waters and 11 in the Baltic Sea around Bornholm. The dedicated MST 2023 survey started on September 16 at Bornholm. A crew change between Leg 1 and Leg 2 took place in Frederikshavn on September 21 and demobilization after the survey took place in Esbjerg on September 28.

Leg 1 started September 16 at Bornholm upon completion of the other GEUS project and was initiated with a transit to the Karrebæksminde area, as MST vibrocores around Bornholm were carried out a few days earlier during the other project for practical reasons. The leg included collection of 19 vibrocores in inner Danish waters and Kattegat before the crew change in Frederikshavn. Three vibrocores were taken off Grenå as part of another project on September 20 and 21.

Leg 2 started on September 21 and four vibrocores were collected in Kattegat and 34 in Jammerbugt and on Jyske Rev, before the project finished off with demobilisation in Esbjerg. During Leg 2, 19 vibrocores were taken off Lønstrup and Løkken as part of another project.

Four periods of weather standby were encountered. One offshore in Aarhusbugten, one in Aarhus harbor, one was used for crew change in Frederikshavn as well as one offshore in Jammerbugt.

A total of 72 vibrocores were collected for MST before and during the MST 2023 survey and during the survey some ship time was also allocated for the collection of 22 vibrocores on other projects, as described above. Details on the vibrocore positions are provided in the survey log, included as Appendix A.

2. Introduction and purpose

GEUS has carried out fieldwork for the Danish Environmental Protection Agency (Miljøstyrelsen, MST) as part of their marine raw material mapping in 2023. The survey is hereafter referred to as the MST 2023 survey. The MST 2023 survey included 32 so-called 'Fællesområder' and 'Potentielle Fællesområder' as well as three raw material interest areas in the Baltic Sea around Bornholm, the inner Danish Waters and Kattegat, Jammerbugt and on Jyske Rev.

The purpose of the MST 2023 survey was to collect vibrocores and obtain geological information to improve the knowledge of raw material resources in Danish waters. The vibrocores are used for ground truthing the presence of resources interpreted on geophysical data and the cores provide information on sediment composition and quality of the resources. Thus, the main aim of the MST 2023 survey was to supplement existing data to provide the necessary information for a sustainable management of national raw materials by the Danish Environmental Protection Agency.

Before the survey, GEUS worked out a proposal for vibrocoring activities for the Environmental Protection Agency based on previous geophysical mapping and vibrocoring.

An overview of the survey areas and the collected vibrocores is shown in Table 1 in section 3.1 and in Figure 3.2.

3. Overview of survey activities

The MST 2023 survey was carried out using the survey vessel Fortuna Crane (Figure 3.1) provided by Foga Consult ApS.

Figure 3.1 Survey vessel Fortuna Crane.

Mobilization of vibrocore equipment on board the Fortuna Crane took place in Esbjerg on August 14 as part of another GEUS survey for the Danish Energy Agency (Energistyrelsen, ENS). The first MST vibrocores were collected during this ENS survey for practical reasons and in agreement with the Danish Environmental Protection Agency. The MST 2023 survey itself was initiated on September 16 and during the survey, three vibrocores were collected for the Danish Energy Agency (on a separate survey permit) and 19 vibrocores for Kystdirektoratet (as part of the MST survey permit), also in agreement with the Danish Environmental Protection Agency. The survey was finished in Esbjerg on September 28 after completion of vibrocoring in the Baltic Sea around Bornholm, the inner Danish waters and Kattegat as well as Jammerbugt and on Jyske Rev.

3.1 Vibrocoring

A total of 72 vibrocores with sediment cores from the seabed and down to a maximum depth of 6 m were carried out in 35 individual areas (Figure 3.2).

A general overview of the vibrocore activities appears in Table 1, while further details are included in chapter 5 and the vibrocore survey log in Appendix A.

Table 1 Overview of vibrocore areas. Further details are included in chapter 5 and Appendix A.

Area	ID	No. of vibrocores	Bemærkninger
Stokkebæk Flak	SF	1	Fællesomr./Pot. Fæl.
Nordmandshage	NH	1	Fællesomr./Pot. Fæl.
Lysegrund	LYS	1	Fællesomr./Pot. Fæl.
Grønnerevle	GRR	1	Fællesomr./Pot. Fæl.
Rønne	RO	1	Fællesomr./Pot. Fæl.
Klintegrund Vest	KGV	1	Fællesomr./Pot. Fæl.
Klintegrund Syd	KGS	1	Fællesomr./Pot. Fæl.
Bakkegrund Nord	BGN	1	Fællesomr./Pot. Fæl.
Bakkegrund Syd	BGS	1	Fællesomr./Pot. Fæl.
Rønne Banke Øst	RBO	2	Fællesomr./Pot. Fæl.
Rønne Banke Syd	RBS	4	Fællesomr./Pot. Fæl.
Karrebæksminde	KM	1	Fællesomr./Pot. Fæl.
Tranesand	TRS	1	Fællesomr./Pot. Fæl.
Halk Hoved	HH	1	Fællesomr./Pot. Fæl.
Samsø Nord	SN	1	Raw material interest area
Hesbjerg Grund	HG	1	Fællesomr./Pot. Fæl.
Wulffs Flak	WF	2	Fællesomr./Pot. Fæl.
Nord for Wulffs Flak	WFN	1	Fællesomr./Pot. Fæl.
Skadegrund Vest	SGV	1	Fællesomr./Pot. Fæl.
Skadegrund Øst	SGO	1	Fællesomr./Pot. Fæl.
506-44-55-04	506-44-55-04	1	Raw material interest area
Marthe Flak	MF	2	Fællesomr./Pot. Fæl.
Moselgrund	MG	3	Fællesomr./Pot. Fæl.
Klørgrund	KLG	1	Fællesomr./Pot. Fæl.
Hjelm Nordvest	HNV	1	Fællesomr./Pot. Fæl.
Nord for Tvillingerne	TN	1	Fællesomr./Pot. Fæl.
Øst for Læsø	LO	3	Fællesomr./Pot. Fæl.
Skagens Rev	SR	1	Fællesomr./Pot. Fæl.
Jammerbugt	JB	9	Fællesomr./Pot. Fæl.
Jyske Rev C	JRC	2	Fællesomr./Pot. Fæl.
Jyske Rev D	JRD	5	Fællesomr./Pot. Fæl.
Jyske Rev A-F	JRAF	5	Fællesomr./Pot. Fæl.
Jammerbugt Interesseområde	JAM	6	Raw material interest area
Jyske Rev E	JRE	7 (1 retake)	Fællesomr./Pot. Fæl.
Total		**72**	

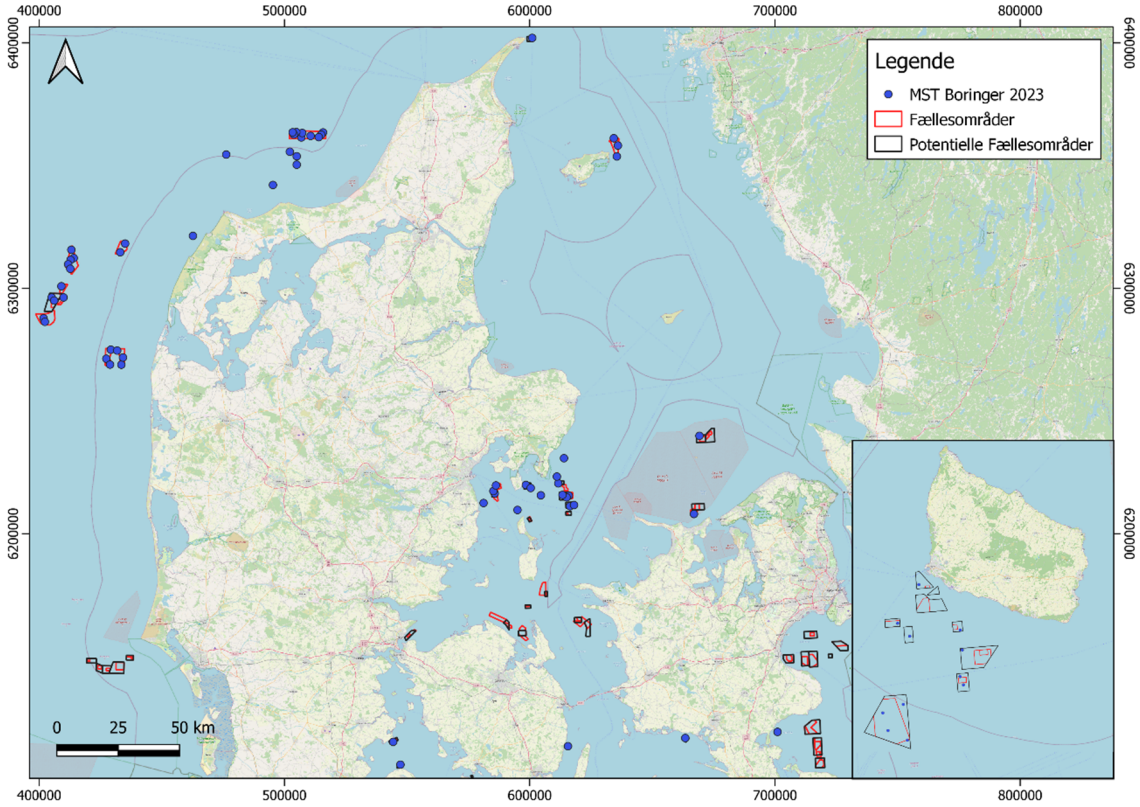

Figure 3.2 Overview map with location of vibrocores.

4. Personnel

Apart from the professional ship crew, GEUS had a crew of four people manning the MST 2023 survey, and a vibrocore crew of four people from Bjerregaard Montage ApS.

Data acquisition was carried out 24/7 and each survey leg was manned with a GEUS cruise lead, a GEUS MST representative and a vibrocore team of four people working in two shifts.

The GEUS cruise lead had the overall responsibility for the vibrocoring survey, and the drilling team operated the vibrocore instrument. The GEUS MST representative was responsible for the on-site quality control of the data.

The following people attended each survey leg:

Leg 1 – Vibrocoring: 16/9 - 21/9

The GEUS personnel was:

- Luna Holland Winther (Cruise lead, marine geologist)
- Lisbeth L. Pedersen (MST representative, BSc in geoscience)

The drilling crew was:

- Andreas Hansen
- Jakob Vind
- Jon Braher
- Ole Camin

Leg 2 – Vibrocoring: 21/9 – 28/9

The GEUS personnel was:

- Henrik J. Granat (Cruise lead, geologist)
- Lis Allaart (MST representative, geologist)

The drilling crew was:

- Andreas Hansen
- Jakob Vind
- Jon Braher
- Ole Camin

5. Equipment and operation

Before vibrocore operations, the vessel was anchored at the desired location using typically one forward anchor and one aft anchor. In a few positions, three-point mooring was necessary using a third anchor.

In Figure 5.1 below, is shown the ship's navigation panel used when anchoring together with a typical anchor layout with respect to wind direction.

Figure 5.1 Navigation panel used when anchoring at the planned vibrocore locations. To the left, a typical anchor layout with respect to wind direction is seen.

The actual vibrocore locations were collected in a WGS84 datum with Lat/Long degrees and decimal minutes with three decimals. The actual positions were mostly within a few meters from the planned positions and in general always within 30 m, with very few exceptions.

5.1 Vibrocoring

The acquisition of vibrocores included sediment cores from the seabed and to a maximum of 6 m depth with a Vibracorer MED-C VC(VKG)-6 operated using the ship crane.

The drilling crew prepared, deployed, operated, and recovered the vibrocore instrument (Figure 5.2). When the vibrocorer was back on deck, the 6 m long plastic core sleave was extracted from inside the metal core barrel and was cut into 1 m segments for storage and handling. GEUS geologists labeled the core segments with site-identifying codes and logged and described the lithology at the top of every one-meter core segment. Additionally, any sediment present in the core-catcher at the tip of the core barrel was noted and described, to get an indication of the geology at the deepest penetration point.

Figure 5.2 Deck arrangement of Fortuna Crane during vibrocore operations, looking aft from the bridge. Port side is to the right and starboard is to the left. The crane is mounted on the starboard side, but the vibrocorer (centre of deck) was always deployed over the port side.

In Figure 5.3 below, the vibrocore instrument is shown in more detail. The vibrator part is the grey box just above the hexagonal foundation, close to the deck. When loading, the vibrator unit is raised to the top of the tower, and a pvc tube is inserted into the steel core barrel before it is raised to a vertical position. The crane is then used to deploy the vibrocorer into the water and to lower it to the seabed where the core barrel and pvc tube is vibrated into the subsurface. When no more penetration is possible, the barrel and pvc tube is pulled out again, and the vibrocore unit is retrieved back on deck and unloaded.

The vibrocorer contains an echo-sounder unit and a current-measuring unit. The echo-sounder unit measures the approximate distance from the vibrocore unit to the seabed, and the current-measuring unit measures the induced amperes within the vibrator part as a proxy for the amount of pressure the vibrocorer uses to penetrate the subsurface.

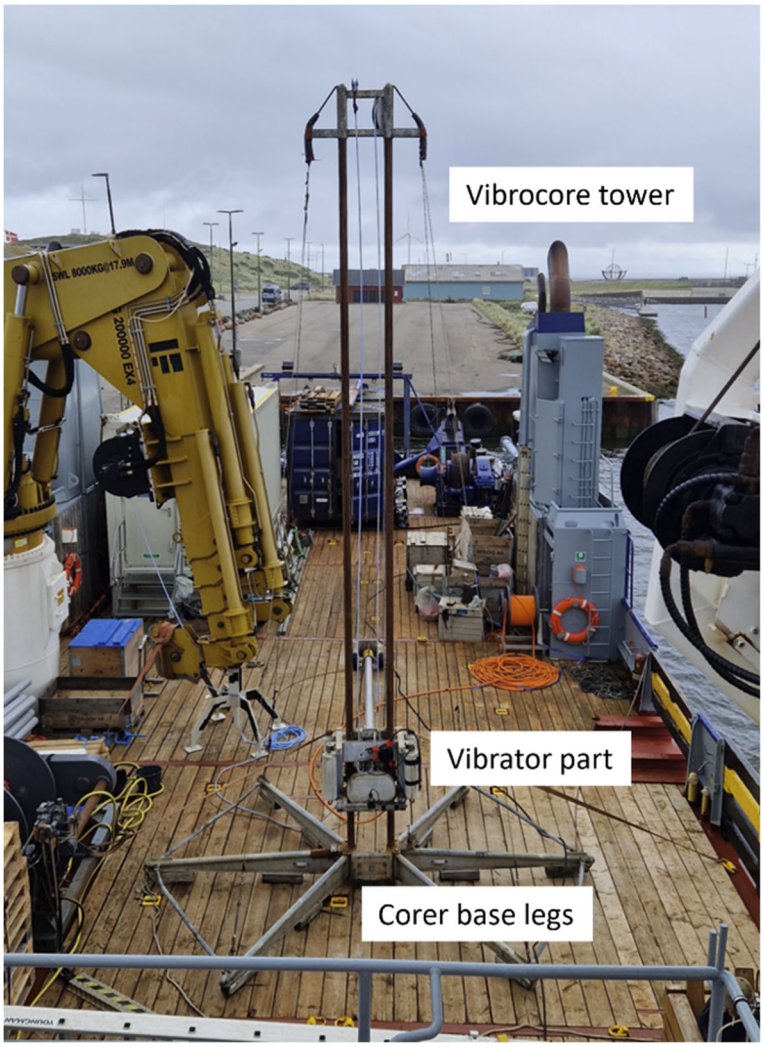

Figure 5.3 Vibrocore instrument used for sediment sampling. The vibrator part is seen as the grey unit above the hexagonal foundation close to the deck.

5.2 Activity report

Mobilization took place in Esbjerg on August 14 as part of a vibrocore survey project for the Danish Energy Agency and the first 15 vibrocores of the MST 2023 survey were collected in 11 specific areas on September 3 (one in Storebælt), September 5 (one in Faxe Bugt and one in Kattegat), September 6 (one in Kattegat) and September 14 and 15 (11 southwest of Bornholm) during the project for the Danish Energy Agency. The MST 2023 survey itself was initiated off Bornholm on September 16 with a transit to Karrebæksminde after finalizing the project for the Danish Energy Agency. Below details of each survey leg are given.

Leg 1 – Vibrocoring: 16/9 - 21/9

Leg 1 included collection of 19 vibrocores in 15 individual areas in the inner Danish waters and Kattegat as well as three vibrocores carried out on September 20 and 21 for the Danish Energy Agency under a separate survey permit.

The survey activities started on September 16 with a transit from Bornholm to the Karrebæksminde area and vibrocoring off Karrebæksminde, followed by vibrocoring in the southern part of Lillebælt, Aarhusbugten and Kattegat until September 20. During some hours on September 18 the weather conditions were too rough for vibrocoring work and some hours of weather standby was encountered waiting offshore for improved conditions. Weather standby was also encountered for a longer period on September 19 and 20, waiting for better conditions in Aarhus Harbor. On September 20 and 21, three vibrocores were carried out on another project off Grenaa for the Danish Energy Agency before transit to the Læsø area. At Læsø the weather conditions were again too rough for vibrocoring work and the weather standby period was used for a crew change in Frederikshavn on September 21.

Leg 2 – Vibrocoring: 21/9 - 28/9

Leg 2 included collection of 38 vibrocores in 8 areas in Kattegat, Jammerbugt and on Jyske Rev as well as 19 vibrocores carried out on September 24 and 26.

At the start of Leg 2, after a weather standby period used for transit and crew change, vibrocore work was resumed in the Læsø area, followed by vibrocoring at Skagen, in Jammerbugt and on Jyske Rev. On September 23, the weather conditions on Jyske Rev became too rough for vibrocoring. After a very short period of weather standby at the Jyske Rev site, it was decided to sail back to Jammerbugt and carry out 19 vibrocores off Lønstrup and Løkken on another GEUS project for Kystdirektoratet. This was done on September 24 and 26, separated by a one day of weather standby while waiting offshore for improved conditions on September 25. On September 26, vibrocoring was resumed on the MST 2023 survey in Jammerbugt followed by vibrocoring on Jyske Rev.

At the very last planned vibrocore position on September 27 on Jyske Rev, a few hours before rough weather conditions were expected to put a hold on further vibrocore operations, the vibrocore instrument was lost at the seabed on the vibrocore location JRAF-02. During attempts to retrieve the vibrocorer, three individual dyneema ropes were broken, one by one. With no more options for retrieval of the equipment and the weather deteriorating, it was decided to leave the site and transit to Esbjerg for demobilization on September 28, where the MST 2023 survey was finalized. Plans will be made to recover the vibrocore instrument at a later stage.

6. Concluding remarks

GEUS has carried out vibrocoring in Danish waters for the Danish Environmental Protection Agency (Miljøstyrelsen, MST) as part of their marine raw material mapping in 2023.

The MST 2023 survey was conducted between September 16 and September 28 from the survey vessel Fortuna Crane and was split in two survey legs.

Before the start of the survey, 15 vibrocores were collected in Storebælt, Faxe Bugt, Kattegat and around Bornholm during another project for practical reasons.

During Leg 1, 19 vibrocores were collected in 15 areas in the inner Danish waters and Kattegat and 3 vibrocores were collected off Grenaa on another project under a separate survey permit.

During Leg 2, 38 vibrocores were collected in Kattegat, Jammerbugt and on Jyske Rev and 19 vibrocores were collected off Lønstrup and Løkken in Jammerbugt on another project.

A total of 72 vibrocores were collected during the MST 2023 survey as part of the raw material mapping of the Danish Environmental Protection Agency and 22 vibrocores were collected as part of other projects. Details on the vibrocore locations are provided in the survey log, included as Appendix A.

The weather conditions were ranging from very good to very poor, and a little more than two days of weather standby were encountered in the MST 2023 survey, while a little more than one day of weather standby was encountered as part of other projects.

Unfortunately, the vibrocore instrument was lost at the seabed in the very last part of the survey and plans will be made for recovery.

The initial quality assessment of the sediment cores reveals high quality for all data serving the purpose of the survey.

Appendiks A: Vibrocore survey log

Project: MST raw material mapping 2023								Client: Miljøstyrelsen															Drilling Platform: Fortuna Crane (Call sign: OZWM2)
Core-ID	Planned positions							Actual positions															Comments
	UTM Zone 32		WGS 84				Water depth	UTM Zone 32		WGS 84				Water depth	Water depth								
	X	Y	LATITUDE		LONGITUDE		Surface to seabed	X	Y	LATITUDE		LONGITUDE		Echo sounder	Surface to seabed	Transit	Transit	Date	Date UTC	Time	Time UTC	Recovery	
	m	m	Degrees	Decimal minutes	Degrees	Decimal minutes	m	m	m	Degrees	Decimal minutes	Degrees	Decimal minutes	m	m	nm	km					m	
SF-02	615605	6113469	55	9,261	10	48,857	9,0	615597	6113468	55	9,260	10	48,850	6,2	9,2	25,4	47,0	03-09-2023	02-09-2023	1.30	23.30	5,86	Core taken during ENS 2023 vibrocore survey
NH-01	701052	6119290	55	10,756	12	9,458	9,8	701052	6119290	55	10,756	12	9,458	6,2	9,2	19,5	36,1	05-09-2023	05-09-2023	02.00	00.00	4,62	Core taken during ENS 2023 vibrocore survey
LYS-01	669197	6239889	56	16,417	11	43,957	10,5	669198	6239907	56	16,426	11	43,959	8,2	11,2	5	9,3	05-09-2023	05-09-2023	22.00	20.00	1,63	Core taken during ENS 2023 vibrocore survey Opankringsproblemer på grund af sten
GRR-01	666972	6208069	55	59,329	11	40,608	10,5	666972	6208075	55	59,332	11	40,609	8,4	11,4	14,6	27,0	06-09-2023	05-09-2023	01.15	23.15	5	Core taken during ENS 2023 vibrocore survey
RO-01	861264	6117368	55	4,273	14	39,644	25,6	861266	6117371	55	4,275	14	39,646	19,1	22,1	0	0,0	14-09-2023	14-09-2023	20.50	18.50	5,44	Core taken during ENS 2023 vibrocore survey
KGV-01	857336	6110198	55	0,596	14	35,432	18,8	857338	6110192	55	0,593	14	35,434	16,1	19,1	4,38	8,1	14-09-2023	14-09-2023	22.00	20.00	3,89	Core taken during ENS 2023 vibrocore survey
KGS-01	859587	6107759	54	59,190	14	37,351		859590	6107763	54	59,192	14	37,354	14	17	1,84	3,4	14-09-2023	14-09-2023	23.00	21.00	3,55	Core taken during ENS 2023 vibrocore survey
BGN-01	868966	6108920	54	59,402	14	46,190	16,8	868964	6108921	54	59,403	14	46,189	13,3	16,3	6,25	11,6	15-09-2023	14-09-2023	00.30	22.30	6	Core taken during ENS 2023 vibrocore survey
BGS-01	869351	6105203	54	57,391	14	46,263	15,8	869356	6105223	54	57,401	14	46,269	12,6	15,6	2,02	3,7	15-09-2023	15-09-2023	02.00	00.00	5,68	Core taken during ENS 2023 vibrocore survey
RBO-01	868925	6100258	54	54,757	14	45,485	14,3	868940	6100273	54	54,764	14	45,500	11,3	14,3	2,68	5,0	15-09-2023	15-09-2023	03.40	01.40	5,75	Core taken during ENS 2023 vibrocore survey
RBO-02	869545	6098710	54	53,899	14	45,943	12,8	869564	6098715	54	53,901	14	45,961	9,6	12,6	0,9	1,7	15-09-2023	15-09-2023	04.40	02.40	6	Core taken during ENS 2023 vibrocore survey
RBS-01	858343	6095097	54	52,449	14	35,244	18,8	858366	6095103	54	52,451	14	35,266	15,7	18,7	6,34	11,7	15-09-2023	15-09-2023	06.15	04.15	3,61	Core taken during ENS 2023 vibrocore survey
RBS-02	854576	6093519	54	51,763	14	31,622	16,5	854571	6093509	54	51,758	14	31,617	13,4	16,4	2,2	4,1	15-09-2023	15-09-2023	07.30	05.30	4,28	Core taken during ENS 2023 vibrocore survey
RBS-03	855545	6090240	54	49,962	14	32,281	15,8	855545	6090240	54	49,962	14	32,281	13,2	16,2	1,85	3,4	15-09-2023	15-09-2023	08.40	06.40	5,96	Core taken during ENS 2023 vibrocore survey
RBS-04	859143	6088442	54	48,844	14	35,493	15,8	859139	6088439	54	48,842	14	35,489	13	16	2,21	4,1	15-09-2023	15-09-2023	09.50	07.50	4,89	Core taken during ENS 2023 vibrocore survey
KM-03	663435	6116794	55	10,243	11	33,968	9,0	663432	6116794	55	10,243	11	33,965	8,5	11,5	217,4	402,6	17-09-2023	17-09-2023	10.20	08.20	3,04	
TRS-02	547299	6105948	55	5,880	9	44,474	24,75	547289	6105953	55	5,883	9	44,465	22,7	25,7	85,8	158,9	17-09-2023	17-09-2023	19.30	17.30	3,6	
HH-02	544331	6115231	55	10,901	9	41,770	14,25	544319	6115221	55	10,896	9	41,759	11,3	14,3	5,31	9,8	17-09-2023	17-09-2023	21.00	19.00	4,69	
WOW																		18-09-2023	18-09-2023	06.15	04.15		WOW start
WOW																		18-09-2023	18-09-2023	15.00	13.00		WOW end
SN-05	595008	6209708	56	1,391	10	31,460		595014	6209708	56	1,391	10	31,466	20,7	23,7	80	148,2	18-09-2023	18-09-2023	16.00	14.00	4,12	
HG-01	581180	6212537	56	3,068	10	18,203	7,5	581187	6212546	56	3,073	10	18,211	4,3	7,3	7,66	14,2	18-09-2023	18-09-2023	18.20	16.20	2,5	
WF-02	585721	6216461	56	5,135	10	22,652	16,5	585726	6216474	56	5,142	10	22,658	4,8	7,8	3,23	6,0	18-09-2023	18-09-2023	19.40	17.40	2,88	
WF-01	585177	6217429	56	5,663	10	22,146	19,5	585177	6217429	56	5,663	10	22,146	7,4	10,4	0,6	1,1	18-09-2023	18-09-2023	20.30	18.30	4,54	
WFN-01	586240	6219707	56	6,879	10	23,215	17,3	586228	6219706	56	6,879	10	23,204	13,4	16,4	1,31	2,4	18-09-2023	18-09-2023	22.00	20.00	5,92	
SGV-01	598445	6219890	56	6,836	10	34,992	15,0	598450	6219895	56	6,839	10	34,997	12,4	15,4	6,95	12,9	18-09-2023	18-09-2023	23.40	21.40	4,13	
SGO-01	600415	6218661	56	6,149	10	36,864	12,8	600402	6218667	56	6,153	10	36,852	11	14	1,63	3,0	19-09-2023	18-09-2023	01.00	23.00	4,37	
506-44-55-04	604524	6215688	56	4,494	10	40,756		604553	6215694	56	4,497	10	40,784	17,7	20,7	2,75	5,1	19-09-2023	19-09-2023	02.30	00.30	4,82	
WOW																		19-09-2023	19-09-2023	03.00	01.00		WOW start
WOW																		20-09-2023	20-09-2023	06.15	04.15		WOW end
MF-01	616436	6211237	56	1,931	10	52,116		616437	6211242	56	1,934	10	52,117	9,7	12,7	24,2	44,8	20-09-2023	20-09-2023	09.30	07.30	5,44	
MF-02	618072	6211717	56	2,166	10	53,703		618072	6211717	56	2,166	10	53,703	13,4	16,4	0,9	1,7	20-09-2023	20-09-2023	10.40	08.40	5,92	
MG-03	615948	6215501	56	4,236	10	51,757		615939	6215516	56	4,244	10	51,749	8,9	11,9	2,46	4,6	20-09-2023	20-09-2023	11.50	09.50	5,1	
MG-01	615047	6214869	56	3,908	10	50,873		615047	6214879	56	3,914	10	50,873	5,8	8,8	0,52	1,0	20-09-2023	20-09-2023	12.50	10.50	5	
MG-02	613357	6215835	56	4,453	10	49,270		613369	6215837	56	4,454	10	49,281	5,9	8,9	1,44	2,7	20-09-2023	20-09-2023	13.50	11.50	4,62	
KLG-01	611660	6220560	56	7,023	10	47,753		611654	6220560	56	7,023	10	47,748	7,9	10,9	2,69	5,0	20-09-2023	20-09-2023	15.30	13.30	2,13	
HNV-01	611086	6223304	56	8,510	10	47,268		611081	6223318	56	8,517	10	47,264	18,8	21,8	1,51	2,8	20-09-2023	20-09-2023	16.40	14.40	4,44	
TN-01	613969	6230796	56	12,505	10	50,243		613975	6230804	56	12,510	10	50,249	13,4	16,4	4,31	8,0	20-09-2023	20-09-2023	18.20	16.20	5.68	
AS-CPT-06	622544	6254102	56	24,934	10	59,183		622556	6254101	56	24,933	10	59,194	11,9	14,9			20-09-2023	20-09-2023	21.10	19.10	2,63	ENS project and not MST project
AS-CPT-10	625586	6257725	56	26,838	11	2,244		625592	6257726	56	26,838	11	2,249	15,3	18,3			20-09-2023	20-09-2023	22.30	20.30	5,89	ENS project and not MST project
AS-21-NY	636419	6259656	56	27,697	11	12,840		636402	6259653	56	27,696	11	12,824	15,4	18,4			21-09-2023	20-09-2023	00.30	22.30	3,27	ENS project and not MST project
Transit LO-01																71,6	132,6	21-09-2023	21-09-2023	6.30	4.30		Current too strong to perform vibrocoring operations
WOW																		21-09-2023	21-09-2023	6.30	4.30		WOW start, crew change in Frederikshavn
WOW																		21-09-2023	21-09-2023	18.00	16.00		WOW end

Project: MST raw material mapping 2023								Client: Miljøstyrelsen															Drilling Platform: Fortuna Crane (Call sign: OZWM2)
Core-ID	Planned positions							Actual positions															Comments
	UTM Zone 32		WGS 84				Water depth	UTM Zone 32		WGS 84				Water depth	Water depth								
	X	Y	LATITUDE		LONGITUDE		Surface to seabed	X	Y	LATITUDE		LONGITUDE		Echo sounder	Surface to seabed	Transit	Transit	Date	Date UTC	Time	Time UTC	Recovery	
	m	m	Degrees	Decimal minutes	Degrees	Decimal minutes	m	m	m	Degrees	Decimal minutes	Degrees	Decimal minutes	m	m	nm	km					m	
LO-01	635505	6353730	57	18,382	11	14,962		635536	6353750	57	18,393	11	14,993	7,6	10,6	0	0,0	21-09-2023	21-09-2023	18.30	16.30	5,15	Second attempt at coring position LO-01, now less strong current
LO-03	635964	6358191	57	20,777	11	15,566		635959	6358187	57	20,775	11	15,561	10	13	2,51	4,6	21-09-2023	21-09-2023	20.30	18.30	1,39	
LO-02	634283	6361179	57	22,416	11	13,989		634289	6361181	57	22,417	11	13,995	7,3	10,3	1,97	3,6	21-09-2023	21-09-2023	22.00	20.00	3,92	
SR-01	601002	6402018	57	44,933	10	41,818		601001	6402041	57	44,945	10	41,819	6	9	28,46	52,7	22-09-2023	22-09-2023	02.00	00.00	4,51	
JB-09	515751	6363522	57	24,850	9	15,732		515745	6363523	57	24,851	9	15,726	15,7	18,7	65,4	121,1	22-09-2023	22-09-2023	11.00	09.00	4,9	
JB-08	514964	6362625	57	24,369	9	14,943		514973	6362626	57	24,369	9	14,952	17,1	20,1	0,71	1,3	22-09-2023	22-09-2023	11.50	09.50	5,33	
JB-07	513987	6361623	57	23,831	9	13,964		513992	6361622	57	23,830	9	13,969	15,8	18,8	0,78	1,4	22-09-2023	22-09-2023	12.55	10.55	5,18	
JB-06	510659	6362115	57	24,101	9	10,642		510665	6362107	57	24,097	9	10,649	18,9	21,9	1,88	3,5	22-09-2023	22-09-2023	14.00	12.00	5	
JB-05	506889	6361499	57	23,774	9	6,878		506891	6361493	57	23,770	9	6,879	20,1	23,1	2,08	3,9	22-09-2023	22-09-2023	15.15	13.15	6	
JB-04	507248	6363306	57	24,747	9	7,239		507247	6363306	57	24,747	9	7,238	16,3	19,3	1,07	2,0	22-09-2023	22-09-2023	16.15	14.15	1,79	
JB-03	504829	6363690	57	24,956	9	4,823		504832	6363680	57	24,951	9	4,826	15,3	18,3	1,31	2,4	22-09-2023	22-09-2023	17.30	15.30	2,15	
JB-01	503857	6362693	57	24,419	9	3,851		503856	6362681	57	24,413	9	3,850	17,4	20,4	0,74	1,4	22-09-2023	22-09-2023	18.20	16.20	1,42	
JB-02	503338	6363585	57	24,900	9	3,334		503338	6363576	57	24,895	9	3,334	18,9	21,9	0,55	1,0	22-09-2023	22-09-2023	19.30	17.30	3,27	
JRC-02	435028	6318248	57	0,190	7	55,821		435045	6318246	57	0,190	7	55,837	26,9	29,9	44,3	82,0	23-09-2023	23-09-2023	03.00	01.00	5,9	
JRC-01	433029	6314733	56	58,279	7	53,902		433040	6314713	56	58,269	7	53,914	25,3	28,3	2,1	3,9	23-09-2023	23-09-2023	04.15	02.15	5,29	
JRD-01	413094	6315725	56	58,614	7	34,213		413105	6315711	56	58,607	7	34,224	23,9	26,3	10,74	19,9	23-09-2023	23-09-2023	06.35	04.35	3	
JRD-02	414094	6312358	56	56,811	7	35,268		414093	6312350	56	56,807	7	35,268	23,6	26,6	1,9	3,5	23-09-2023	23-09-2023	07.45	05.45	3	
JRD-05	412792	6311574	56	56,374	7	34,001		412789	6311579	56	56,377	7	33,998	23,1	26,1	0,82	1,5	23-09-2023	23-09-2023	08.50	06.50	2,87	
JRD-03	411801	6309807	56	55,411	7	33,061		411799	6309809	56	55,412	7	33,059	22,5	25,5	1,02	1,9	23-09-2023	23-09-2023	09.45	07.45	1,71	
JRD-04	412667	6307980	56	54,436	7	33,953		412671	6307981	56	54,437	7	33,956	19,5	22,5	1,14	2,1	23-09-2023	23-09-2023	10.50	08.50	3,28	
JRAF-04	409049	6300871	56	50,564	7	30,541		409047	6300867	56	50,562	7	30,540	23,3	26,3	4,43	8,2	23-09-2023	23-09-2023	12.15	10.15	2	
JRAF-03	409948	6296305	56	48,114	7	31,523		409948	6296299	56	48,111	7	31,522	23,7	26,7	2,61	4,8	23-09-2023	23-09-2023	13.30	11.30	3,56	
JRAF-06	405074	6296284	56	48,045	7	26,736		405074	6296284	56	48,045	7	26,736	21,1	24,1	2,74	5,1	23-09-2023	23-09-2023	14.40	12.40	6	
JRAF-05	406120	6295045	56	47,390	7	27,791		406118	6295045	56	47,390	7	27,789	20,4	23,4	0,93	1,7	23-09-2023	23-09-2023	15.45	13.45	3,21	
JRAF-01	401801	6287837	56	43,453	7	23,716		401786	6287819	56	43,443	7	23,702	26,7	29,7	4,56	8,4	23-09-2023	23-09-2023	17.25	15.25	4,36	
WOW																		23-09-2023	23-09-2023	18.00	16.00		WOW start
WOW																		23-09-2023	23-09-2023	20.00	18.00		WOW end
LO-VC-14	535212	6357732	57	21,665	9	35,120		535212	6357736	57	21,667	9	35,120	10	13			24-09-2023	24-09-2023	11.45	9.45	2,88	KDI project and not MST project
LO-VC-11	538026	6359067	57	22,371	9	37,938		538026	6359079	57	22,377	9	37,938	9,5	12,5			24-09-2023	24-09-2023	13.05	11.05	4,31	KDI project and not MST project
LO-VC-10	539199	6360289	57	23,023	9	39,120		539196	6360294	57	23,026	9	39,117	10,4	13,4			24-09-2023	24-09-2023	14.15	12.15	5,13	KDI project and not MST project
LO-VC-18	536665	6361056	57	23,449	9	36,598		536663	6361052	57	23,447	9	36,596	14,4	17,4			24-09-2023	24-09-2023	15.20	13.20	4,92	KDI project and not MST project
LO-VC-15	534288	6360420	57	23,118	9	34,221		534291	6360432	57	23,124	9	34,223	9,7	12,7			24-09-2023	24-09-2023	16.40	14.40	2,5	KDI project and not MST project
LO-VC-08	548284	6376936	57	31,942	9	48,383		548305	6376934	57	31,941	9	48,405	8,9	11,9			24-09-2023	24-09-2023	18.50	16.50	4	KDI project and not MST project
LO-VC-04	549046	6377761	57	32,382	9	49,157		549040	6377777	57	32,390	9	49,151	9,2	12,2			24-09-2023	24-09-2023	20.00	18.00	3,15	KDI project and not MST project
LO-VC-09	550353	6378943	57	33,010	9	50,481		550348	6378937	57	33,007	9	50,476	12,6	15,6			24-09-2023	24-09-2023	21.10	19.10	5	KDI project and not MST project
LO-VC-03	549697	6377313	57	32,136	9	49,804		549688	6377313	57	32,136	9	49,795	8,2	11,2			24-09-2023	24-09-2023	22.15	20.15	3.31	KDI project and not MST project
WOW																		24-09-2023	24-09-2023	22.30	20.15		WOW start, KDI project and not MST project
WOW																		26-09-2023	26-09-2023	06.00	04.00		WOW end, KDI project and not MST project
LO-VC-06	548177	6375129	57	31,495	9	49,452		548183	6375136	57	30,973	9	48,260	10,1	13,1			26-09-2023	26-09-2023	6.50	4.50	4,18	KDI project and not MST project
LO-VC-02	546216	6377527	57	32,274	9	46,318		546231	6377528	57	32,274	9	46,333	11,1	14,1			26-09-2023	26-09-2023	8.00	6	2,95	KDI project and not MST project
LO-VC-07	545889	6376451	57	31,696	9	45,978		545890	6376457	57	31,699	9	45,979	12	15			26-09-2023	26-09-2023	9.00	7	4,22	KDI project and not MST project
LO-VC-01	544634	6375706	57	31,302	9	44,713		544626	6375708	57	31,303	9	44,705	10,7	13,7			26-09-2023	26-09-2023	9.50	7.50	3,49	KDI project and not MST project
LO-VC-05	549361	6376119	57	31,495	9	49,452		549365	6376114	57	31,492	9	49,456	6,9	9,9			26-09-2023	26-09-2023	11.10	9.10	2	KDI project and not MST project
LO-VC-12	539230	6357600	57	21,574	9	39,125		539229	6357608	57	21,578	9	39,125	9,6	12,6			26-09-2023	26-09-2023	13.20	11.20	2,42	KDI project and not MST project
LO-VC-13	532997	6359171	57	22,450	9	32,922		533000	6359167	57	22,448	9	32,925	10,6	13,6			26-09-2023	26-09-2023	14.30	12.30	1,81	KDI project and not MST project

Project: MST raw material mapping 2023								Client: Miljøstyrelsen															Drilling Platform: Fortuna Crane (Call sign: OZWM2)
Core-ID	Planned positions							Actual positions															Comments
	UTM Zone 32		WGS 84				Water depth	UTM Zone 32		WGS 84				Water depth	Water depth								
	X	Y	LATITUDE		LONGITUDE		Surface to seabed	X	Y	LATITUDE		LONGITUDE		Echo sounder	Surface to seabed	Transit	Transit	Date	Date UTC	Time	Time UTC	Recovery	
	m	m	Degrees	Decimal minutes	Degrees	Decimal minutes	m	m	m	Degrees	Decimal minutes	Degrees	Decimal minutes	m	m	nm	km					m	
LO-VC-19	532488	6356632	57	21,084	9	32,394		532490	6356630	57	21,083	9	32,396	13	16			26-09-2023	26-09-2023	15.30	13.30	4	KDI project and not MST project
LO-VC-16	535863	6354496	57	19,918	9	35,741		535869	6354511	57	19,926	9	35,747	8,9	11,9			26-09-2023	26-09-2023	16.30	14.30	3,77	KDI project and not MST project
LO-VC-17	532888	6354356	57	19,856	9	32,775		532902	6354368	57	19,862	9	32,789	11	14			26-09-2023	26-09-2023	17.35	15.35	5,12	KDI project and not MST project
JAM-51	502183	6355659	57	20,628	9	2,176		502193	6355659	57	20,629	9	2,186	18,4	21,4	0	0,0	26-09-2023	26-09-2023	20.30	18.30	3,84	
JAM-50	505011	6353813	57	19,632	9	4,993		505011	6353812	57	19,632	9	4,993	17,1	20,1	1,84	3,4	26-09-2023	26-09-2023	21.10	19.10	4,46	
JAM-49	505015	6350376	57	17,780	9	4,993		505015	6350374	57	17,779	9	4,993	14	17	1,86	3,4	26-09-2023	26-09-2023	22.00	20.00	5,17	
JAM-48	495302	6342119	57	13,330	8	55,332		495307	6342116	57	13,328	8	55,337	14	17	6,92	12,8	26-09-2023	26-09-2023	23.45	21.45	5,94	
JAM-52	476271	6354494	57	19,964	8	36,352		476265	6354527	57	19,982	8	36,345	24,7	27,7	12,23	22,6	27-09-2023	27-09-2023	02.05	00.05	5,4	
JAM-47	462685	6321375	57	2,060	8	23,110		462688	6321385	57	2,065	8	23,113	16,2	19,2	19,49	36,1	27-09-2023	27-09-2023	5.45	3.45	6	
JRE-01	429209	6275019	56	36,842	7	50,793		429203	6275024	56	36,845	7	50,788	20,8	23,8	33,88	62,7	27-09-2023	27-09-2023	10.30	8.30		Metal coretube broke around 10:30 New core barrel installed for retake
JRE-01	429209	6275019	56	36,842	7	50,793		429205	6275016	56	36,841	7	50,790	20,8	23,8	0	0,0	27-09-2023	27-09-2023	12.50	10.50	4,59	
JRE-02	427369	6271333	56	34,839	7	49,057		427373	6271335	56	34,840	7	49,061	21,7	24,7	2,23	4,1	27-09-2023	27-09-2023	13.55	11.55	3,87	
JRE-03	428888	6268931	56	33,558	7	50,580		428882	6268938	56	33,562	7	50,574	24,2	27,2	1,72	3,2	27-09-2023	27-09-2023	15.00	13.00	2,37	
JRE-06	433494	6268898	56	33,581	7	55,076		433495	6268898	56	33,581	7	55,077	19	22	2,5	4,6	27-09-2023	27-09-2023	16.10	14.10	3,91	
JRE-04	434143	6271822	56	35,163	7	55,665		434163	6271831	56	35,168	7	55,684	19,5	22,5	1,6	3,0	27-09-2023	27-09-2023	17.15	15.15	3,34	
JRE-05	431791	6274662	56	36,673	7	53,323		431800	6274668	56	36,676	7	53,332	22,6	25,6	1,89	3,5	27-09-2023	27-09-2023	18.15	16.15	1,9	
JRAF-02	402328	6286381	56	42,675	7	24,266		402324	6286383	56	42,676	7	24,262	26,9	29,9	17,08	31,6	27-09-2023	27-09-2023	21.15	19.15	?	Vibrocore rig lost in this position, plans will be made for retrival
Transit Esbjerg																97	179,6	28-09-2023	28-09-2023	10.15	8.15		End of survey
																Sum	1856,5						

Danish Ministry of Climate,
Energy and Utilities

Geological survey of
Denmark and Greenland (GEUS)

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