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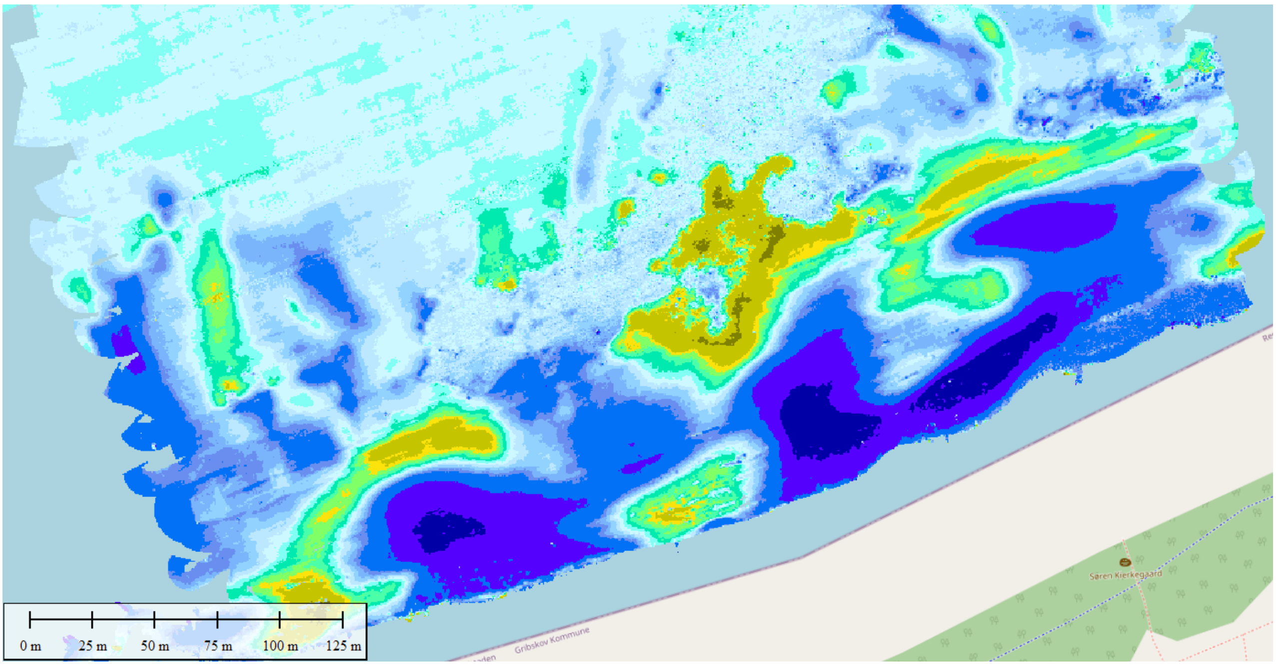
HESSSELØ BATHYMETRY SURVEY 2021 – WP D
SURVEY REPORT



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HESSSELØ BATHYMETRY SURVEY 2021 – WP D
SURVEY REPORT

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CONTENTS

1. EXECUTIVE SUMMARY

As part of the Hesselø cable route survey project Ramboll Denmark [Ramboll] has performed a repeat MBES survey along the cable route to compare the 2020 MBES data with 2021 re-acquired data. The marine survey has been divided into 2 main parts: an offshore part surveyed by MEWO S.A from Poland using the vessel Mintaka I (total of 1062,75 km was acquired) and an inshore/shallow part surveyed by Ramboll using the vessel Rambunctious (total of 18.6 km was acquired).

The acquired data for WP D complies with the IHO order 1a and have a ping density significantly above 4 pings/m^2 inside the survey corridor. However, a sound velocity layer in the water column causes refractions in the acquired MBES data. The refractions are mainly seen in the outer beams of the swath but are still clearly to be seen.

By comparing the acquired data in WP A & B from 2020 with data for WP D from 2021 the most significant changes can be seen close to the shore influenced by currents and waves.

In general, the sediment accretion along the corridor is within 0m to 0.08m whereas the overall erosion is within 0m to 0.08m. The highest erosion and accretion rates are seen close to shore ranging up to 1.3m.

2. INTRODUCTION

Energinet has requested a survey work package (WP D) which includes a repeat 2021 bathymetric survey of Hesselø cable route corridor. The purpose was to provide data for comparing the datasets from the 2020 (work package A and B) with the 2021 data to be able to conclude on the dynamical conditions of the seabed.

An overview of the cable corridor is shown in Figure 2-1. The survey has been divided in a nearshore shallow part and an offshore part. The latter consist of the main corridor and an eastern arm and a western arm defined by the KP values shown in Table 2-1.

All survey operations were acquired as close to shore as possible.

Figure 2-1 Overview map showing the survey area for the 2021 bathymetry survey.

Table 2-1 showing KP references for the different sections of the suvey

Section	KP interval
Nearshore/shallow survey	KP 0.074 to 0.451
Offshore section main corridor	KP 0.451 to 21.7
Eastern Arm	KP 21.7 to 46.57
Western Arm	KP 21.7 to 43.54

See also Appendix 1 for further information about the reference lines.

3. VESSELS AND PROGRAM

3.1 Offshore vessel

The Offshore part of the geophysical survey program was conducted with the survey vessel *Mintaka I*. Figure 3-1 show the vessel used for the marine geophysical survey.

Figure 3-1 offshore survey vessel Mintaka I

The following equipment were used for data acquisition on the Mintaka I, see Table 3-1. For the bathymetric survey a pole mounted multibeam echo sounding system was used.

Table 3-1 Equipment onboard Mintaka I

Navigation and Acquisition software	QPS Qinsy
Primary GPS	Trimble BX982
Secondary GPS, gyro and motion sensor	POSMV WaveMaster II
Multibeam Echosounder	SeaBat T50
Sound Velocity Profiler	SWIFT SVP

The offshore bathymetric survey was carried out as shown in the acquisition summary in Table 3-3.

The bathymetric survey was performed parallel to the provided reference lines and with infill lines to cover data gaps and in areas with very shallow waters or buoys.

3.2 Shallow survey vessel

The shallow survey was carried out using the vessel Rambunctious (see Figure 3-2).

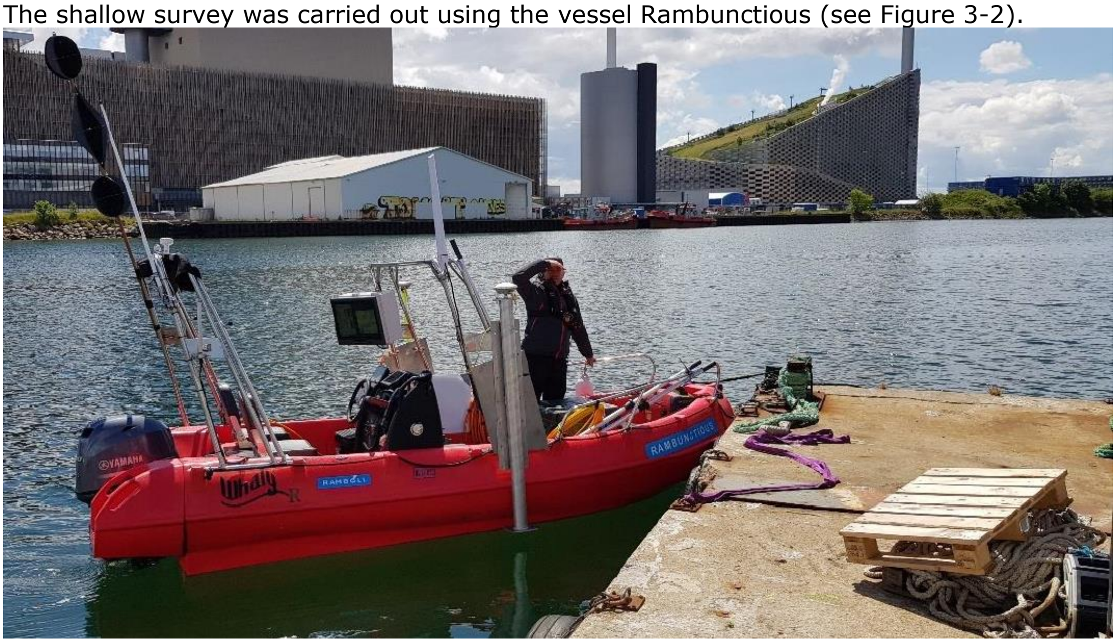

Figure 3-2 Shallow water survey vessel Rambunctious

Table 3-2 list the equipment used for data acquisition in the shallow water part onboard the Rambunctious. The MBES equipment was pole mounted on the starboard side of the vessel.

Table 3-2 Equipment used onboard the Rambunctious.

Navigation and Acquisition software	NaviPac, NaviScan
GNSS, Gyro and motion sensor	Applanix OceanMaster INS
Multibeam Echosounder	Norbit iWBMSh with integrated Applanix OceanMaster
Sound Velocity Profiler	AML Minos X

The shallow water survey was acquired as shown in the acquisition summary in Table 3-3.

3.3 Data acquisition

The total length of the survey corridor is app. 70 km with a width of 1000 m. One section has been extended so the corridor is app. 1400m wide at this location.

As for the 2020 survey, the corridor was divided into 12 sections with a line direction being parallel to the corridor in the offshore areas. For the shallow water survey the lines where planned to run parallel to the shoreline.

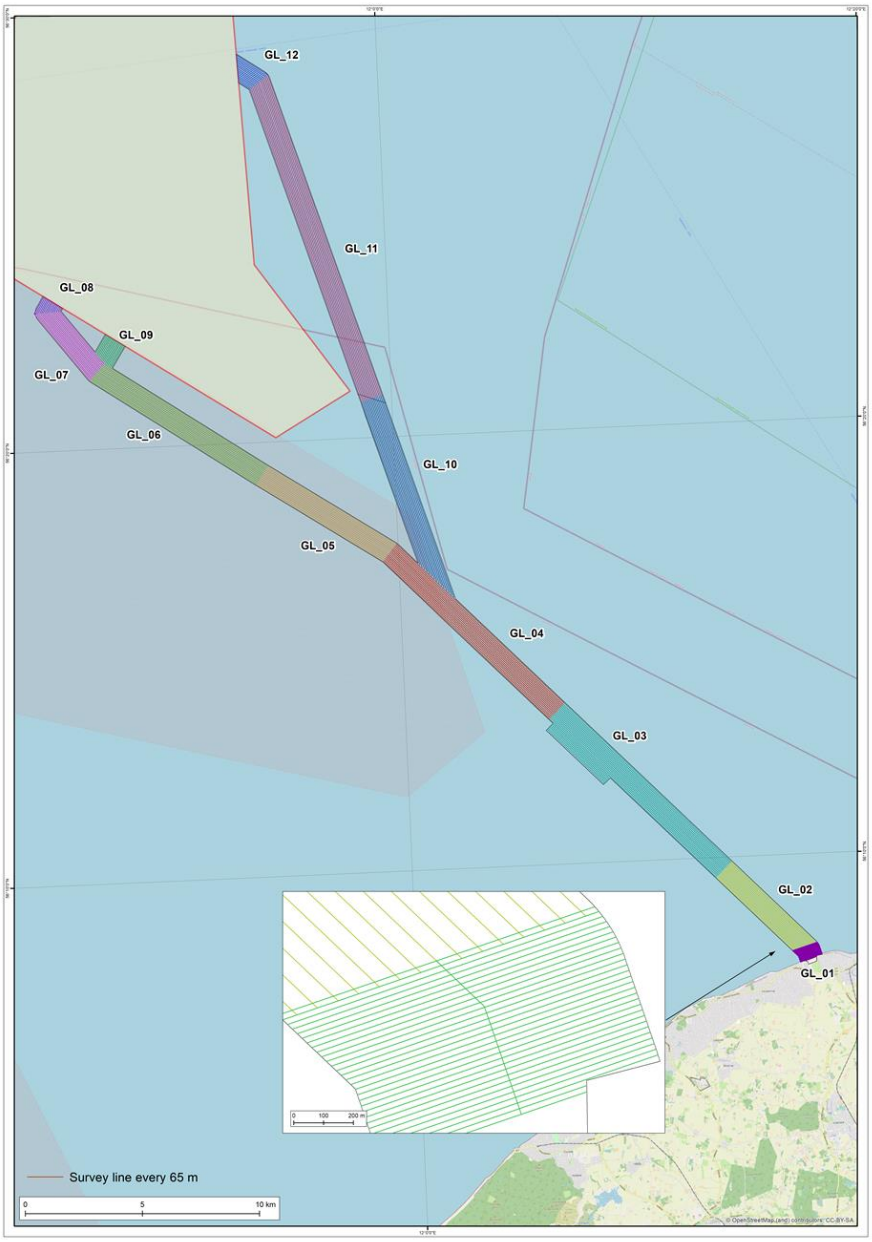

Figure 3-3 Survey area showing the sub-division into 12 sections with inserts showing planned line direction..

Lines was planned to ensure 100% MBES coverage inside the corridor. In section 2 to 12 (the offshore part) the survey lines were planned with a spacing of 65m with one centerline and 7 wing-lines to each side giving a total of 15 planned lines.

The shallow survey was conducted with a total of 38 lines with a line spacing ranging from 5 to 20m. A total of 18.65 line km was acquired as part of the shallow survey.

During acquisition data was QC'd online for sound velocity, standard deviation, RTK signal, coverage and density.

An overview of the dates for the different survey activities are listed in Table 3-3.

Table 3-3 Acquisition summary

Task – WP D	Period Offshore survey	Period shallow survey
Mobilization	02-09-2021	09-09-2021
Calibration	05-09-2021	10-09-2021
Survey	06-09-2021 to 13-09-2021	10-09-2021
Demobilization	15-09-2021	10-09-2021

4. TECHNICAL SETUP AND CALIBRATION

Prior to the commencement of survey operations all equipment was installed and calibrated to ensure optimum performance. A report of the acceptance tests was produced to cover the relevant pre-survey procedures, see Appendix 2. The Acceptance Test report covers all tests and calibrations made during the initial procedures.

Instrument checks were performed for the following equipment.

- DGNSS positioning system: Checking position and height.
- Gyro and motion sensor unit: Checking installation angles and calibrating heading.
- Multibeam echo sounder: Calibrated for heading, pitch, roll and time delay.

4.1 Geodetic parameters

The used reference coordinate system and height system is shown in Table 4-1.

Table 4-1 Geodetic parameters

Geodetic datum	ETRS89
Projection	UTM, Zone 32 N
Vertical datum	DTU18 MSL

4.2 Positioning

All positions were received with RTK corrections. The GPS data were recorded in the EIVA software *NaviPac* or *QPS Qinsy*, depending on the vessel, which calculated the offset coordinates of the sensors on board the vessel. At the same time the quality and accuracy of the coordinates was monitored.

During the survey, all navigation data were recorded at 1 Hz rate. Accurate positions and heights for the MBES sensor was calculated and corrections for roll, pitch, and heave at the sensor location were applied during all survey operations.

4.3 Sensor Offsets

For both survey vessels all offsets (X, Y, Z) between each sensor and the vessel reference point (RP) were measured, recorded and put into the navigation computer before start of survey. The vessel RP was placed at the center of gravity of the vessel, the vessel heading offset, the position of the MBES transducer head and the Primary GNSS antenna was also determined prior to survey.

4.4 Gyro and motion sensor unit setup (IMU – Inertial Motion Sensor Unit)

The equipment used are listed in Table 3-1 and Table 3-2. The motion sensor provides the true heading i.e., the heading with respect to geographical north. The pitch, roll and heading readings acquired by the instruments was calibrated with values measured during a patch test prior to commencement of the survey. While surveying, all motion sensor data were logged into a combined file with the raw multibeam data.

4.5 Multibeam echo sounder

On the Mintaka I The Teledyne Reson seabat T50 multibeam echo sounder was pole mounted. This MBES instrument emits 1024 beams and has a maximum swath angle of 220 degrees.

A pole mounted system was also applied on the Rambunctious. The Norbit iWBMSh emits 512 beams and has a maximum swath angle of 210 degrees.

The multibeam data were monitored by viewing the recorded DTM online for efficient quality control. Also, during the survey point clouds and DTMs could be exported for further QC.

4.6 Sound Velocity Profiles

In order to obtain valid underwater positioning as well as multibeam echo sounding, accurate measurements of the sound velocity in the water was required at least every 6^{th} hour. An AML Minos X and a SWIFT SVP was used on this survey to record the sound velocity profile. The probe was cast manually during operations. The sound velocity was entered into the recording/processing software.

5. DATA PROCESSING

5.1 Shallow water survey

PosPac was used to process the navigation data. This provides highly accurate positioning and orientation. Here the PP-RTX method is used which is a multi-frequency GNSS positioning technology.

Processing of the raw multibeam echo sounder data was performed by *Ramboll* using the software NaviEdit and NaviModel. Mewo used AutoClean processing software. Figure 5-1 shows the bathymetric processing workflows for shallow survey.

Figure 5-1 Workflow for the MBES processing in NaviEdit.

The processing steps in NaviEdit comprises the application of sound velocity profiles, header editor and filtering of data. Sound velocity profiles were measured regularly during the survey and a linear temporal interpolation was made between each sound velocity profile. Subsequently, a manual spike cleaning was performed in NaviModel using state of the art cleaning tools like the S-CAN algorithm.

For the Autoclean process the following was done. Raw bathymetric data was loaded into AutoClean. The POSPac derived SBET files was applied for post processed position and motion. This was then merged into the raw MBES files in AutoClean.

Figure 5-2 Workflow for the MBES processing in AutoClean.

An AutoClean profile tool was used to examine cross sectional profiles of the surface. All the above was created to assess that the MBES data met the requirement for density, and positional accuracy. At this point any issues were corrected, including tidal errors/spikes, quality of navigation and attitude and any obvious errors in sound velocity. Special attention and manual cleaning was paid to areas around significant features.

Preliminary 0.5m gridded surface with the following attributes: mean depth, sounding density and a TVU using a 95% Confidence level surface of the soundings was generated. This surface was exported as a 0.5m tiff to show the extents of the MBES coverage.

After processing the deliverables were exported using GlobalMapper. See Table 8-1 for the digital deliverables submitted with this report.

6. DATA QUALITY

The acquired multibeam echo sounder data was in several offshore sections affected by noise possibly relating to the presence of thermoclines. This issue is further discussed in section 6-2 below. The remaining data is mainly of good quality.

6.1 Accuracy and estimates of spatial uncertainty

The accuracy of the different equipment is tested in the Acceptance Test Reports. The uncertainties can be seen in Table 6-1.

Table 6-1 Uncertainties of the MBES system for WP D found during the acceptance test.

Equipment	Easting [m]	Northing [m]	Depth [m]
MBES (Mintaka I)	0.004	0.01	0.02
MBES (Rambunctious)	0.076	0.078	0.006

The accuracy depends on the combined uncertainties of all elements in the process. E.g. the accuracy of the bathymetry is affected by the combined uncertainties of the following processes: i) height of reference position of vessel by GNSS RTK, ii) roll and pitch of vessel recorded by motion sensor, iii) vector from reference point to multibeam transponder, iv) mounting angles of multibeam transponder, v) timing accuracy in the combination of position, angles and data stream from transponder.

Uncertainties can be estimated a-priori by calculating Total Propagated Error, TPE. The contributions from the separate processes are combined based on an assumption of uncorrelated and normal distributed errors. A-posterior estimates are derived for the DGNSS positioning and the bathymetry.

Besides the instrumental uncertainty results are affected by the natural variability of the seabed; few surfaces in nature are smooth. The representation of this natural variability must be added to the instrumental uncertainty.

Error contributions from various sensors and processes are shown in Table 6-2.

Table 6-2 Bathy error contribution from separate sensors and processes for Rambunctious

System	Vertical Error	Horizontal Error	Source
GPS Positioning	0.02 m	0.02 m	Estimate
Gyro heading		$0.02° \rightarrow r^{1)} \times$ *tan*$(0.02°)$	Specifications
Motion sensor	$0.03° \rightarrow r \times$ *tan*$(0.03°)$	$0.03° \rightarrow r \times$ *tan*$(0.03°)$	Specifications
Echosounder transducer	0.01 m		Estimate
Pole movement	0.05 m	0.05 m	Estimate

1) *r denotes radial distance to bespoke sensor*

Table 6-3 Bathy error contribution from separate sensors and processes for Mintaka I

System	Vertical Error	Horizontal Error	Source
GPS Positioning	0.01 m	0.01 m	Estimate
Gyro heading		$0.03° \rightarrow r^{1)} \times$ *tan*$(0.03°)$	Specifications
Motion sensor	$0.04° \rightarrow r \times$ *tan*$(0.04°)$	$0.04° \rightarrow r \times$ *tan*$(0.04°)$	Specifications

Echosounder transducer	0.01 m		Estimate
Pole movement	0.05 m	0.05 m	Estimate

[1)] *r denotes radial distance to bespoke sensor*

By combination of the above separate error contributions the total propagated error, TPE, can be estimated for the resulting data products: The bathymetry, the sonar gram etc. Calculated Total Propagated Error is presented in Table 6-4. The calculation assumes each error source independent and normally distributed. Thus, the variance of the sum of the error distributions equals the sum of the variances: $\sigma_{\sum i^2} = \sum \sigma_i^2$.

Table 6-4 Calculated TPE for the bathymetry

Data type	Vertical TPE	Horizontal TPE
Bathymetry (Mintaka I)	0.07	0.06
Bathymetry (Rambunctious)	0.08	0.07

In addition to the theoretical calculation of the obtainable accuracy it is important to observe the fact that any acoustic ranging to the seabed has a certain acoustic 'foot print' on the seabed and the result of the measurement depends in a complicated way of the average within this foot print. For this reason, there is a lower limit to the accuracy of acoustic ranging. This is estimated to be comparable to the short-scale roughness of the seabed.

6.2 Noise in the offshore data

The acquired data is affected by refraction issues caused by sudden changes in the sound velocity through the water column. The refractions affect the acquired MBES on the outer beams and causes jumps between survey lines. In almost every profile a variation of the sound speed values is noticeable. Example of the sound velocity changes can be seen in Figure 6-1. During the post-processing attempts of reducing the refractions by using filters, reducing the opening angle and by sound velocity inversion tools was made. However, using these methods did only show some improvement at certain locations.

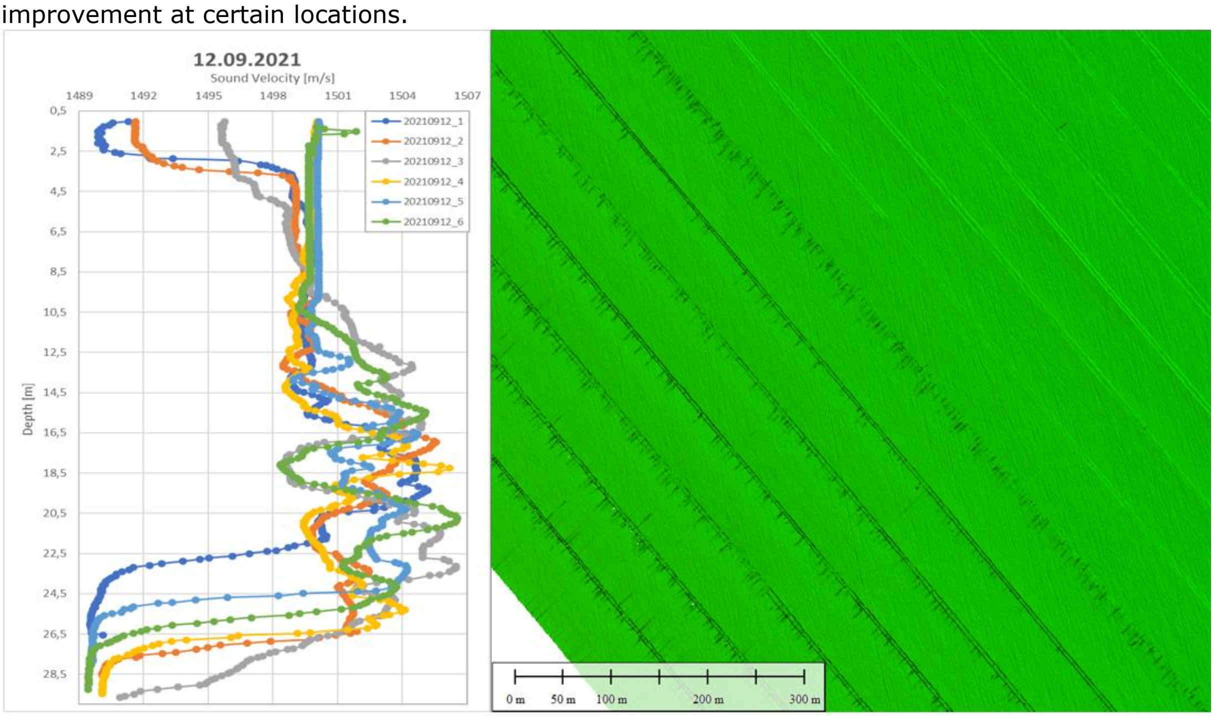

Figure 6-1 Example of the sound velocity that shows a sudden change in speed around 23m water depth. The right image shows the gridded average surface where refractions are visible at line edges.

6.3 Data quality

The data quality complies with IHO order 1a and for most cases also IHO special order. See Appendix 2 including operation reports that describes the data quality further. The statistics for each survey section can be seen in Table 6-5. Table 6-6 outlines the IHO order 1a requirements.

Table 6-5 data quality statistics for each survey section

Section	Data density [ping/m²]	Standard Deviation 95% [m]	Mean THU [m]	Mean TVU [m]	Max. allowable TVU for mean depth [m]
GL_01	406	0,06	0,56	0,086	0,51
GL_02	135	0,05	0,79	0,094	0,53
GL_03	50	0,05	1,23	0,129	0,58
GL_04	47	0,03	1,17	0,130	0,63
GL_05	69	0,04	1,19	0,017	0,63
GL_06	63	0,04	1,21	0,144	0,63
GL_07	41	0,03	1,16	0,022	0,61
GL_08	44	0,03	1,15	0,137	0,60
GL_09	43	0,04	1,20	0,130	0,62
GL_10	50	0,04	1,18	0,123	0,64
GL_11	50	0,05	1,21	0,133	0,66
GL_12	39	0,03	1,24	0,125	0,66

Table 6-6 IHO order 1a requirements

Max. allowable THU (95% confidence level)	5 meters + 5% depth
Max. allowable TVU (95% confidence level)	a= 0,5 m b= 0,013
Feature Detection	Cubic features > 2 m, in depths down to 40 m; 10% of depth beyond 40 m
Fixed Objects, Aids, Features Above the Vertical Reference Significant to Navigation	THU – 2 m TVU – 0,5 m

Figure 6-2 and Figure 6-3 shows standard deviations for the nearshore section, GL02, and for the offshore section GL06. The standard deviation (95%) grid does mainly not show values above 20-30 cm. High standard deviation are mainly caused by boulders.

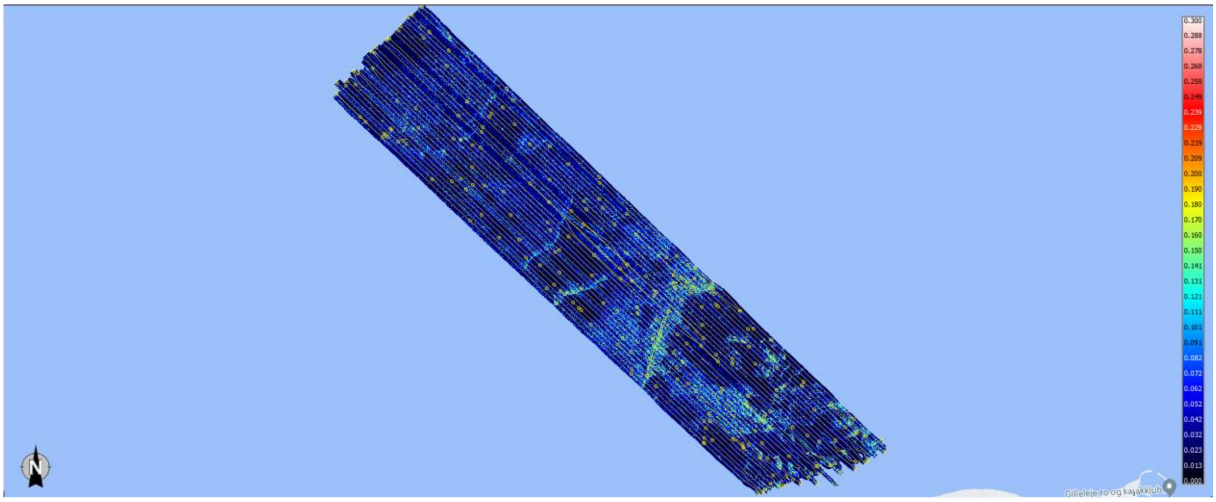

Figure 6-2 Standard deviation of the nearshore section, GL02

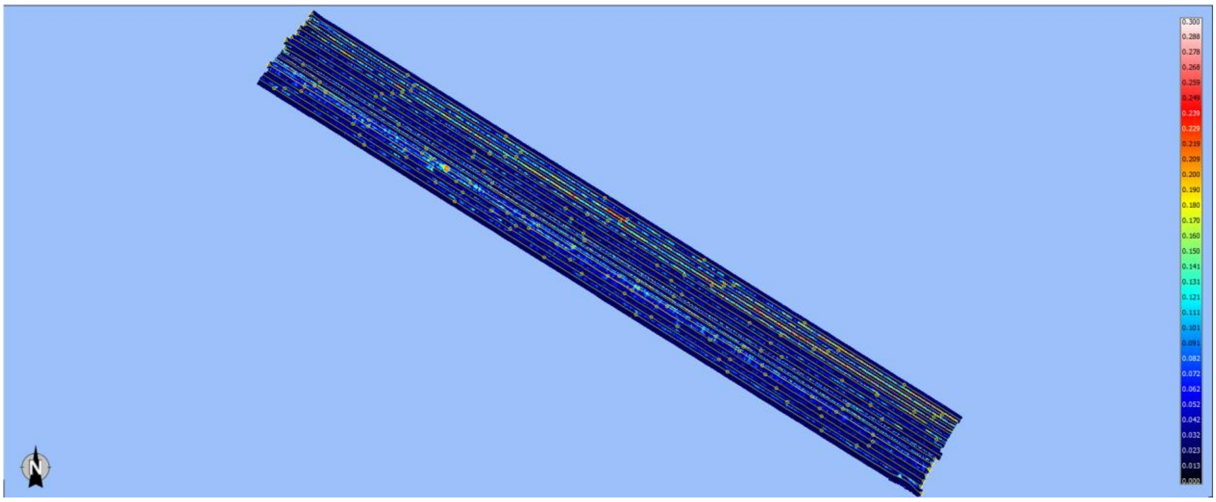

Figure 6-3 Standard deviation of the nearshore section, GL06

7. RESULTS

The results in the below sub-sections are also shown in the North-Up Charts included in Appendix 3.

7.1 2021 Bathymetry

The following sub-section provides seabed elevation profiles along the mapped survey corridor. Figure 7-1 to Figure 7-3 show the bathymetry within the survey area with water depths ranging from -0.1m to -37.4m. Figure 7-4 to Figure 7-6 displays the elevation profiles along the centerline.

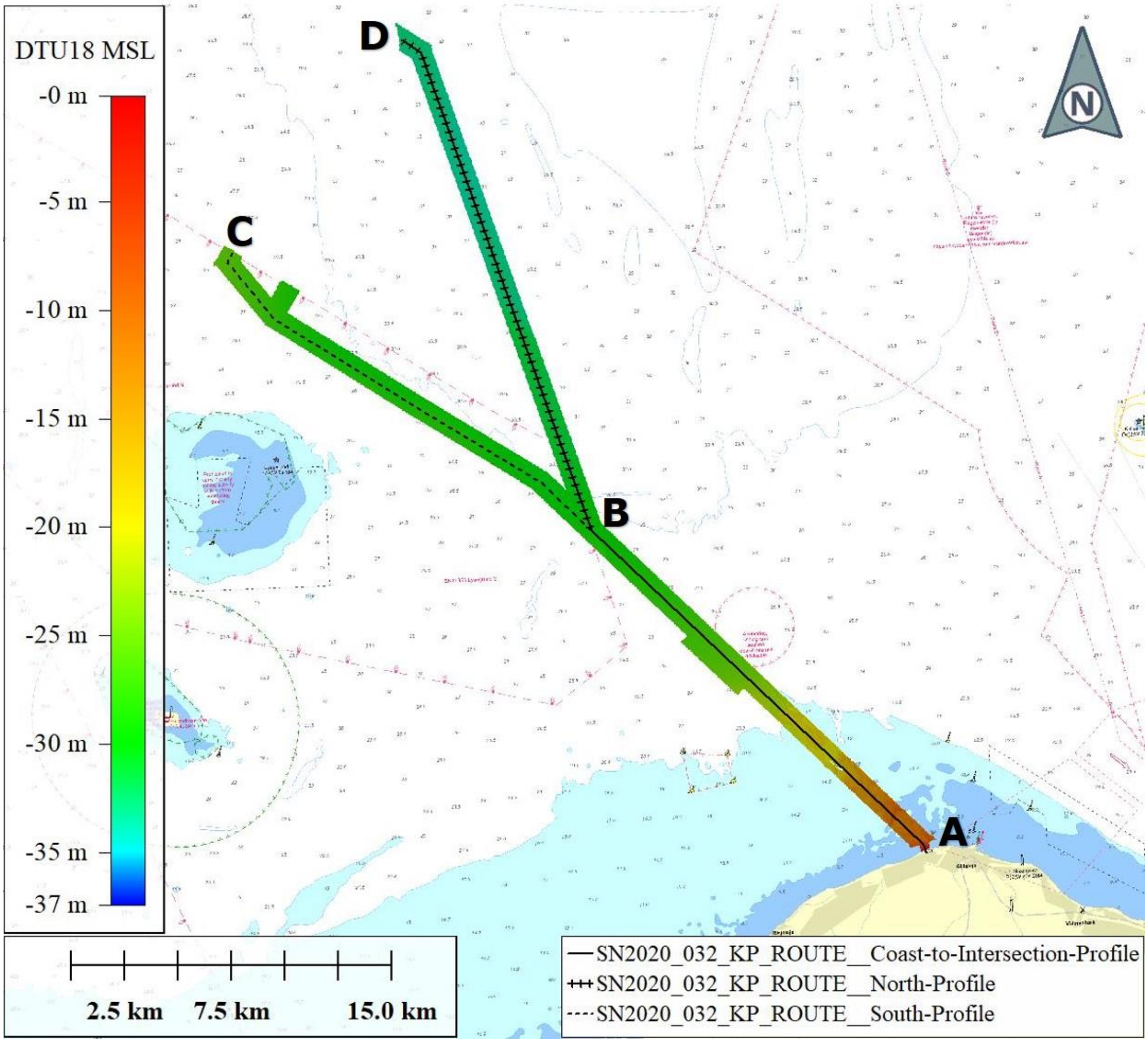

Figure 7-1 2021 acquired bathymetry

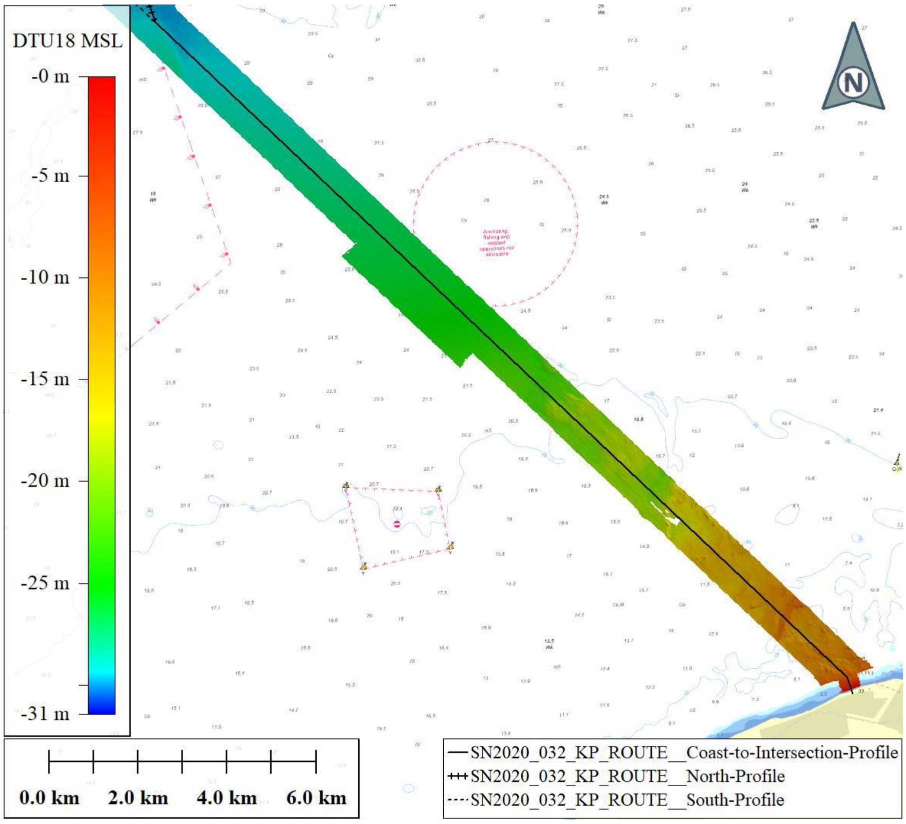

Figure 7-2 2021 acquired bathymetry from the coast to the intersection between the eastern and western arm.

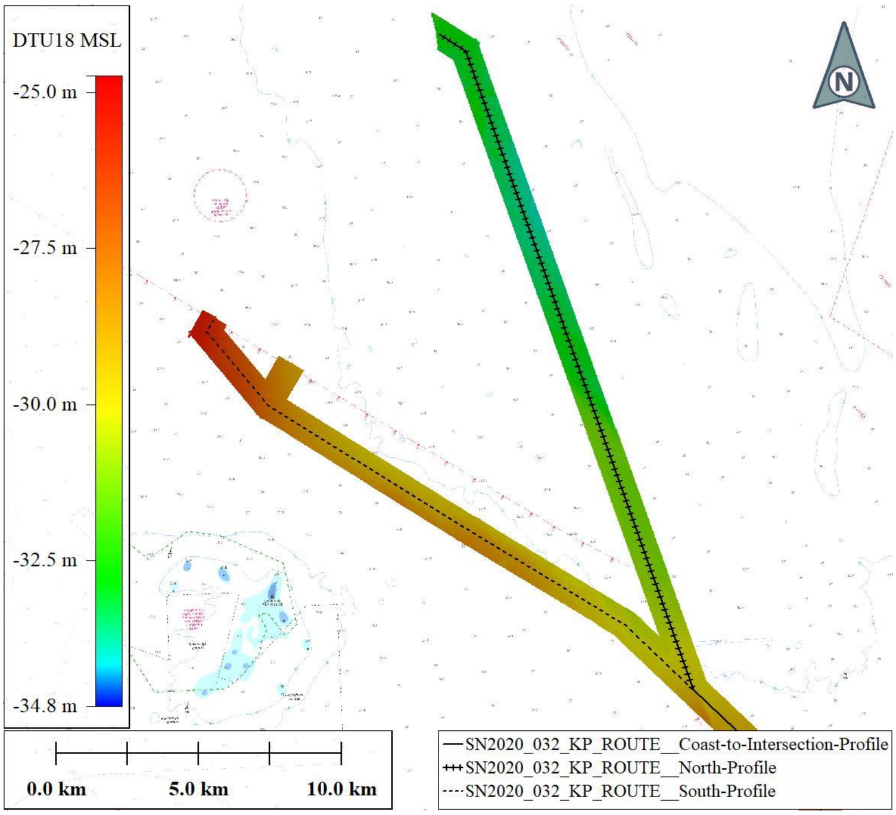

Figure 7-3 2021 acquired bathymetry from the intersection point along the eastern and western arm.

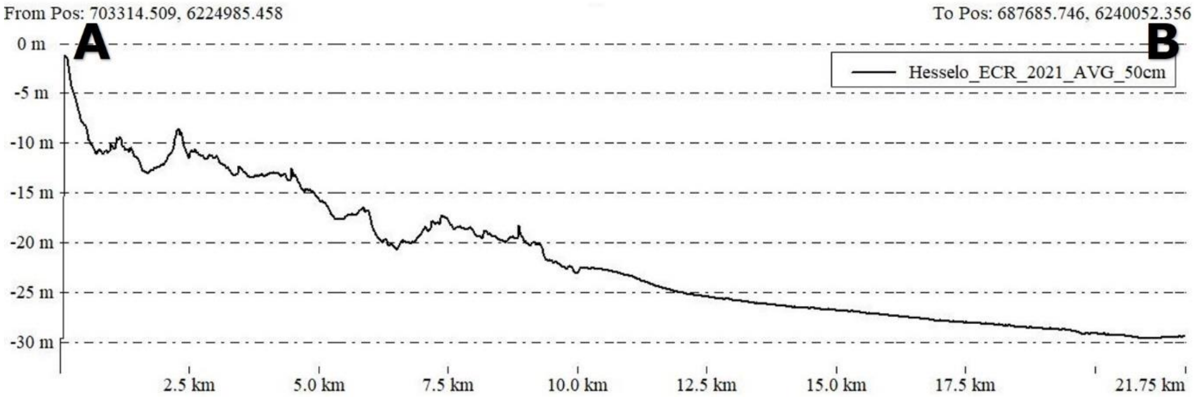

Figure 7-4 Seabed elevation profile from the coast to the intersection point between the eastern and western arm.

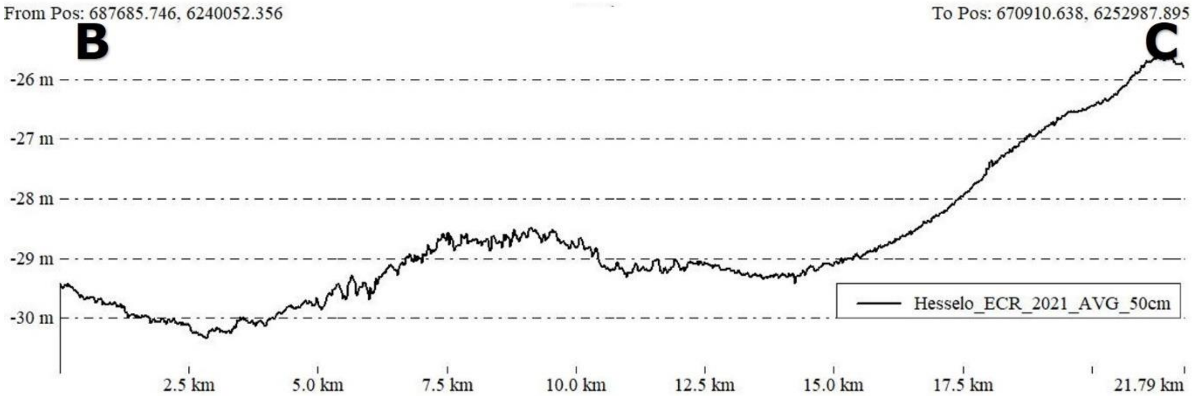

Figure 7-5 Seabed elevation profile along the western arm, from the intersection B-point.

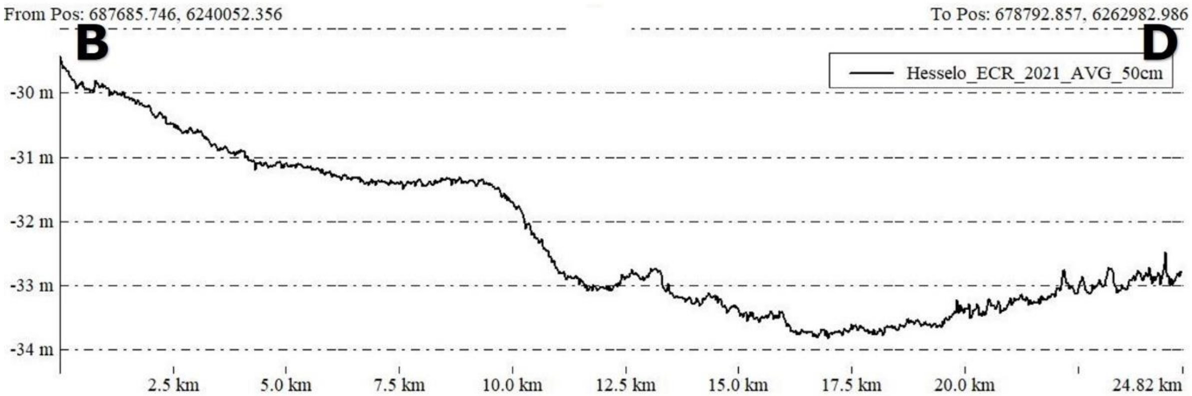

Figure 7-6 Seabed elevation profile along the eastern arm, from the intersection B-point.

7.2 Bathymetry comparison (2020 & 2021)

The following sub-section provides a comparison between 2021 and 2020 datasets. Firstly, by assessment of the difference plot along the planned cable route, followed by their contrast at specific locations.

7.2.1 Difference plots (2020 & 2021)

Figure 7-7 shows an overview of the bathymetric differences. The differences fluctuate between -1.5m to 1.5m. A detailed evaluation of the data variation is shown in Figure 7-8 histograms. Profiles were also created along the centerline; see Figure 7-9 to Figure 7-11.

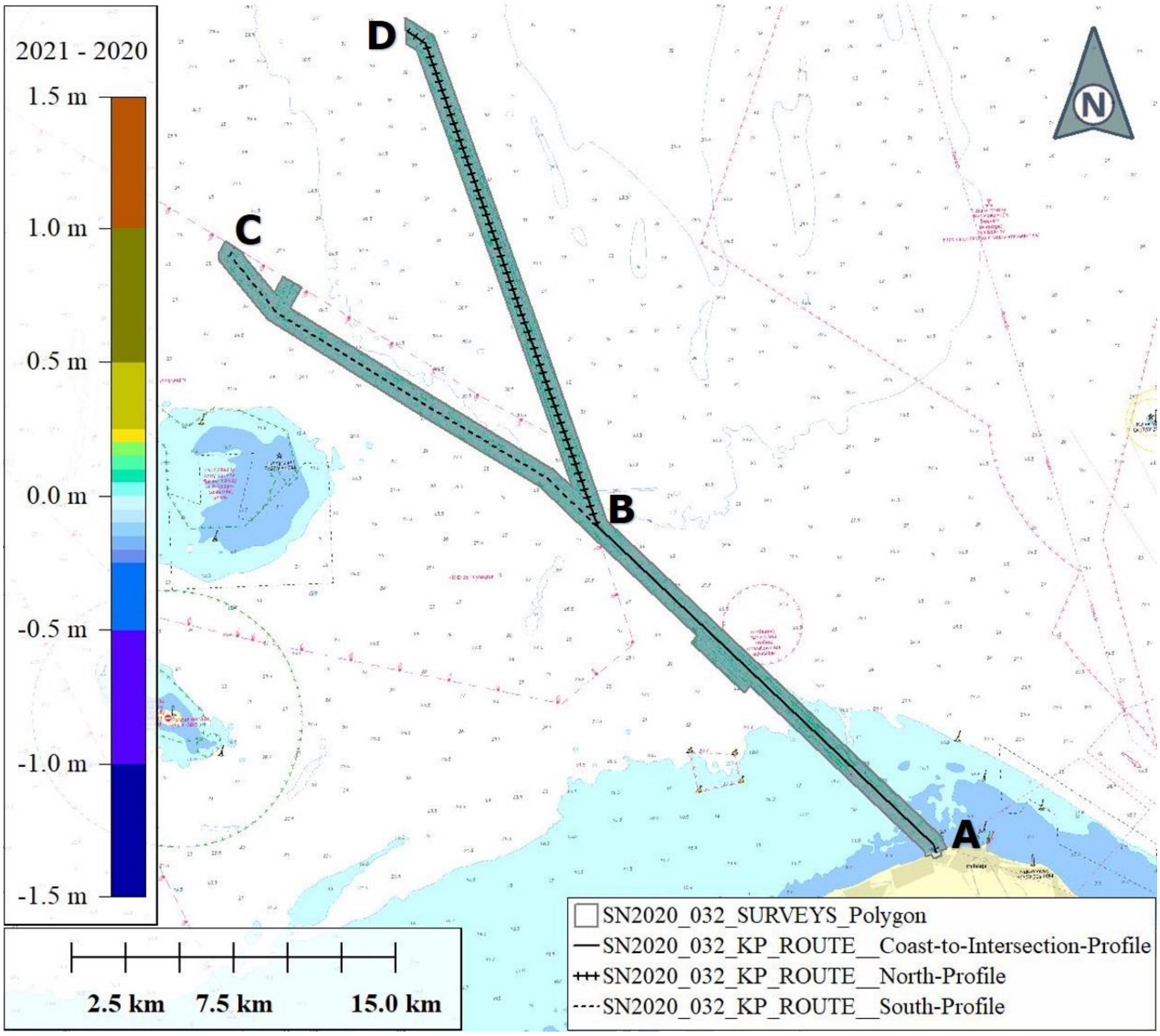

Figure 7-7 Difference 2021 – 2020 datasets with an overview of the three profiles areas along the cable routes.

By comparing the 2021 survey with 2020 data a slight accretion of sedimentation is observed. Figure 7-8 shows how the difference in data is mainly located between -0.2m to 0.2m. However, within this range, 52.6% is among 0m to 0.12m whereas 45.0% is between 0m to -0.12m.

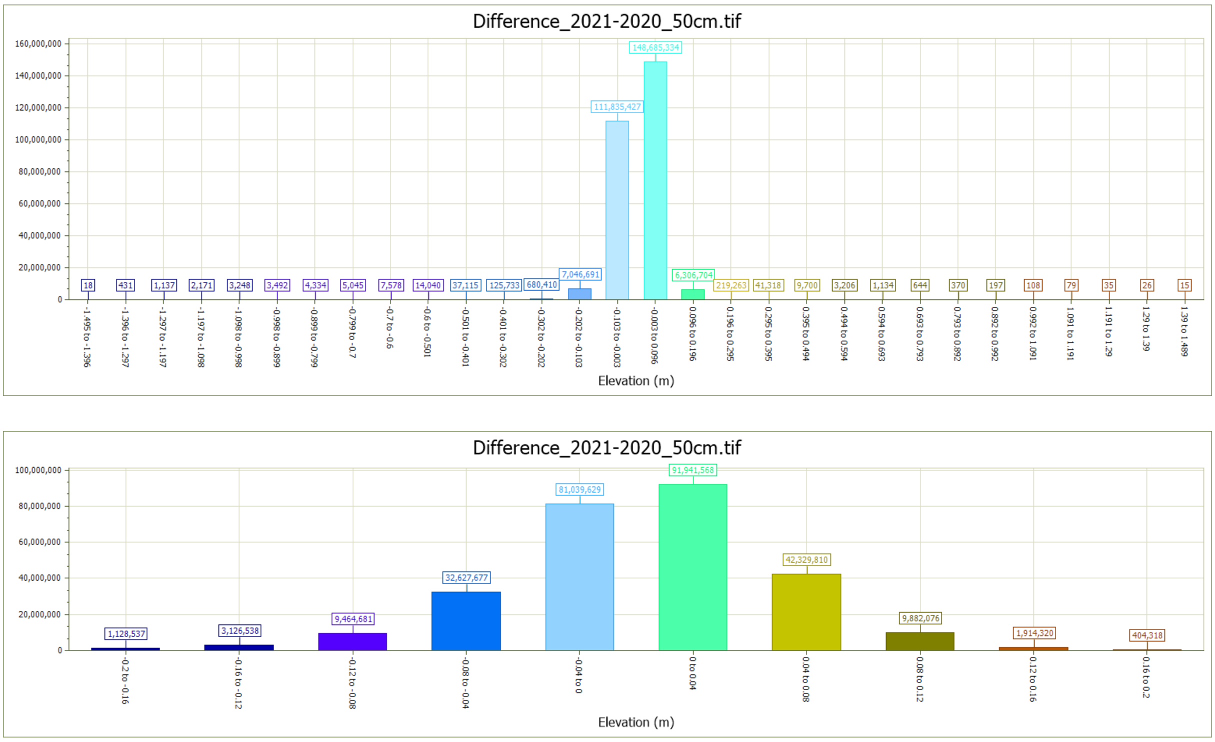

Figure 7-8 2021-2020 difference-histograms. Above, along the entire grid, and below; for between -0.2 to +0.2 m. Negative values indicate erosion whereas positive are related to accretion of sediment.

The below profiles show the differences in 3 sections along the center line. Variations of 0.03m to 0.1m are mainly seen in the figures, with some outliers along the lines. Erosion areas close to the coast and at the end of the south and north routes are visible, with few centimeters of accretion along most of the surveyed area.

Figure 7-9 shows mainly erosion values up to 0.2m around the coast area and further to the coast, an average accretion of 0.03m with a maximum accretion of 0.1m until the intersection point between the eastern and western arm. From this point, toward the south, Figure 7-10 shows an average accretion of 0.03m with local maximum accretion areas of 0.1m. However, from the intersection towards the eastern arm, Figure 7-11 shows an average erosion of 0.05m with a maximum erosion of 0.15m.

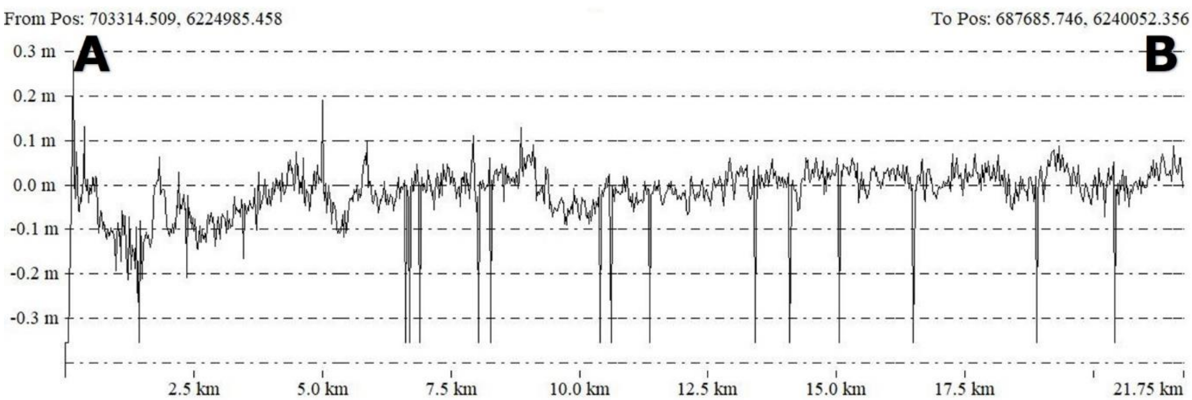

Figure 7-9 Difference 2021 – 2020 from the coast to the intersection point between the eastern and western arm. Negative values indicate erosion whereas positive are related to accretion of sediment.

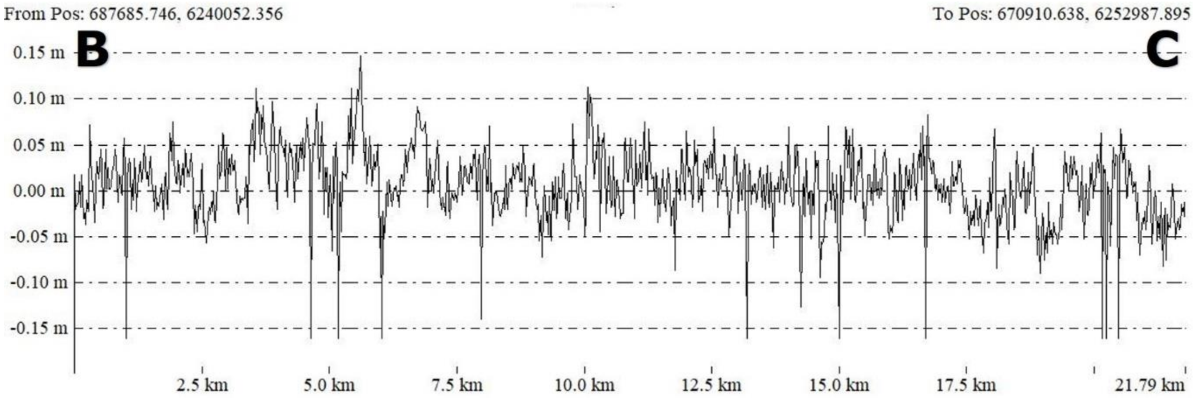

Figure 7-10 Difference 2021 – 2020 along the intersection and the south line. Negative values indicate erosion whereas positive are related to accretion of sediment.

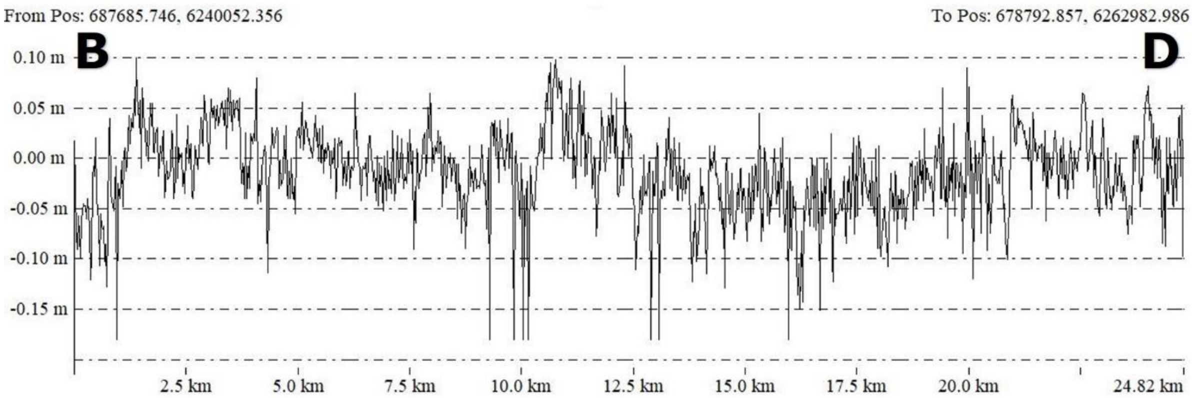

Figure 7-11 Difference 2021 – 2020 along the intersection and the north line. Negative values indicate erosion whereas positive are related to accretion of sediment.

The most conspicuous differences between 2020 and 2021 data are seen towards the landfall where large erosional areas can be observed. Whereas a minor accretion appears just after, see Figure 7.12. In the landfall areas erosion of up to 1.3m can be identified where few hundred meters further offshore accretion of up to 0.5m are seen.

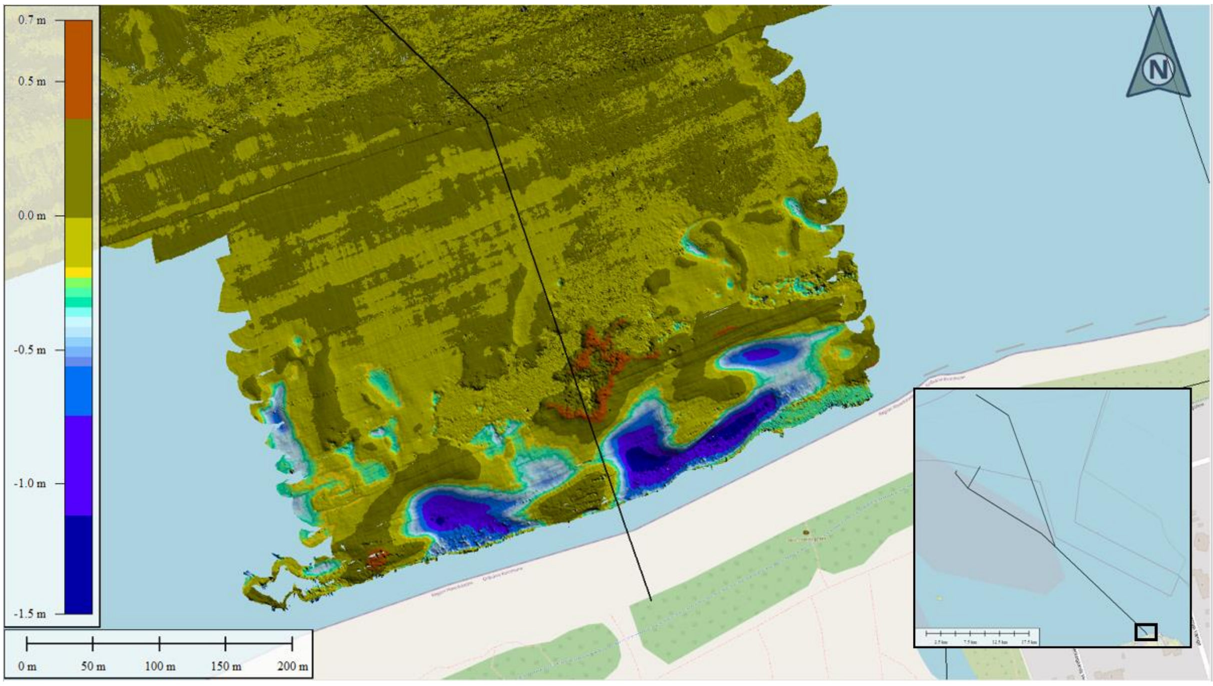

Figure 7-12 difference plot close to the shore. Accretion is positive values and erosion is negative values

7.2.2 Seabed Surface Features comparison (2020 & 2021)

As expected from the above sub-section, minor variations are seen between datasets around seabed features and up to 0.18m in some local areas; see Figure 7-13 to Figure 7-15.

Even though most anthropological seabed features remain unchanged in the 2021 survey, few new elements are visible across the new dataset, as seen from Figure 7-16 to Figure 7-19.

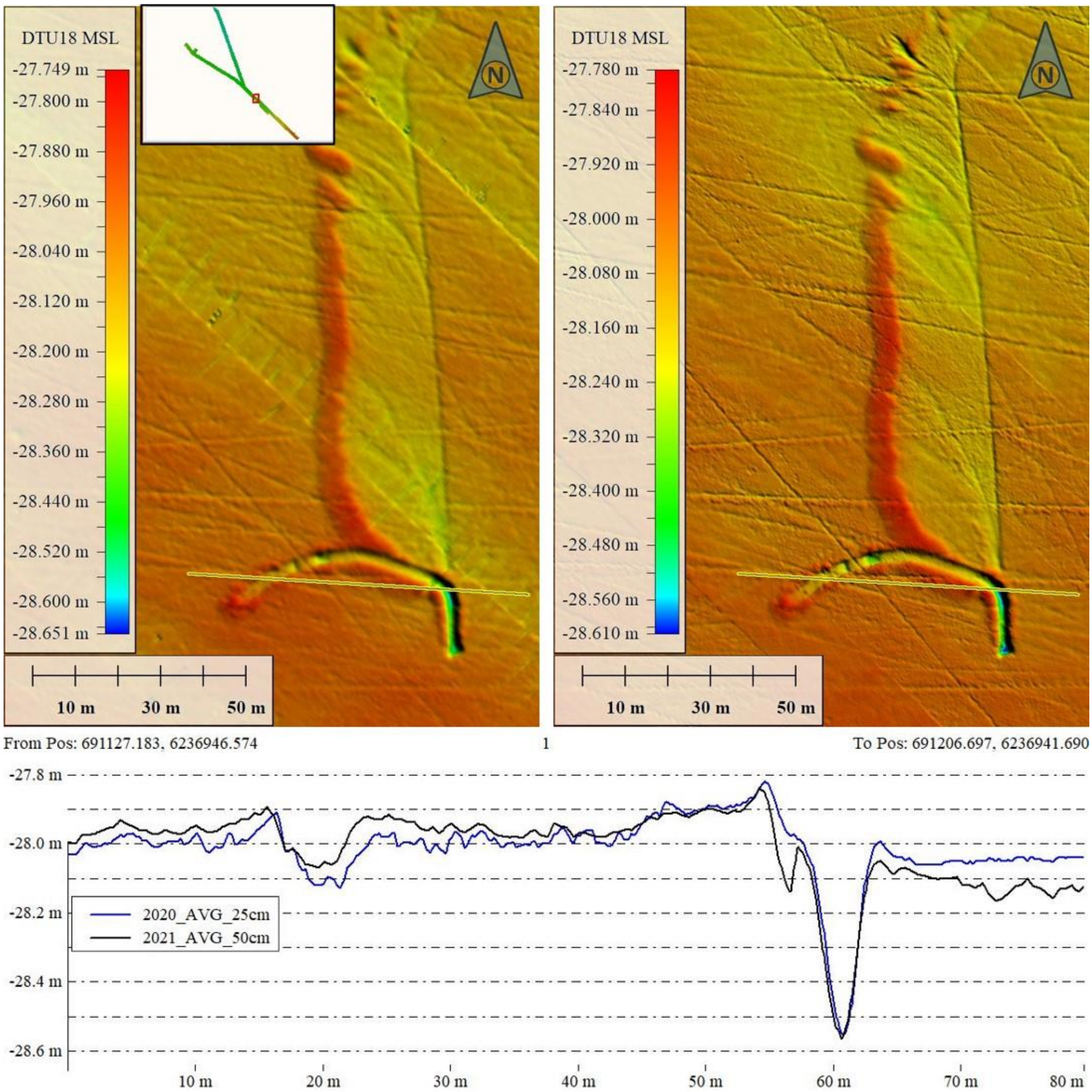

Figure 7-13 Survey comparison of a seabed feature example with depth profiles; 2021 (left) and 2020 (right). Minor data variations are seen between datasets and up to 0.18m in some local areas.

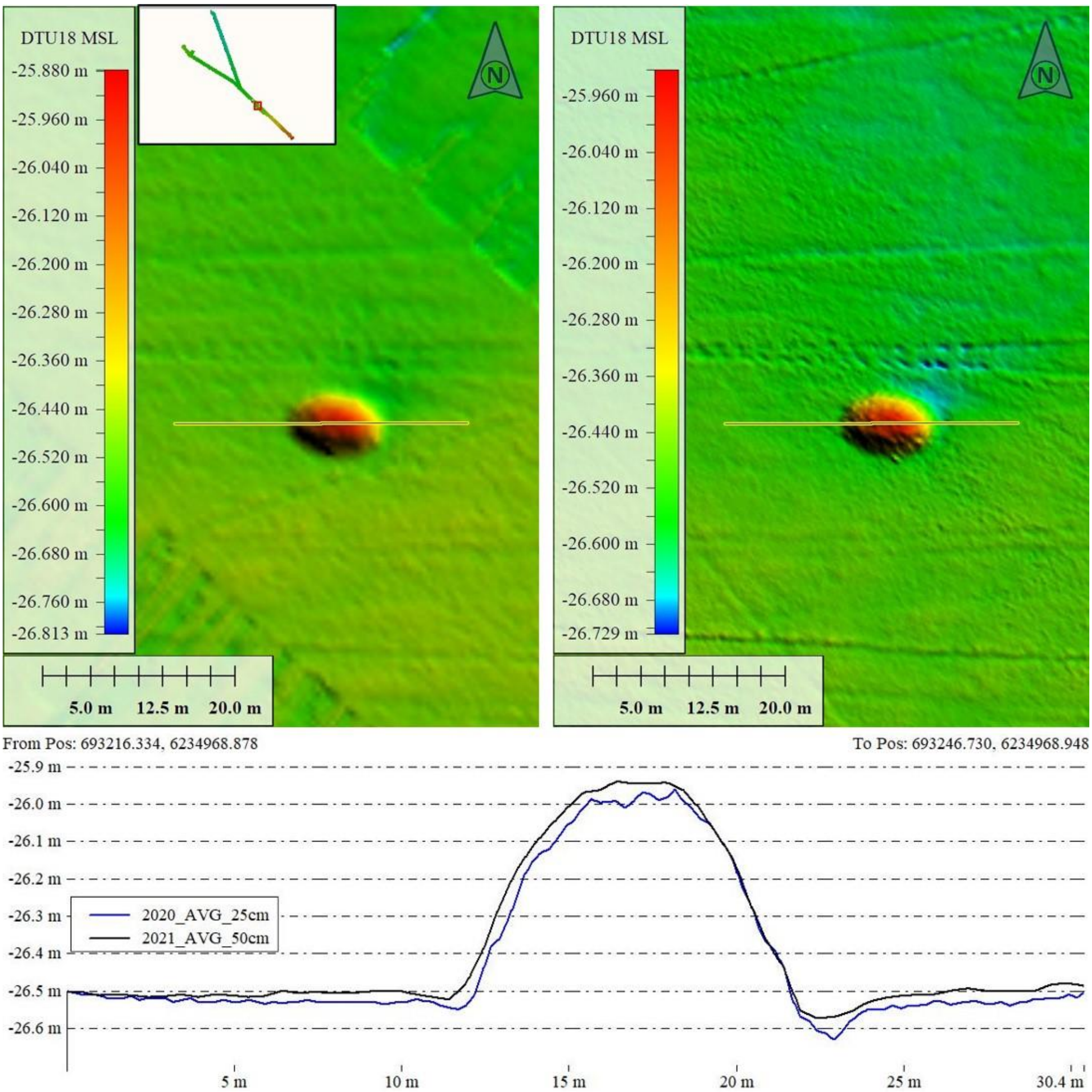

Figure 7-14 Survey comparison of a seabed feature example with depth profiles; 2021 (left) and 2020 (right). Minor data variations are seen between datasets and up to 0.06m in some local areas.

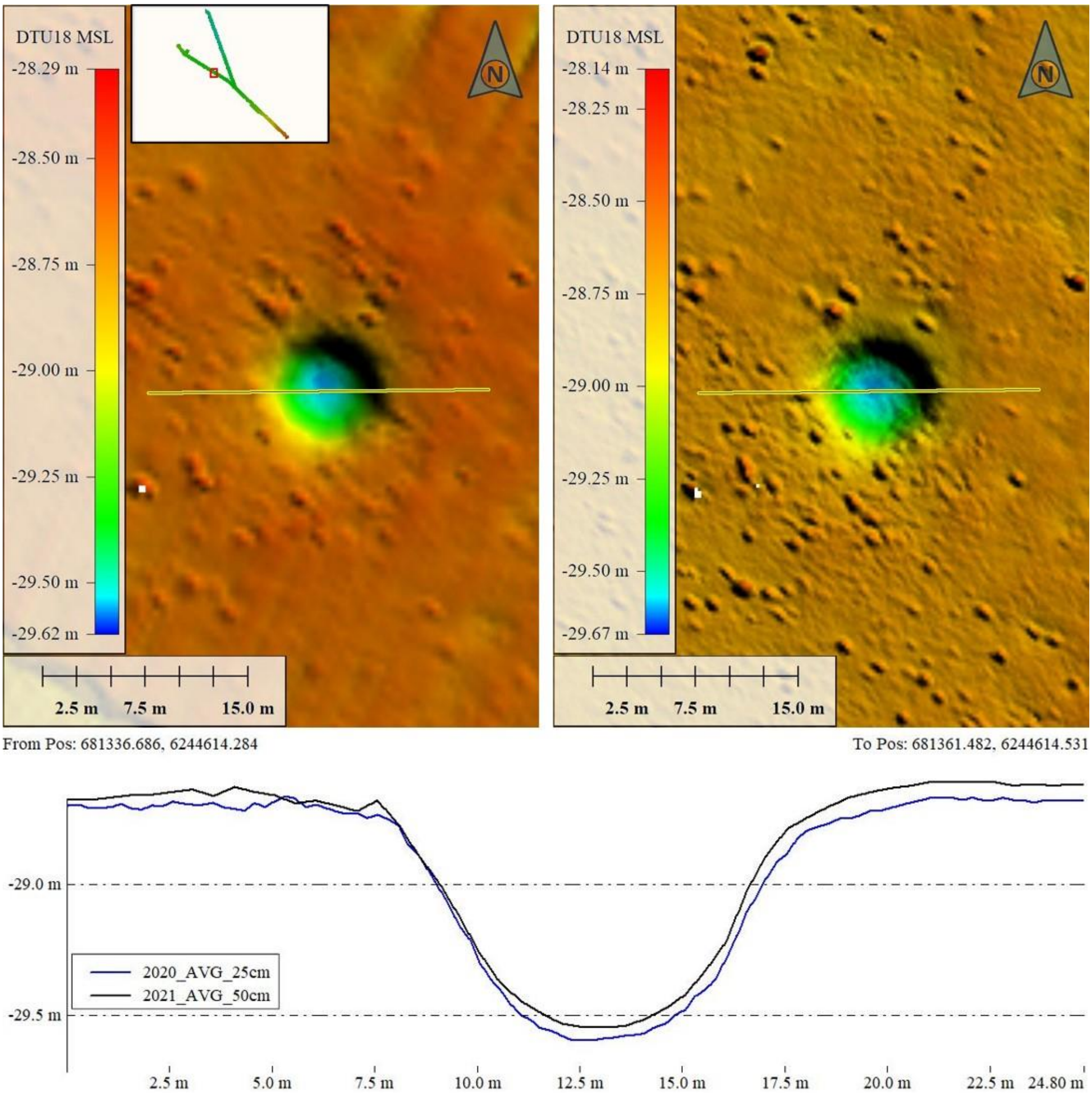

Figure 7-15 Survey comparison of a seabed feature example with depth profiles; 2021 (left) and 2020 (right). Minor data variations are seen between datasets and up to 0.07m in some local areas.

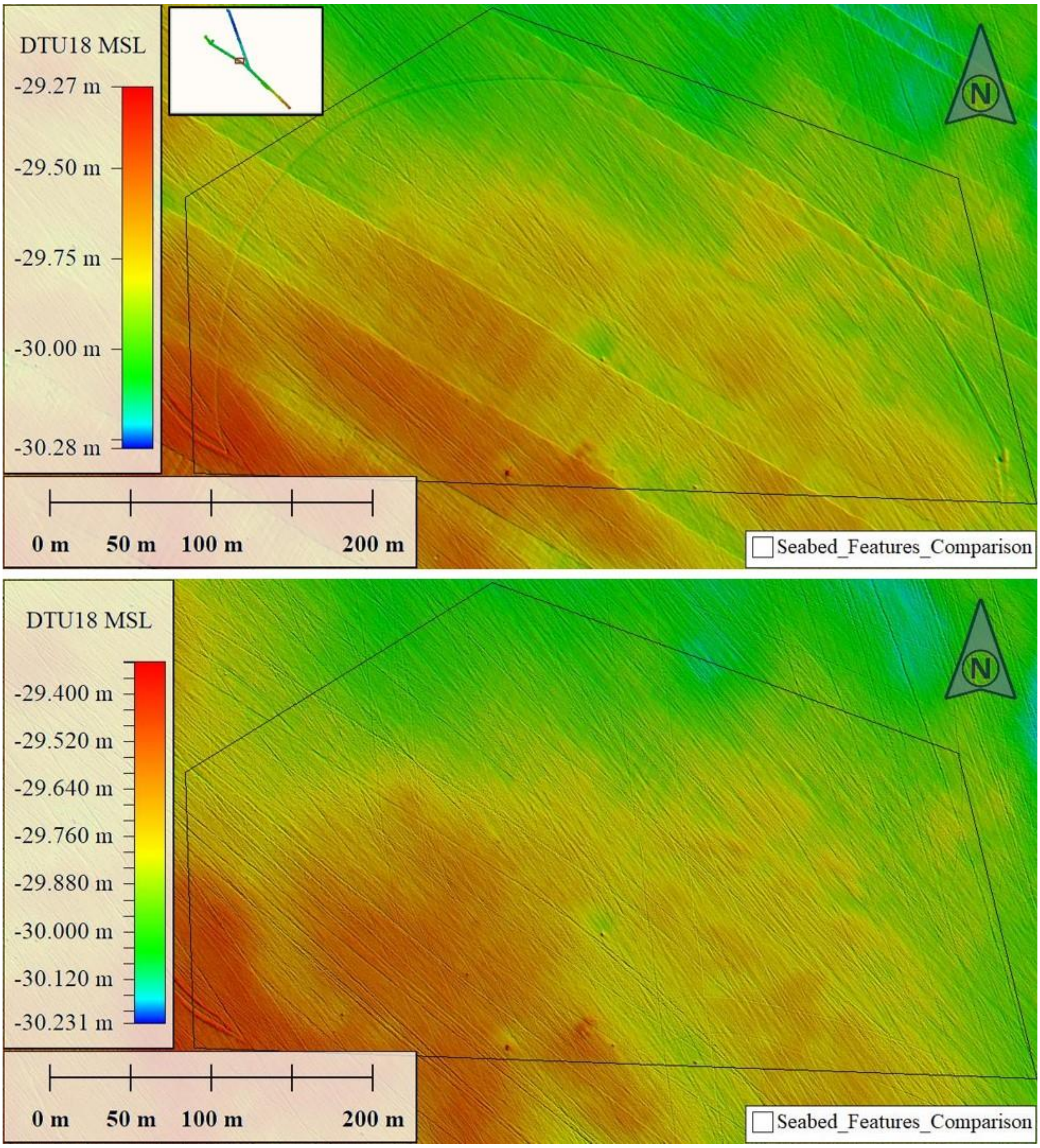

Figure 7-16 Survey comparison with new anthropological features appearing in latest survey (UTM 32N position: 683975.780 E, 6243381.321 N); 2021 (above) and 2020 (below).

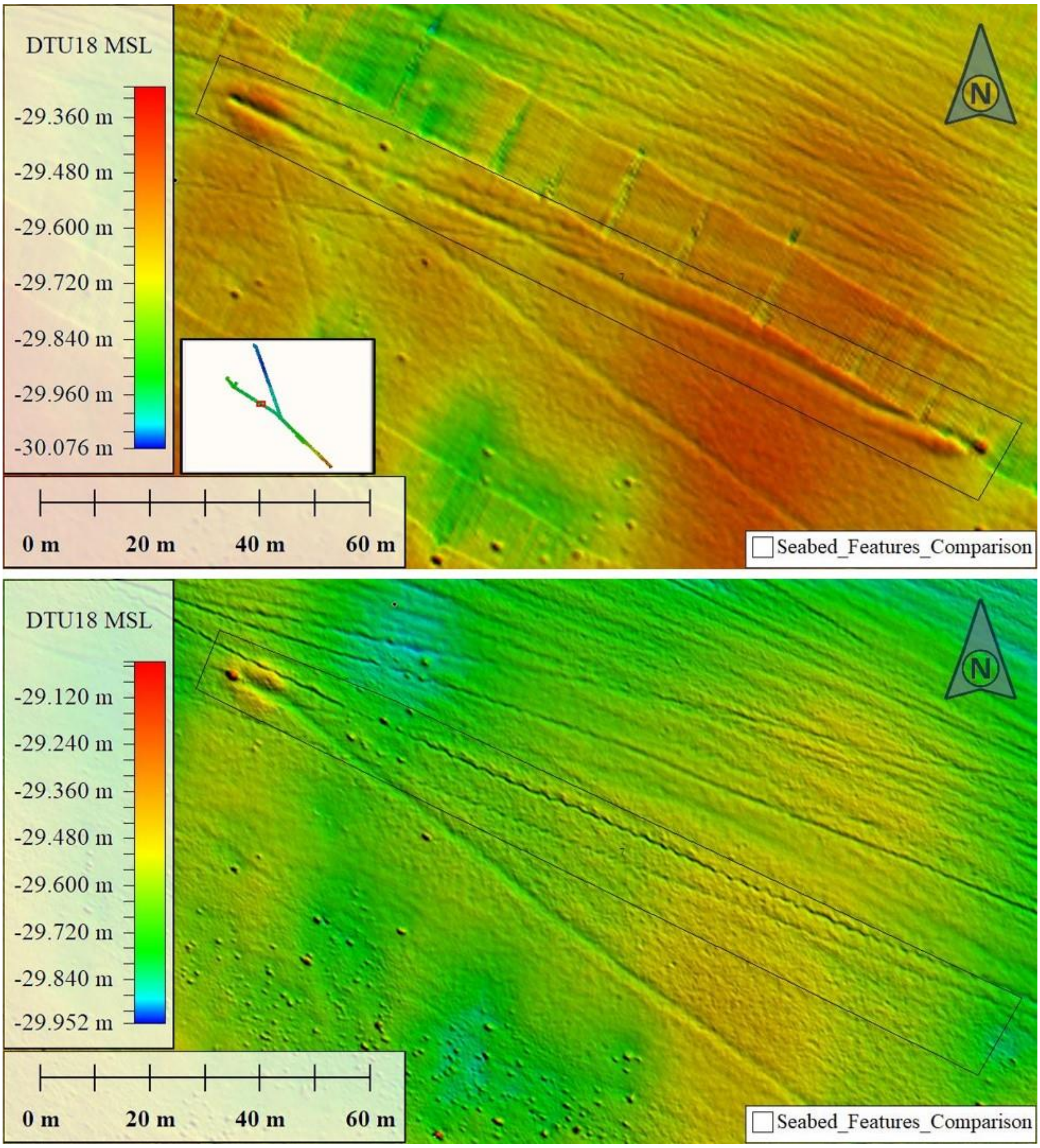

Figure 7-17 Survey comparison with new anthropological features appearing in latest survey (UTM 32N position: 681241.650 E, 6245241.935 N); 2021 (above) and 2020 (below).

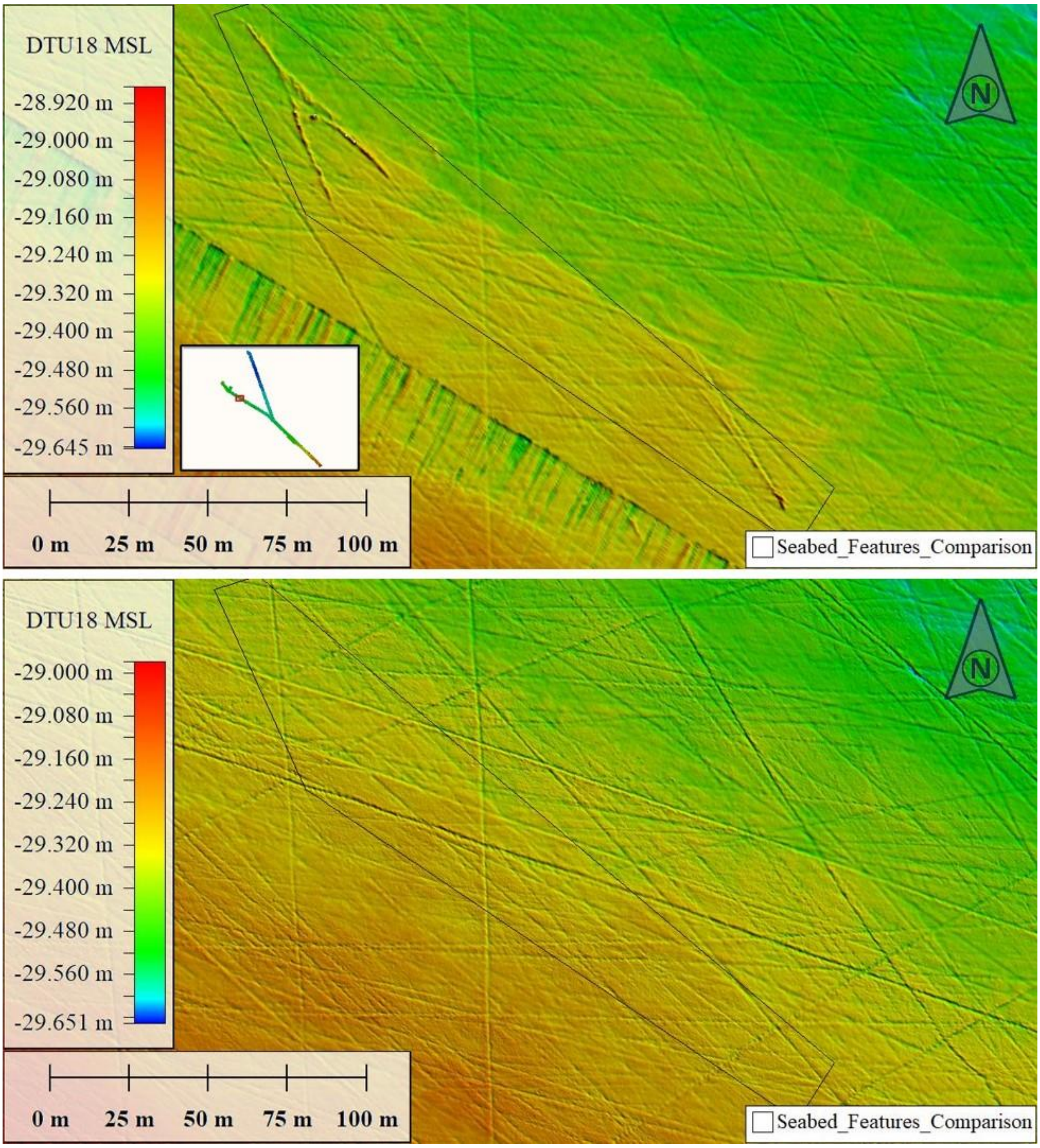

Figure 7-18 Survey comparison with new anthropological features appearing in latest survey (UTM 32N position: 676515.190 E, 6247715.486 N); 2021 (above) and 2020 (below).

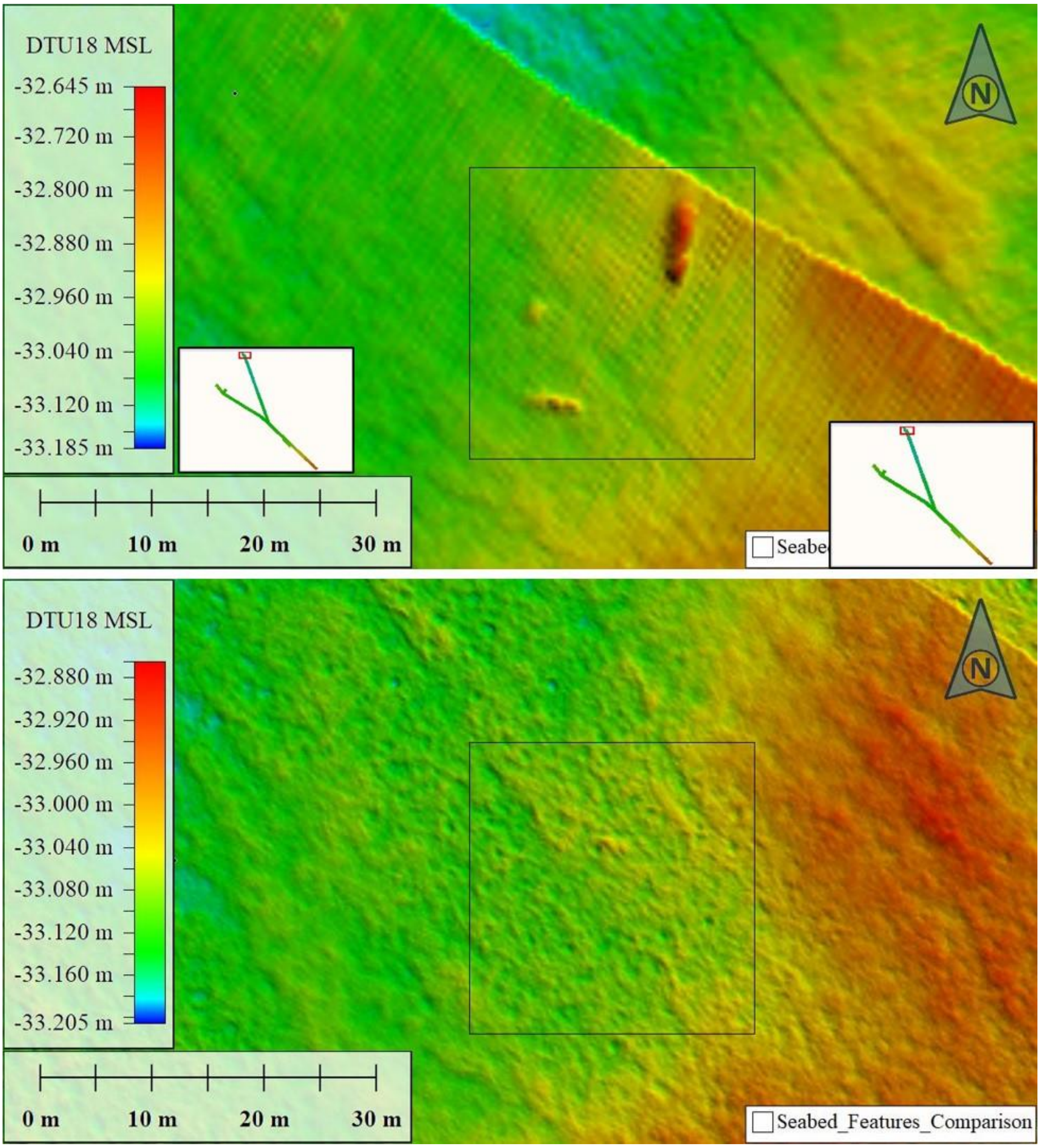

Figure 7-19 Survey comparison with new anthropological features appearing in latest survey (UTM 32N position: 680070.247 E, 6262767.607 N); 2021 (above) and 2020 (below).

7.3 Seabed sediment results from WP A & WP B (2020 campaign)

The following seabed sediment classes have been identified in the interpretation of the seabed surface geology:

- **Till/diamicton:** Mixed sediment type of glacial origin. Often covered by a thin layer of sand, gravel, boulder and/or sandy mud washed out of the till.
- **Gravel and coarse sand:** Mixed sediments of more than 0.50 m thickness. Lag sediments covering till, meltwater deposits or fossil coastal deposits.
- **Sand:** Homogeneous layer of loose, well-sorted sand.
- **Muddy sand:** A mixed sediment type composed of variable content of sand and mud. Deposited at the rim of basins or as a thin cover layer in erosion areas.

- **Quaternary clay and silt:** Marine, meltwater or lake deposits of clay. Often laminated with sand/silt and/or peat layers, in some cases covered by few cm of lag sediments (sand, gravel or pebbles).

The classification expresses the sediment type of the upper 0.50 m of the seabed. Each sediment class is defined based on the specific grain size distribution. Sediment description and grain size distribution of grab samples and vibrocores, collected at locations along the corridor, have been used to ground truth the reflectivity from the side scan sonar and backscatter intensity, and derive the seabed surface geology, including the seabed sediment classes.

The predominant seabed surface geology along the corridor is *Sand* and *Muddy sand*, although the area is characterised by the outcrop of glacial *Till* and quaternary *Clay* at the seabed. The outcrops are primarily located in the southern part of the corridor. See seabed sediment distribution in Figure 7-20.

Section 1 to 4:
Close to the landfall, three seabed samples are classified as *Sand*, two seabed samples denotes *Gravel* and one vibrocores *Till*. Further North seabed samples have been collected in with seabed sediment analysed as either *Sand*, *Clay* or *Till*.

Section 5-6:
Here seabed sediments changes from *Muddy sand* to *Sand* and *Gravel*. The gravelly area is a mixed sediment of till, coarse sand and slightly clayey.

Section 7-12:
For the remaining corridor the reflectivity is quite uniform meaning that there are no major sediment changes on the seabed and the geotechnical samples reveals large areas with *Muddy sand* to *Sand*.

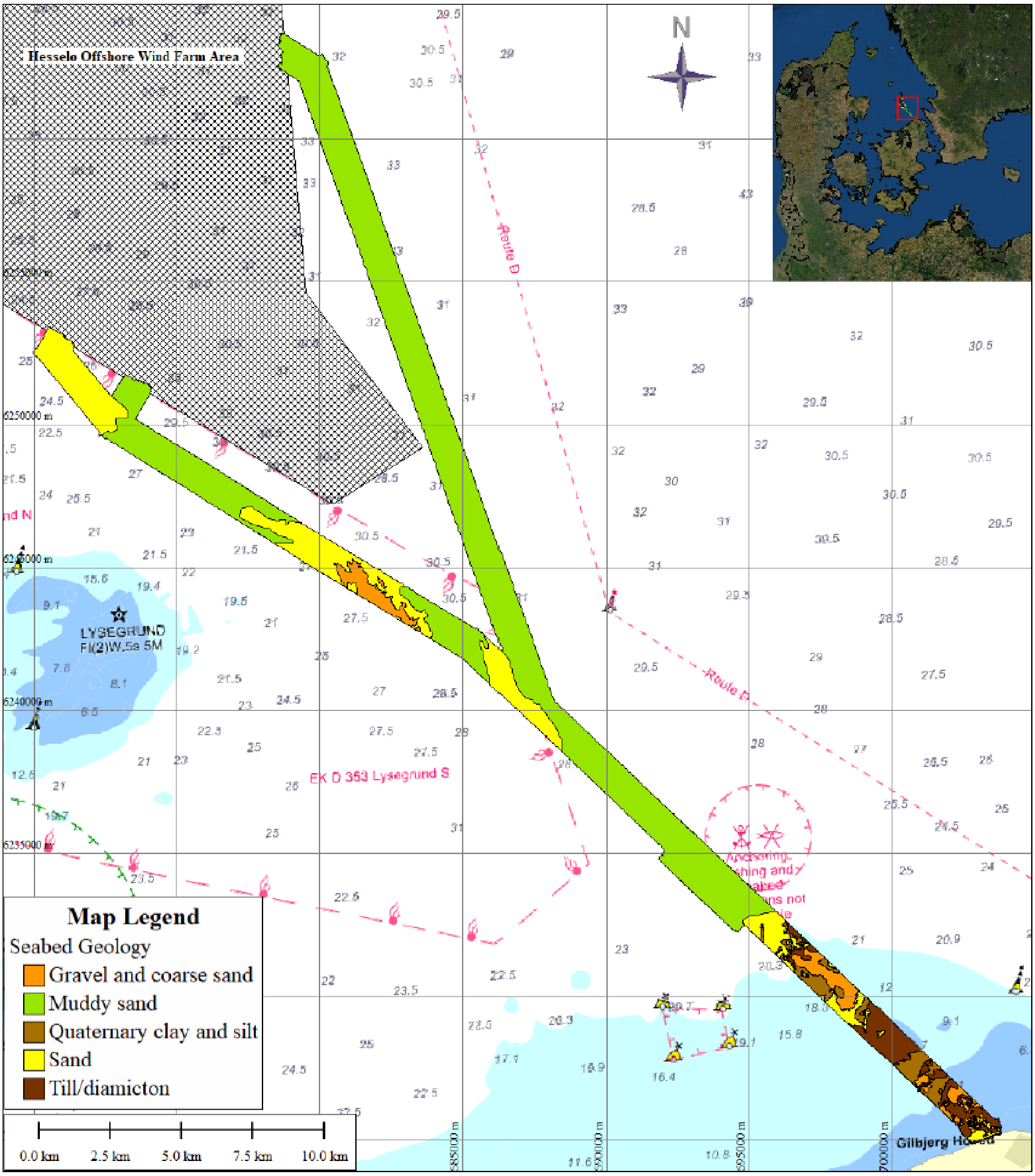

Figure 7-20 Overview of the interpreted seabed surface geology alongside the ECR corridor from Gilbjerg Hoved in the south to the OWF area in the north. Nearshore seabed geology is a mix of clay and till, whereas offshore seabed geology is manly sand or muddy sand.

7.4 Summary

The acquired data for WP D complies with the IHO order 1a and have a ping density significantly above 4 pings/m^2 inside the survey corridor. However, a sound velocity layer in the water column causes refractions in the acquired MBES data.

By comparing the acquired data in WP A & B from 2020 with data for WP D from 2021 the most significant changes can be seen close to the shore influenced by currents and waves. The erosion starts from around KP 0.200 to KP 0.400 in the shallow water where the coastal dynamics are much more affected by waves. The shallow areas are dominated by *Gravel*, *Till* and a *Sand* lens which has been eroded. Whereas the remaining corridor is mainly dominated by *Muddy sand* and *Sand* where the differences between 2020 and 2021 data is oscillating around zero meter.

52.6% of the difference plot is among 0m to 0.12m whereas 45.0% is between 0m to -0.12m which indicates a slightly sediment accretion that mostly occurs offshore where the erosion is more conspicuous in the nearshore parts.

When comparing the 2020 and 2021 data in regards of differences it is important to consider the uncertainties between the two surveys in terms of; 1) equipment limitations, 2) when measuring the sensor offsets, 3) the post-processing procedures and other factors described in section 6.1. This can easily introduce inaccuracies of 5-10cm. Therefore, when having differences below 10cm it can also be considered as no or neglectable variations between the two datasets. However, differences below 10cm are still mentioned as accretion or erosion as these are observed values between the 2020 and 2021 datasets.

8. LIST OF DIGITAL DELIVERABLES

The Appendix of the Survey Report (this report) contains the Acceptance Test Report (Appendix 2) and the North Up Charts (Appendix 3). Therefore, the Survey Report also contains all report deliverables. All report deliverables are in PDF format.

Table 8-1 lists the digital data deliverables together with description and file format.

Table 8-1 Digital data deliverables.

Items	Data	Format
Bathymetric data	Ungridded soundings, XYZ	ASCII format
	Gridded soundings, 50cm, XYZ	ASCII format
	Gridded soundings, 50cm, image grid format	GeoTIFF
	Gridded soundings, 1m, XYZ	ASCII format
	Gridded soundings, 1m, image grid format	GeoTIFF
	Gridded soundings, 5m, XYZ	ASCII format
	Gridded soundings, 5m, image grid format	GeoTIFF
	Bathymetric contours with 50cm intervals, TSG object CONTOURS_LIN	.gdb
	Vessel tracks as TSG object TRACKS_LIN	.gdb
	Bathymetry - TVU 1.00 m, XYTVU	ASCII format
	Bathymetry - TVU 1.00 m, image grid format	GeoTIFF
	Bathymetry - THU 1.00 m, XYTHU	ASCII format
	Bathymetry - THU 1.00 m, grid format	GeoTIFF
	Sound velocity profiles (SVP) in native format	.txt

Table 8-2 Chart deliverables provided with this report, see appendix 3

North up charts
Overview map showing coastlines, EEZ, large scale bathymetric features and area of investigations.
Map showing actual performed survey lines.
Map with bathymetry with contour lines and presented as color shaded relief maps.
Map with seabed surface change, Work Package A/B with D.

APPENDIX 1
RPL list

APPENDIX 2
Operations Reports

APPENDIX 3
North up Charts