Cruise report
RV Pelagia campaign 64PE503
North Sea Methane
Texel-Texel, 6-22 June 2022

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NIOZ Royal Netherlands Institute for Sea Research

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Cover photo: The B13 platform in the early morning light. Photo Sharyn Ossebaar.

Index

Summary

This cruise report documents the scientific activities and preliminary results of the RV Pelagia campaign 64PE503 that was carried out 5-22 June 2022 as part of the North Sea Methane Project, carried out by NIOZ and TNO on behalf of Dutch State Supervision of Mines. The goal of this first campaign was to assess the extent of gas ebullition in the Dutch North Sea, by determining the presence of ebullition at a representative selection of wells and natural background sites. A total of 68 locations of interest was surveyed during the campaign, comprising 57 abandoned wells, 7 locations where natural ebullition was expected, 2 ship wrecks, a section of pipeline, and one reference location. The presence of active ebullition was assessed on the basis of water column acoustic backscatter profiles acquired with Kongsberg EM2040 high resolution multibeam. Surveys with G882 magnetometer were conducted to verify the given position of abandoned well heads buried below the seabed. Profiles of the shallow subsurface geology were acquired with Innomar Medium 100 Sub Bottom Profiler. The CTD-Rosette system of NIOZ was used to obtain vertical profiles of a range of water column parameters above abandoned wells and other points of interest, and to collect water samples from discrete depth intervals for chemical analysis. Analysis of gas content in surface and deep water was performed with a laser spectrometer. In addition to analysis of gases in water, air taken in at approximately 10 m above sea surface was continuously analysed for atmospheric CO_2 and CH_4 with a Picarro G2301 gas concentration analyzer. Preliminary analysis of the acquired data indicates that the most active ebullition, with multiple bubble plumes emanating from the seabed, occurred at the natural seep site B13-BS. Ebullition associated with abandoned wells was observed at only 6 of the 57 wells surveyed during the campaign, at wells A08-01, A14-02, A15-03, F01-01, B17-03 and B17-05. At each of these locations, enhanced concentrations of methane were measured in the water column by laser spectrometry.

1. Introduction

This cruise report documents the scientific activities and preliminary results of the RV Pelagia campaign 64PE503 that was carried out 5-22 June 2022 as part of the North Sea Methane Project. The aim of the project is to determine ebullition from abandoned wells in the Dutch sector of the North Sea and to place it in perspective of possible natural ebullition and seeps. Ebullition is the process in which gas, for example methane, seeps from the seabed to the water column via bubbles. Part of that gas dissolves and is absorbed by the seawater and part reaches the atmosphere. Methane is a strong greenhouse gas and thus contributes to climate change.

In order to gain more insight into possible methane ebullition associated with exploitation of oil and gas from the North Sea (from the precautionary principle and to map the contribution to climate change), SodM (Dutch State Supervision of Mines) has asked TNO and NIOZ to carry out measurements at sea. A first campaign of 18 days with RV Pelagia was carried out 5-22 June 2022, and subsequent campaigns are planned in 2023 and 2024. The goal of this first campaign was to assess the extent of gas ebullition in the Dutch North Sea, by determining the presence of ebullition at a representative selection of wells and background sites. The focus was on wells that are drilled through ‘bright spots’ as seen on seismic data, which is an indicator for so-called shallow gas. Shallow gas is natural gas (mostly biogenic methane, Verweij et al., 2021) that is present in the upper unconsolidated sediments to a maximum depth of 1000 m. Böttner et al. (2020) previously stated that all (=100%) of the wells that are closer than 300 m from or penetrating a shallow gas pocket are leaking. However, research by TNO showed that shallow gas may not in all cases be the cause of the observed ebullition (Wilpshaar et al, 2021). Other possible sources of biogenic methane gas that can occur in the North Sea are shallow peat layers and so-called tunnel valleys. That is why TNO wants to look beyond just wells that penetrate bright spots / shallow gas deposits.

The next two campaigns planned for 2023 and 2024 will focus on the extent to which ebullition varies over time and its determining factors, the composition and origin of the gas, and the extent to which the gas dissolves in the water column, is metabolized by microbes, or is released in the atmosphere.

2. Study area

The North Sea is a shelf sea of almost 1000 kilometres long and 600 kilometres wide, enclosed by the British Isles to the west, the central European mainland to the south and Denmark and the Scandinavian Peninsula to the east, and open to the Norwegian Sea to the north. Via the English Channel in the southwest it connects to the Atlantic Ocean, and via the Skagerrak and Kattegat in the east it connects to the Baltic Sea. The North Sea receives freshwater from a number of European continental watersheds, as well as the British Isles. The largest and most important rivers flowing into the North Sea are the Elbe and the Rhine – Meuse. For the most part, the North Sea lies on the European continental shelf with a mean depth of 90 metres. The only exception is the Norwegian trench, which extends parallel to the southern Norwegian shoreline with maximum depth of 725 metres. In the central North Sea, the Dogger Bank rises to a mere 15 to 30 m below the surface.

The Dutch sector of the North Sea to which investigations of the North Sea Methane project are limited encompasses an area of 58.500 square kilometers, extending from the Dutch coastline toward the median line that has been defined as the boundary between the EEZ of France, Belgium, The Netherlands, Germany, Denmark and Norway on one side and the EEZ of UK on the other side. Water depth in the Dutch sector is more than 50 m in the Oyster Grounds (Fig. 2.1).

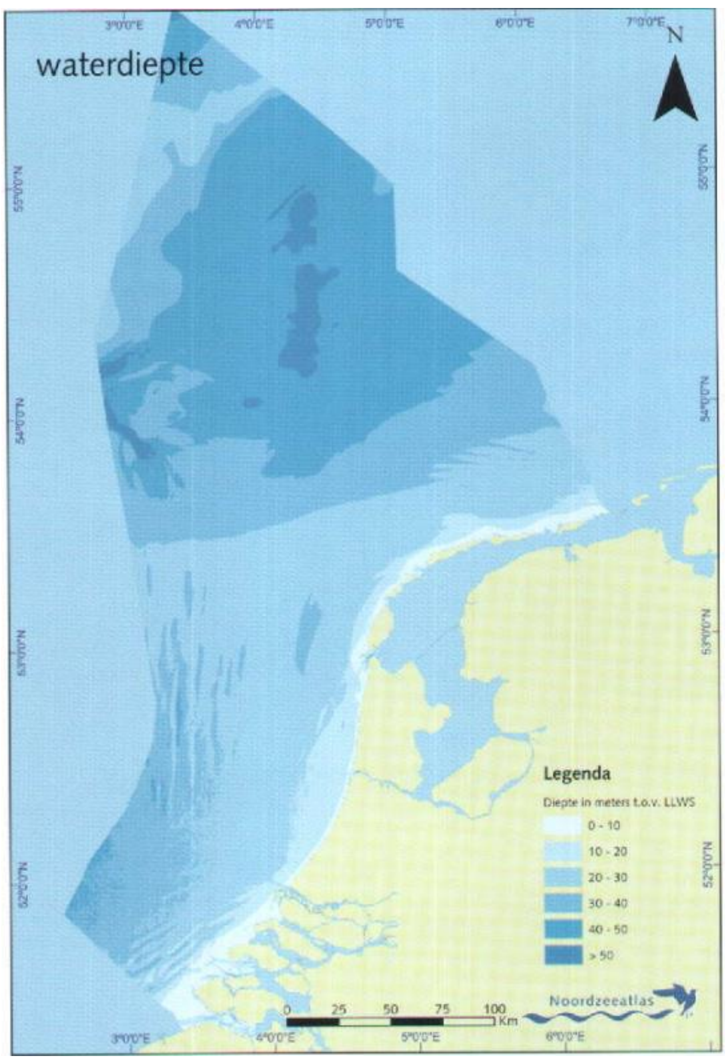


Figure 2.1: Bathymetry of the Dutch sector of the North Sea (Noordzee Atlas, Ministerie van Verkeer en Waterstaat/Rijkswaterstaat directie Noordzee, 2004)

The geology of the area goes back as far as the early or middle Paleozoic. Most relevant to our research are the Carboniferous coal-rich deposition that acts as a source rock for thermogenic natural gas (methane, ethane, etc.) in the area. They area overlain by Permian terrestrial deposits that could potentially act as a reservoir for the gas from the Paleozoic source rocks. Thick Zechstein salt is found on top of this, acting as a seal. These salts are characterized by salt-tectonism, which impacted the creation of biogenic gas at a later stage. The Zechstein also incorporates limestone deposits that has been considered to act as gas reservoirs as well. Since the North Atlantic rifting during the Jurassic and Cretaceous period, a shallow sea has almost continuously existed between the uplands of the Fennoscandian Shield and the British Isles, its extent growing and shrinking with the rise and fall of the eustatic sea level. Subsidence in the North Sea graben and its margins during the Mesozoic and Cenozoic accommodated the accumulation of up to several km of mostly shallow marine deposits, including hydrocarbon source rocks of the Jurassic and reservoir rocks of the Jurassic and Cretaceous.

Of most interest to our study are the unconsolidated sediments of the Eridanos delta which were mainly deposited during the Pliocene and Pleistocene. The Eridanos delta consist of approximately 1 km of fine sand, silt, and clays. Within these sediments, biogenic gas (methane) is generated and accumulated. This gas is called ‘shallow gas’ and one of the potential sources of methane-emissions.

Since the start of the Quaternary period about 2.6 million years ago, the growth of continental ice masses and consequent sea level drops during glacial periods repeatedly resulted in retreats of the North Sea to north of Doggerbank. The present-day coastline formed after the Last Glacial Maximum when the sea began to flood the European continental shelf. During the last ice age large tunnels formed under the ice. These so called ‘tunnel valleys’ are found throughout the study area, and they might be linked to ebullition (gas bubbling from the seafloor) and to pockmarks (depressions in the seafloor formed by fluid or gas escape. Finally, during the Holocene, peat layers we deposited in large parts of the study area. The peat layers could potentially be a source of methane-emissions too.

Offshore test drilling for hydrocarbons began in 1966, and in 1969 Phillips Petroleum Company discovered the Ekofisk oil field. Commercial exploitation began in 1971, and was boosted by the climb in international oil prices during the 1973 oil crisis, which made the large investments needed for offshore oil extraction profitable. Oil transport to shore was initially realised by tankers, and since the mid 1970-ies also via pipelines. Currently there are 160 active oil and gas platforms in the Dutch sector of the North Sea, connected to shore by 4500 km of pipeline (www.rijkswaterstaat.nl). In the Dutch North Sea the main gas fields are found to the south in respect to the area that was studied. Within the study area, there are eight shallow gas fields and several Jurassic and Cretaceous oil fields.

3. Methodology

3.1 Selection of locations of interest

For all locations considered of interest for our study it was checked whether they are more than 1000 m away from an offshore hydrocarbon production platform. This is more than the legal distance (500 m) that ships are required to maintain from a production platform. The larger distance is needed to maneuver safely while towing equipment behind the research vessel during the measurements, which prevents it from navigating tight turns.

It was decided to limit the research to the AB and F blocks (Northern part of the Dutch North Sea). This is the area where most shallow gas accumulations are found. Wells in the L blocks were investigated but no sites were selected since they are located near or in busy shipping lanes.

For all wells of potential interest, it was established whether a cement evaluation log is present. If wells have a cement evaluation log (CBL, VDL, CET, SBT/SLT) then it might be possible to make statements about gas origin in case of any observed ebullition.

Wells through shallow gas

TNO has drawn up a list of wells in the Dutch sector of the North Sea that have been drilled through bright spots, an indicator for shallow gas deposits (TNO2019 R11562). This list has been updated before the campaign (not published yet). First a list with all wells that are drilled through a shallow gas related bright spot was made. Then, it was examined whether the wells encountered gas (so-called “gas show”) during drilling. The EBN HC Show database was used for this.

In some cases, there are several wells roughly at the same location. The assumption is that most of the wells are drilled (sub)vertically through the sediments of the Upper North Sea Group, which contains the shallow gas accumulations. If wells are less than 10 meters apart at the surface, they are considered as one (surface) location. In the ABF blocks a total of 89 locations was identified where one or more wells have (possibly) been drilled through shallow gas.

For these wells in the ABFL blocks, it was also checked whether they were drilled through a tunnel valley and/or drilled through the ‘Basisveen Bed’ (NUNIBA), or peat layer.

Furthermore, 12 of the selected wells of interest have a cement evaluation log.

Wells without shallow gas

In order to test the hypothesis that wells drilled through shallow gas have a higher chance of leakage, wells that are not drilled through shallow gas were also selected as a control group. Since there are many wells that are not drilled through shallow gas, many more than wells that are drilled through shallow gas, a selection could be made containing only wells with a cement evaluation log. Furthermore, only wells close to the planned route (via ‘shallow gas wells’) were selected for measurements.

Natural seep locations

There are a number of natural seep locations in the Dutch North Sea where methane ebullition cannot be linked to wells, because they are located too far away. In general, natural seep locations could be associated with (1) shallow gas accumulations, (2) pockmarks, (3) subsurface salt domes, (4) ‘gas chimneys’ and/or (5) peat layers. A number of locations were selected based on literature and by studying available data (side scan sonar data, high resolution shallow seismic data, etc.)

Background measurements

A background measurement was taken at a location that was as far away from any potential methane sources as possible. The location was selected based on the absence of wells, infrastructure, bright spots, salt domes, tunnel valleys, and peat layers.

3.2 Used equipment and sampling methodology

An overview of equipment used during the campaign is given in Table 3.2.1.

Table 3.2.1. Overview of equipment used during the campaign.

SHIP	
Vessel	RV Pelagia
Positioning System	Seapath 380-5 Kongsberg
Antenna	Novatel GNSS-850
Positioning Correction Service	Fugro Marinestar PPP Correction Service
Motion Reference Unit (MRU)	Kongsberg MRU 5th Generation
Sound Velocity Log (SVL)	Valeport miniSVS (MBES mounted)
Underwater tool positioning: USBL	IXBlue GAPS
GEOPHYSICS	
Multibeam Echosounder incl. Backscatter and Water Column	Kongsberg EM2040_40 With SIS Acquisition Software
Sub Bottom Profiler	Innomar Medium 100
Magnetometer	G882 cesium-vapour Magnetometer with MagLog Acquisition Software
SAMPLING OF WATER AND ATMOSPHERE	
Water column profiler and sampler	CTD-Rosette System (Conductivity, Temperature, Depth)
Laser spectrometer	Tunable Infrared Laser Direct Absorption Spectroscopy; TILDAS; Aerodyne Research Inc., Billerica,UA
Gas analyser	Picarro G2301: Picarro, Inc., Santa Clara, USA

RV Pelagia

RV Pelagia is the Netherland's largest sea-going research vessel, owned by the Dutch Science Organization NWO-I and operated by NIOZ. The ship was built in 1990 at Verolme Shipyard in Heusden. While initially designed for North Sea research, the ship's working range has extended steadily and the ship has since sailed on all oceans except the Arctic Ocean and the seas surrounding Antarctica. RV Pelagia is a versatile vessel for multidisciplinary research. Normally the ship sails with a crew of 12 and up to 13 scientists and technicians. To accommodate the large variety of research activities that take place at sea, the ship uses containerized laboratories of which a total of nine can be placed on board. In addition to the container laboratories, three permanent laboratories are also available for general use. For overboard activities, the ship has two a-frames with 10 T hoisting capacity, one mid-ship at starboard side and one at the aft, and a number of winches with different types and lengths of cable. Systems used for navigation are listed in Table 1. The ship's HiPAP underwater positioning system was not used as it's resolution is not optimal for relatively shallow water of the North Sea. The ship's single-beam EM600 echosounder was switched off during most of the campaign to avoid possible interference with acoustic equipment needed for scientific purposes. The ship's EM302 multibeam echosounder unfortunately malfunctioned and could not be repaired in time. The ship's Aquaflow system provides continuous monitoring of hydrographic parameters for water taken in at the bow of the ship at 4 m depth below the water line.

GAPS

GAPS is an ultrashort baseline system (USBL) for determining the underwater position of equipment. The used system was rented from VLIZ, Flanders Marine Institute, Ostend. The GAPS antenna was fixed on a pole mounted with a pivot amidships on the starboard side of the ship (Fig. 3.2.1). For use of the GAPS, the pole was lowered to bring the antenna 4 m below the waterline where the transmitted and received signal is not disturbed by the hull of the vessel. Since the pole could be used only at a ship speed through water of not more than 2 nm/h, it was retrieved to deck whenever not strictly needed. The GAPS was mainly used to determine the underwater position of the magnetometer. Initially it was also used to determine the position of the weighted end of the SLURF, the hose used for pumping up deep water for laser spectrometer gas analysis. However, the hose had such a constant and predictable location in relation to the ship, and the weight holding it down was also well visible in multibeam water column data, that the GAPS was not used in later deployments of the SLURF.

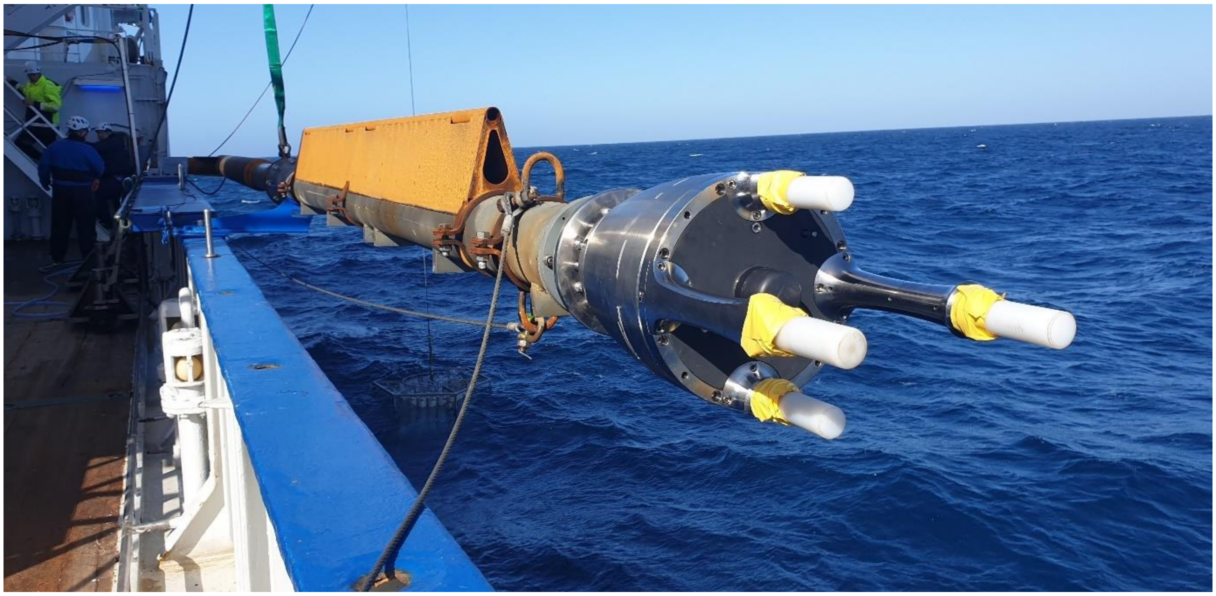


Figure 3.2.1: The GAPS antenna on the starboard pole. When retrieved to deck the acoustic receivers are shielded from sunlight by protective caps. Photo Mélanie Diaz.

Multibeam Echosounder

To visualize bubble plumes in the water column, a Multibeam Echosounder System (MBES) was used. Specifically, the Kongsberg EM2040, a high-resolution MBES suitable for use in relatively shallow water. The transducer unit for transmitting and receiving the signal was fixed on a pole mounted with a pivot amidships on the port side of the ship (Fig. 3.2.2). For use of the MBES, This pole was lowered to bring the transducer unit 4 m below the waterline where the transmitted and received signal is not disturbed by the hull of the vessel. Since the pole could be used only at a ship speed through water of not more than 3 nm/h, it was retrieved to deck whenever not strictly needed.
For each location where multibeam data was recorded, a water column sound velocity profile (SVP) was made prior to the MBES survey with the CTD water column profiler (see section CTD below). A sound

velocity profile is essential for acquiring good quality MBES data. Furthermore, two so-called patch tests were performed on shipwrecks to enable proper corrections for pitch, roll and heave.

Figure 3.2.2: The Kongsberg EM2040 multibeam and Innomar SES 2000 medium transducer heads on the portside pole. Photo Henko de Stigter.

Settings used during the survey are summarized in Table 3.2.2. At each location at least 5 parallel lines were recorded with a swath overlap of approximately 50%, with lines performed as shown in Figure 3.2.3. In order to achieve sufficient overlap, a distance of 40-50 m was maintained between subsequent lines, depending on the water depth. In total an area of approximately 250 by 400 m was covered per well location. The orientation of the lines was largely decided on the basis of maneuverability of the ship depending on weather and seastate conditions.

Table 3.2.2.

	Settings MBES
Coverage	100%
Swath overlap	50%
Survey speed	Average 2 nm/h
Opening angle	120°
Online Grid	1 m
SVP	1 for each Location, unless the several wells were very close to each other. Then one SVP was used for multiple locations
Frequency	400 kHz
	Test with 300kHz and 400 kHz were done at one location with a bubble plume. 400kHz gave the best image of the bubble plumes
Depth mode:	Shallow (as it is related to Pulse length, we decided to stay with shallow, as it gives a more defined vertical resolution for water column data)
Beam spacing	High density (equal distance)
Max ping rate	30 (but the System was just using 7-8Hz ping rate in ~45m depth and 12 pings in ~30m depth)
Colour set up (water column)	Colour map [-90; 0] for online visualization
Distance between lines	40-50 m

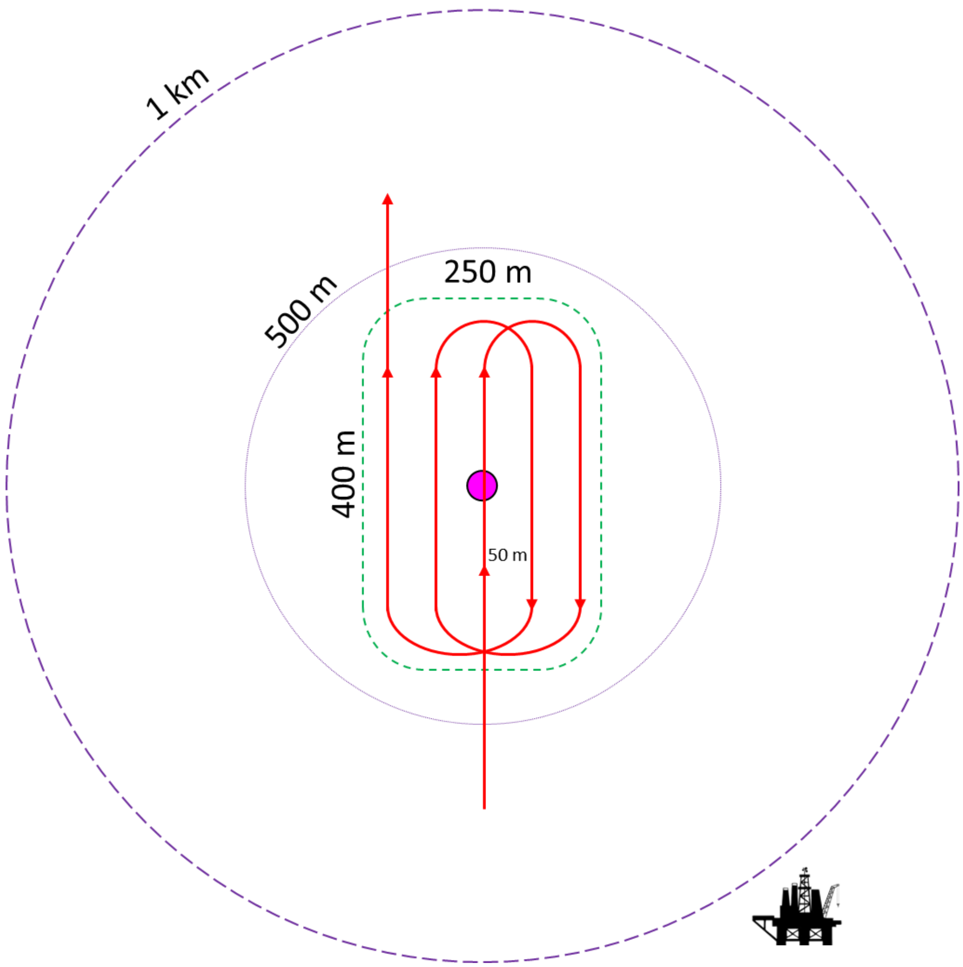


Figure 3.2.3: schematic diagram of the route and coverage of the MBES at the well location point.

Sub Bottom Profiler

An Innomar Medium 100 Sub Bottom Profiler (SBP) was used to visualize geological structures in the uppermost meters below the seabed (Fig. 3.2.4). The transducer unit was mounted next to the MBES transducer unit on the portside measuring pole (Fig. 3.2.2). Unfortunately, the MBES and SBP were not synchronized and were therefore interfering. Consequently, SBP measurements could not be performed simultaneously with MBES surveys, but were usually combined with magnetometer surveys.

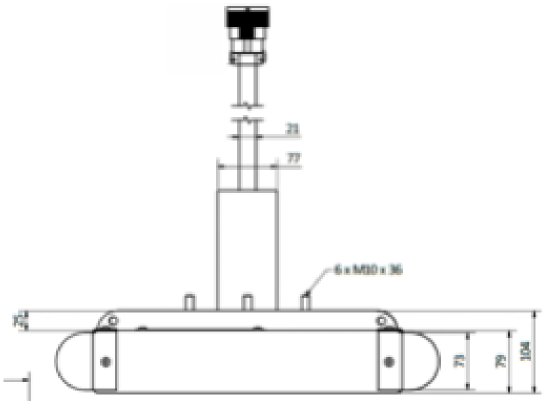


Figure 3.2.4: Technical drawing of the transducer head of the Innomar Medium 100 Sub Bottom Profiler.

Magnetometer

A magnetometer was used to verify the location of abandoned wells as reported by the operators. A number of wells was drilled decades ago when positioning methods were less accurate than current GPS positioning. The Dutch Hydrographic Service (part of the Ministry of Defense) had already mapped magnetic anomalies in part of the NL sector of the North Sea, including 89 abandoned wells. When the locations of the magnetic anomalies are compared with the coordinates of the wells supplied by the operator, it appears that the position of most of the wells (70%) corresponds to the location of a measured anomaly. The other 30% of the wells have a slight deviation of 38 meters on average, with a maximum of 88 meters. For a proper judgment if observed bubble plumes can be attributed to abandoned wells, the position of the latter should be accurately known.

In order to determine the location of wells that had not already been measured by the Dutch Hydrographic Survey, the Geometrics' G-882 Marine Magnetometer was used (Fig. 3.2.5). The magnetometer was towed about 100 m behind the ship, sufficiently far to not be affected by the magnetic disturbance caused by the ship (Fig. 3.2.6). The magnetometer was towed with a non-magnetic Dyneema (high strength braided synthetic material) cable. The data cable, through which magnetometer readings were transferred in real-time to the ship, was clipped to the towing cable, and both cables together were fed through a low-friction ring mounted under a float that was towed behind the ship with a Dyneema cable (Fig. 3.2.7). The float was equipped with an AIS radar transponder, to help the crew steer the magnetometer over the desired coordinates. A GAPS transponder was attached to the magnetometer data cable 1 m ahead of the magnetometer for determining underwater position of the magnetometer by iXblue GAPS USBL. In order to acquire an optimal magnetic signal from the cut-off steel casings of well heads buried several metres below the sediment surface, the magnetometer was flown at an altitude of 5-10 m above bottom. Flying altitude was controlled by varying the speed of the ship, the distance of the float behind the ship, and the length of magnetometer cable paid out.

At least two overpasses per well location were made (Fig. 3.2.8). The first overpass was done over the coordinates provided by the operator that drilled the well. When there was a difference between the location of the peak in the magnetic field (measured by the magnetometer) and the known coordinates, the second overpass was adjusted to the coordinates of the magnetic peak observed during the first overpass. Operational settings of the magnetometer are summarized in Table 3.2.3.

Figure 3.2.5: The G882 cesium-vapour magnetometer connected to data cable (green) and Dyneema towing cable (grey). A GAPS transponder for determining the underwater position of the magnetometer is mounted on the data cable 1 m before the magnetometer. Photo Stephan Rutten.

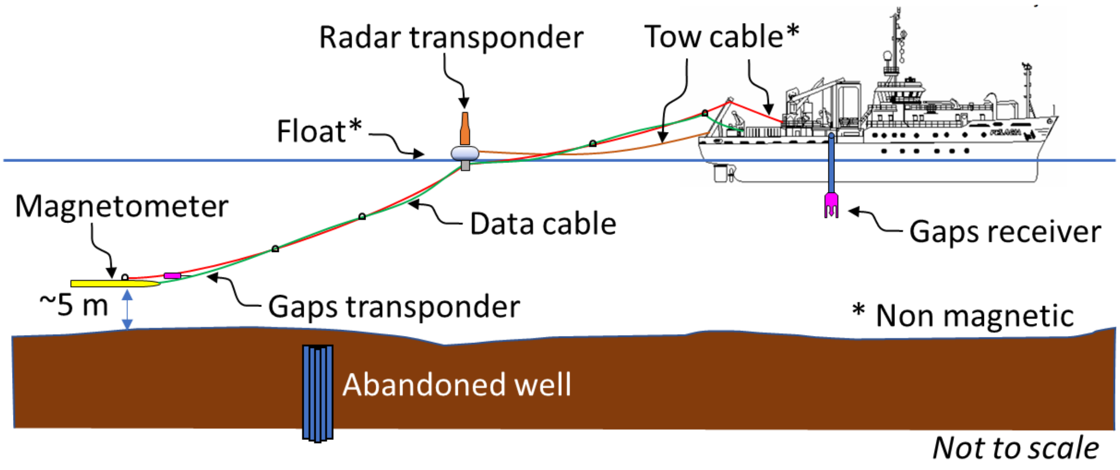


Figure 3.2.6. Schematic diagram of the design of the magnetometer and the GAPS system for the determination of the location of abandoned wells.

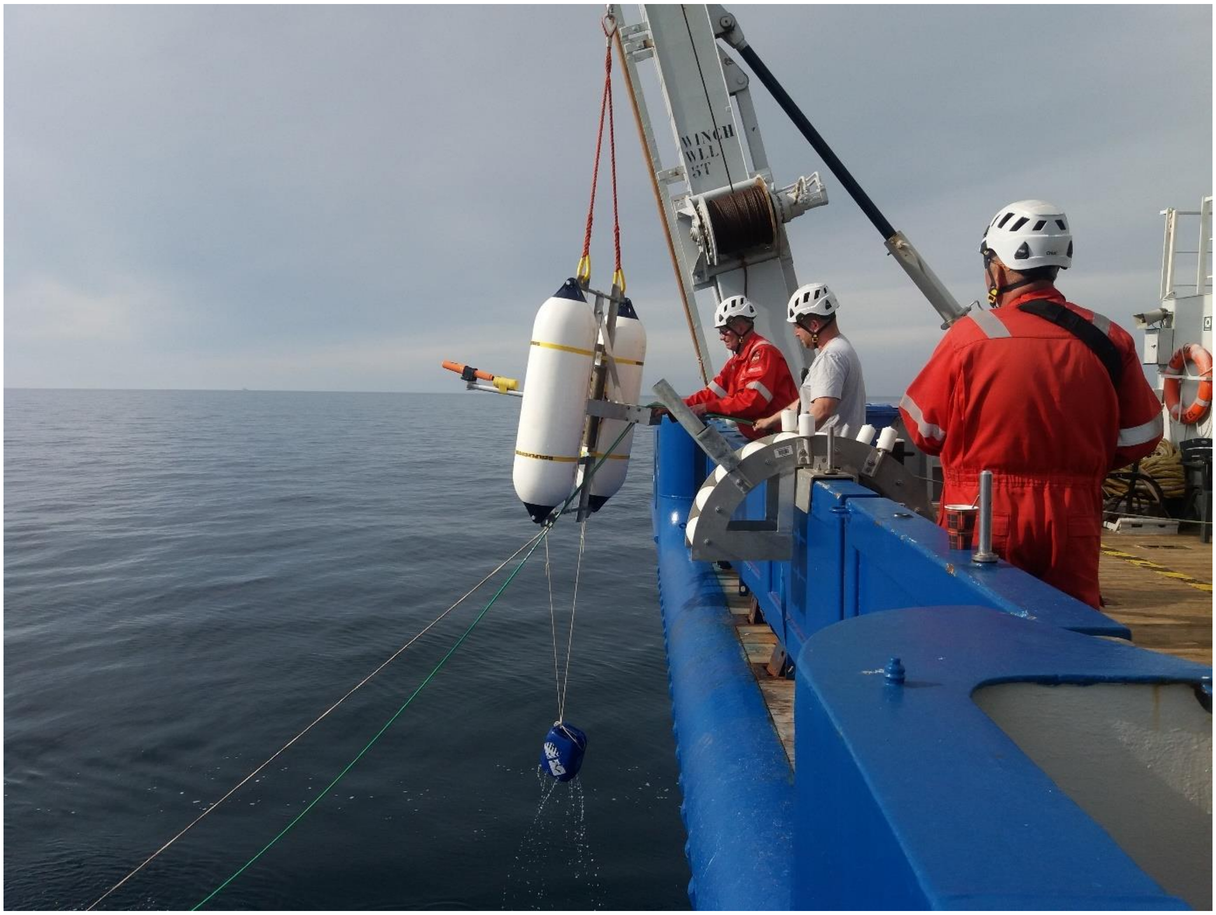


Figure 3.2.7: The float used for controlling flying altitude of the magnetometer. The data cable (green) and Dyneema towing cable of the magnetometer pass through a low-friction ring under the float. An AIS radar beacon and GPS tracker are mounted on top of the float. An improvised drag anchour gives the float more stability in the water. Photo Henko de Stigter.

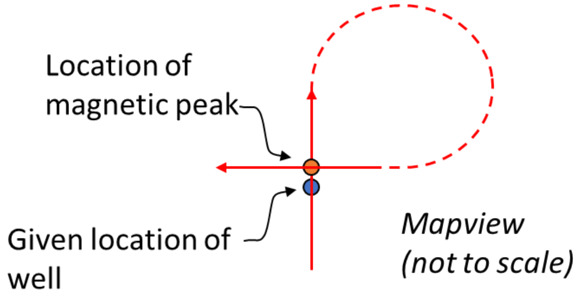
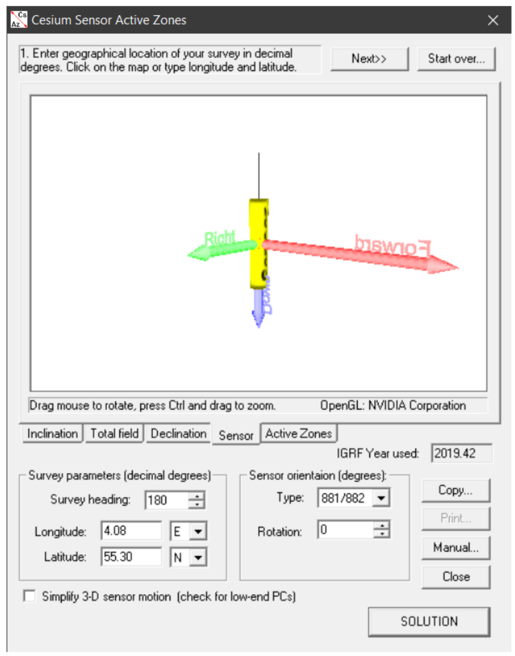


Figure 3.2.8: The route for determining the location of abandoned wells by magnetometer.

Table 3.2.3: Operational settings of the magnetometer.

<table>
<tr><th></th><th>Settings</th></tr>
<tr><td>Sampling frequency</td><td>10Hz</td></tr>
<tr><td>Survey speed</td><td>~2 nm/h trough the water</td></tr>
<tr><td>USBL System</td><td>GAPS</td></tr>
<tr><td>Flying Altitude</td><td>On average ~5 meter
But it was alternating between 10m, 7m, 5m</td></tr>
<tr><td>Sensor Orientation</td><td>0°

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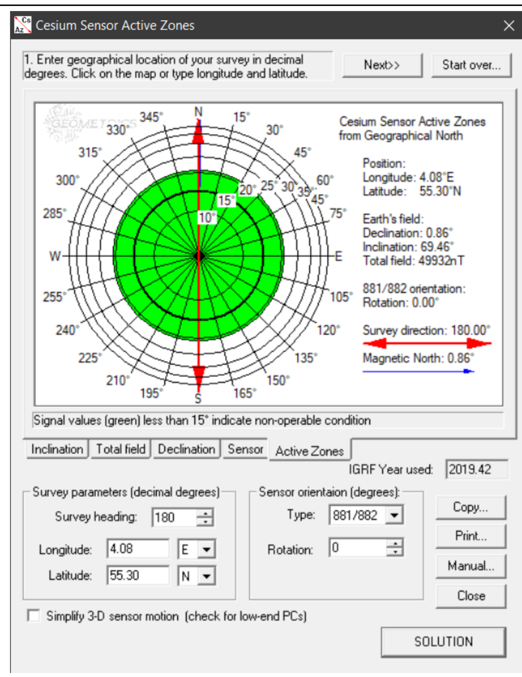
<tr><td>Active zones</td><td>
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CTD-Rosette water column profiling and sampling

The CTD-Rosette system of NIOZ (Fig. 3.2.9), lowered via the ship's starboard A-frame, was used to obtain vertical profiles of a range of water column parameters above abandoned wells and other points of interest, and to collect water samples from discrete depth intervals for chemical analysis. Sensor data, relayed to ship via the coax cable and read out in real-time on board, were used to choose relevant depth intervals for water sampling. The CTD-Rosette system was equipped with sensors for pressure, temperature, conductivity, oxygen, fluorescence, photosynthetically active radiation (PAR), and light transmission. Sensor specifications are given in Table 3.2.4. Derived parameters calculated from the primary sensor data include salinity, potential temperature, density, water depth and sound velocity. The water column density profile is important to determine whether and to what extent the water column is stratified, which is an important factor controlling gas fluxes through the water column. Specifically for this campaign, an AMT shallow water pH sensor and a Franatech LSM methane sensor for measuring the CH_4 partial pressure in the water column were added to the CTD-Rosette system. These sensors are relatively new and advanced, and thus require calibration by reference to conventional analysis of water samples taken in parallel with the sensor measurements. Towards the end of the campaign, a communication problem with the methane sensor occurred where the methane sensor data were not streamed with the CTD data stream. The data collected by the sensor were not lost but could be downloaded directly from the sensor every day. In addition to the sensors mentioned above, one and occasionally more JFE Advantech optical backscatter sensors and a Nortek Aquadopp 2 MHz current profiler were mounted on the CTD frame for measurement of optical and acoustic backscatter.

Figure 3.2.9: The NIOZ CTD-Rosette retrieved after a nightly deployment. Photo Sharyn Ossebaar.

Table 3.2.4: Specification of the standard sensor package on the NIOZ CTD-Rosette system.

Sensor	Sensor Model	Serial Number	Last calibration
Pressure	Paroscientific Digiquartz	261	15-10-2019
Temperature	SBE 3	1360	03-08-2021
Conductivity	SBE 4	1046	28-09-2021
Transmissometer	WET Labs C-Star	CST-1406DR	14-02-2022
Fluorometer	Chelsea Aqua 3	088-026	06-12-2021
PAR	PAR/Logarithmic, Satlantic	092	01-12-2020
Oxygen	SBE 43	43 4230	23-12-2021

For the majority of locations, the first action done was a cast with the CTD-Rosette system exclusively for measuring a water column sound velocity profile (SVP), which was needed for subsequent MBES data acquisition at the same location. Usually a second cast with the CTD-Rosette system was dedicated to water sampling in parallel with water column profiling. Water samples were taken at discrete water depths by means of the PRISTINE ultraclean sampler bottles developed by NIOZ (Rijkenberg et al., 2015), which were remotely closed through the CTD control system (Fig. 3.2.10). The CTD-Rosette system is equipped with 24 of these bottles with volume of 12 L, but in view of the shallow water column in the Dutch North Sea only 12 of these bottles were used. Bottles were closed at two, three or four depth levels, depending on the water column depth and vertical density structure.

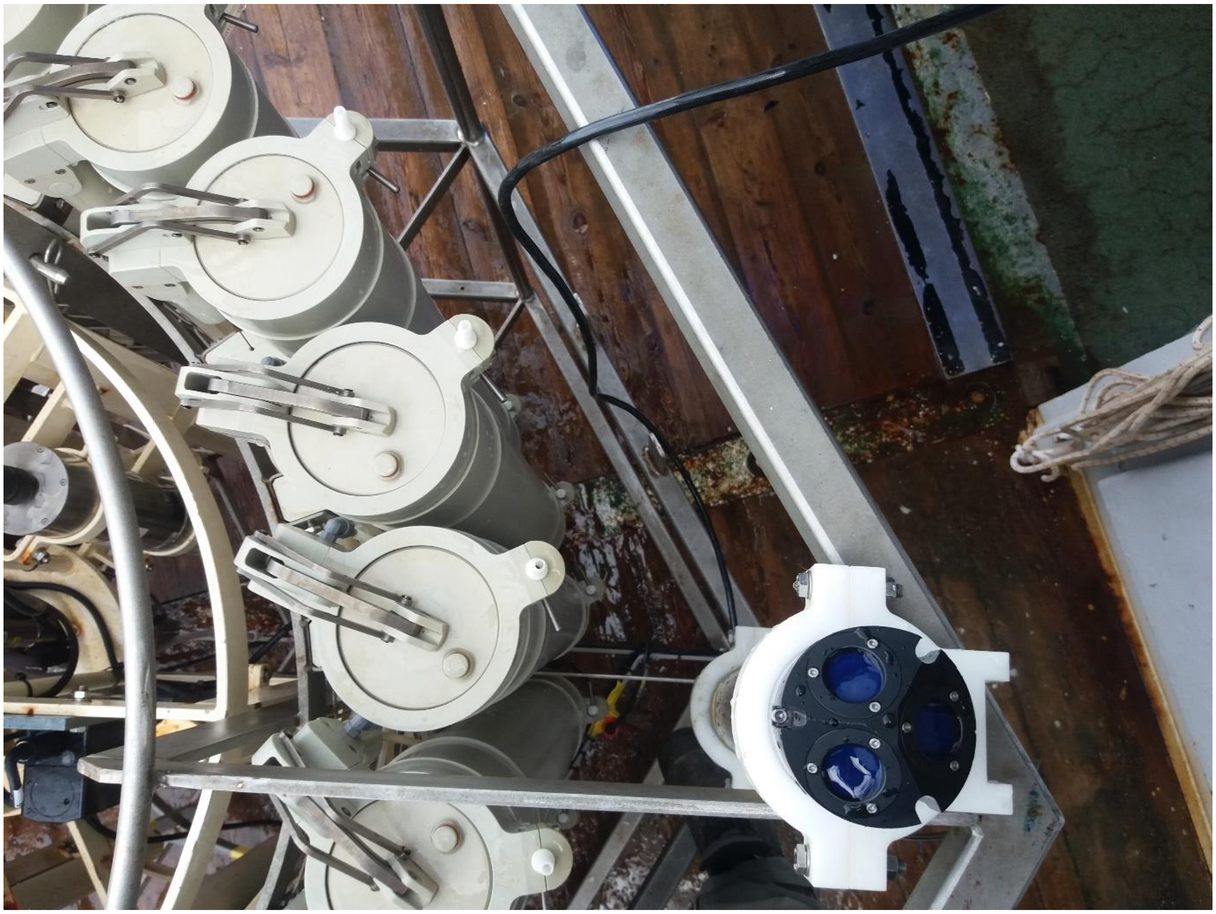

Figure 3.2.10: Top view of the PRISTINE water sampling bottles used on the NIOZ CTD-Rosette system, showing the butterfly valves developed by NIOZ. Photo Henko de Stigter.

From the collected water samples, subsamples were taken for analysis of methane, MOx (aerobic oxidation products of methane), oxygen, carbonate system (pH, Total Alkalinity (TA) and Dissolved Inorganic Carbon (DIC)), salinity and nutrients (silicate, phosphate, nitrate/nitrite, ammonia), whereas at selected stations a bio-sample was taken (Fig. 3.2.11). The majority of the analyses will be done in the laboratories on land. The results will be used to calibrate the pH and CO_4 sensors that were mounted on the CTD-Rosette system. Ultimately we hope to determine CH_4 concentrations and fluxes from the seabed, assess the contribution of thermogenic vs. biogenic gases, assess whether CO_2 is also released from the wells, and whether and how decomposition of gases by microbial activity takes place. In order to determine the potential for methane oxidation (MOx) a radiotracer assay will be carried out involving sample incubations with tritium CH_4, and -C_3H_4). In addition to the water sampling for geochemical analysis, water samples were also collected for determining concentration of suspended particulate matter (SPM). The latter data will be used for conversion of data from turbidity sensors to SPM concentration. Methods of sample processing for the different parameters are given below.

Figure 3.2.11: Water samples collected with the PRISTINE sampling bottles of the CTD-Rosette system are being subsampled for chemical analysis. Photo Sharyn Ossebaar.

Sample processing

Methane: samples were collected in narrow-neck 200 ml glass bottles using Tygon tubing, allowing for overflow of at least two times the bottle volume and ensuring the absence of bubbles. The bottles were immediately sealed with butyl rubber stoppers with steel needle penetrating to the bottom of the stopper in order to remove the excess of seawater. Additionally, the bottles were sealed with aluminium crimp-caps. After sampling on deck, the methane bottles were processed in the lab container on board the ship (Fig. 3.2.12) as follows: A headspace was created through the injection of a total of 10 ml of nitrogen gas in each bottle, and the excess of water was removed with a syringe inserted through the butyl rubber stopper. The samples were poisoned with 5 ml of sodium hydroxide (NaOH).

MOx: The samples were collected in ~10 ml glass vials with an overflow of at least two times the bottle volume and ensuring the absence of bubbles. The bottles were sealed with butyl rubber stopper with steel needle penetrating to the bottom of the stopper in order to remove the excess of seawater. The needles were afterwards removed, and the samples stored in the dark at 8°C.

The methane and MOx samples were collected following the headspace method (Steinle et al., 2015).

Dissolved Oxygen: oxygen samples were directly collected after the methane samples in ~120 ml glass bottles with Tygon tubing and following the Winkler method. The bottles were filled and overflown with at least three times their volume and ensuring the absence of bubbles. Immediately after filling the bottles, the chemicals were added, and the glass stopper was inserted displacing then the excess of water. A rubber band was used to tighten the seal and the samples were thoroughly shaken. The samples were kept in the dark and stored immersed in water at 25°C.

Marine carbonate system: samples for pH, TA and DIC were collected following the best-practice recommendations (Dickson et al., 2007a). The samples were collected with Tygon tubing into borosilicate glass bottles (500 ml for pH samples and 250 ml for TA and DIC). The bottles were rinsed three times, filled from the bottom smoothly and overflowed for two times the bottle volume and sealed with ground glass stoppers. In the laboratory onboard the ship, for every sample a headspace was created by removing 1% of the volume using a pipette, after which the samples were poisoned with a saturated mercury (II) chloride solution (100 µl for DIC and TA samples and 200 µl for pH samples). The samples were sealed with greased glass stoppers to prevent gas exchange and stored in the dark at 25°C.

Of all the parameters that were sampled, only the pH was analysed on board of the ship in the NIOZ CO_2 container lab. The analytical procedure for pH analysis is based on the spectrophotometric method developed by Clayton and Byrne (1993) and following the guide to best practices for Ocean CO_2 measurement (Dickson et al., 2007). The samples were analysed using the Agilent Cary 8454 UV-Vis spectrophotometer. The measurements are based on the addition of a pH sensitive dye, the m-Cresol purple (mCP), then the absorbances of the acid and base forms of the indicator are measured and used to calculate the pH.

Salinity: samples for salinity were collected into 200 ml glass salinity bottles that were rinsed three times before filling. The bottle necks were first dried in order to prevent salt crystallization. The bottles were sealed with plastic inserts then closed with screw caps.

Nutrients: the nutrient samples were firstly collected through a long silicone tube in syringes numbered 1 to 12 and corresponding to the PRISTINE bottles. In the laboratory onboard the ship, the content of the syringes were filtered into 5 ml polyethylene vials that were rinsed 3 times before filling. The samples for ammonium, phosphate, nitrate and nitrite analysis were frozen at approximately -20°C and the silicate samples were stored at 4-8°C in the dark.

Figure 3.2.12. Processing of water samples in the CO_2 lab container. Photo Henko de Stigter.

Water sampling for Spectrometer analysis

To measure CH_4, C_2H_6, N_2O, CO_2 and CO, a laser spectrometer (Tunable Infrared Laser Direct Absorption Spectroscopy; TILDAS; Aerodyne Research Inc., Billerica, USA) was used. This instrument contains a quantum cascade laser (QCL) and an interband cascade laser (ICL) and can simultaneously measure CH_4, C_2H_6, N_2O, CO_2 and CO. For measurements of the concentration and composition of gas in the water column, measurements were made with the help of the cascading laser spectrometer on: 1) deep water that was pumped up via a weighted hose ("SLURF") from a few meters above the bottom or 2) surface water of 4 m depth which was taken in at the bow of RV Pelagia via the Aquaflow system of the ship (Fig. 3.2.13). The SLURF was deployed from midship starboard side, taped to a steel cable with depressor weight that was lowered via the starboard A-frame (Fig. 3.2.14). The water from both sources flowed through a few metres of hose to a temperature-controlled lab container placed on the aft deck. The inflow of water from one or the other source into the laser spectrometer system was controlled by means of a valve.

During the recording of multibeam data, usually the deep water pumped up with the weighted hose was analyzed, while during transit or recording of magnetometer data, surface water collected with RV Pelagia's Aquaflow system was analyzed. This meant that water samples were being analyzed almost continuously during the entire duration of the campaign.

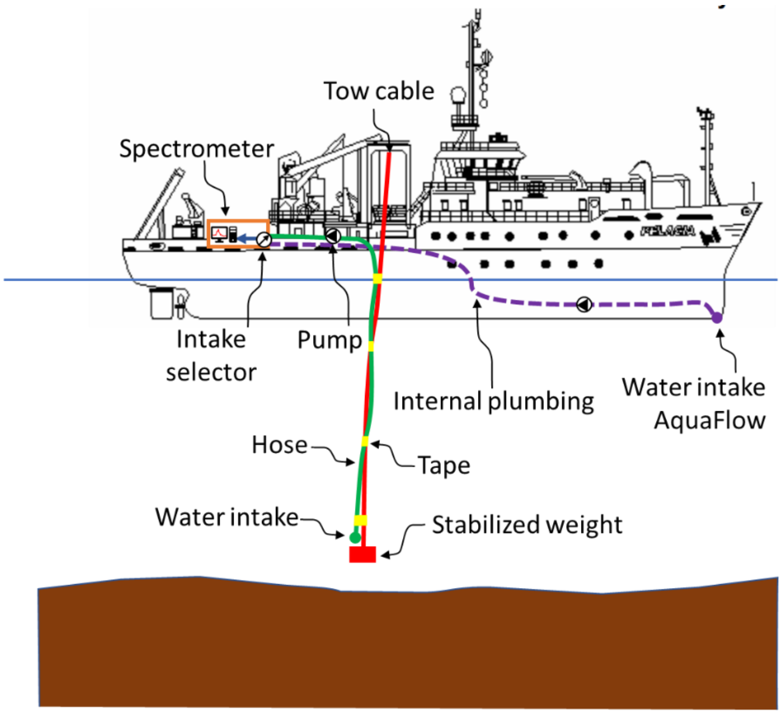

Figure 3.2.13: Schematic diagram of the setup of the deep-water intake hose "SLURF" and the Aquaflow system for the analysis of gases with the laser spectrometer.

Figure 3.2.14: The lower end of the water intake hose SLURF, attached to steel cable and depressor weight with stabilizing fin. A GAPS transponder was attached to the weight for determining the underwater position of the water intake. It was later removed as the position of the weight could also be determined from the MBES water column data. Photo Henko de Stigter.

Besides the switch between the Aquaflow and the SLURF, the technique to extract gas from the water phase was performed in two different ways: 1) with a Weiss equilibrator (Yuhong *et al.*, 2015) and 2) a membrane (3M-Liqui-Cel, MM Series; 3M Nederland B.V., Delft). There was also a valve to be able to switch between the Weiss equilibrator and the membrane. The Weiss equilibrator is a well-known technique to exchange trace gases from the water phase by an equilibrium system, but it needs equilibrium and therefore more time. The 3M membrane is able to extract trace gases from the water phase faster, to make plumes of methane directly visible. A schematic set-up of the lab-container is shown in Figure 3.2.15. A picture of the water part, with the Weiss equilibrator and the 3M Liqui-Cel membrane is shown in Figure 3.2.16, and a picture of the air part, with the laser spectrometer is shown Figure 3.2.17.

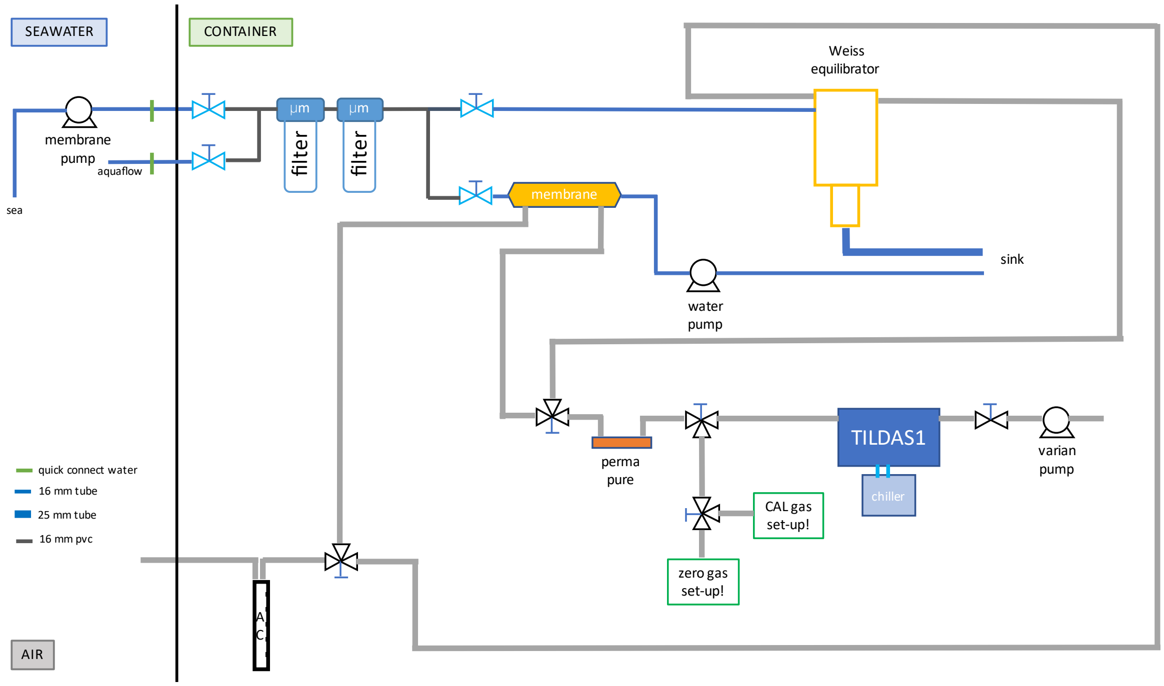

Figure 3.2.15: Schematic overview of measurement set-up in the lab-container.

Figure 3.2.16: The water part of the spectrometer measurement set-up in the lab container. From left to right the switchboard for anternating between deep water taken in by the SLURF and surface water taken in by the Aquaflow system, filters for prefiltering the water, membrane, and Weiss equilibrator. Photo Ilona Velzeboer.

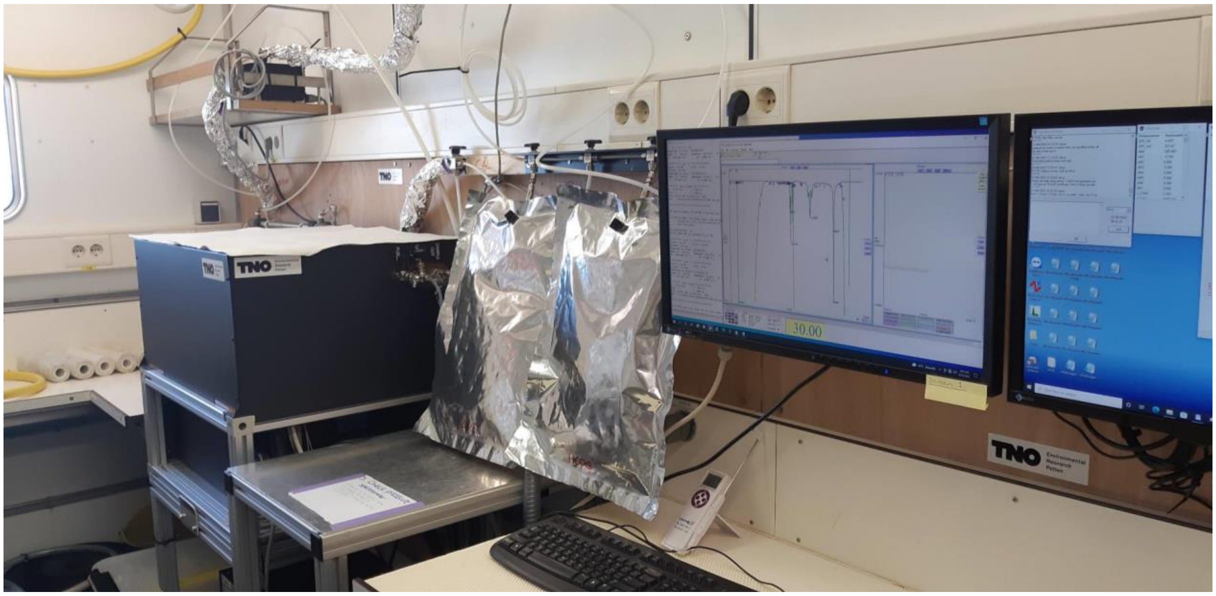

Figure 3.2.17: The air part of the laser spectrometer measurement set-up in the lab container, with the laser spectrometer on the left. Photo Ilona Velzeboer.

Atmospheric measurements

In addition to water sampling for analysis of gases, air was continuously taken in at the foremast of the ship at approximately 10 m above sea surface and led via tubings to the wet lab for analysis of atmospheric CO_2 and CH_4 with a Picarro G2301 gas concentration analyzer (Picarro, Inc., Santa Clara, USA) (Fig. 3.2.18). Next to the inlet, also a GPS corrected 2D sonic anemometer was placed. The measurements started on 2 June, when installing all instrument onboard and stopped on 22 June, when entering the NIOZ harbour. Continuous measurements took place in between.

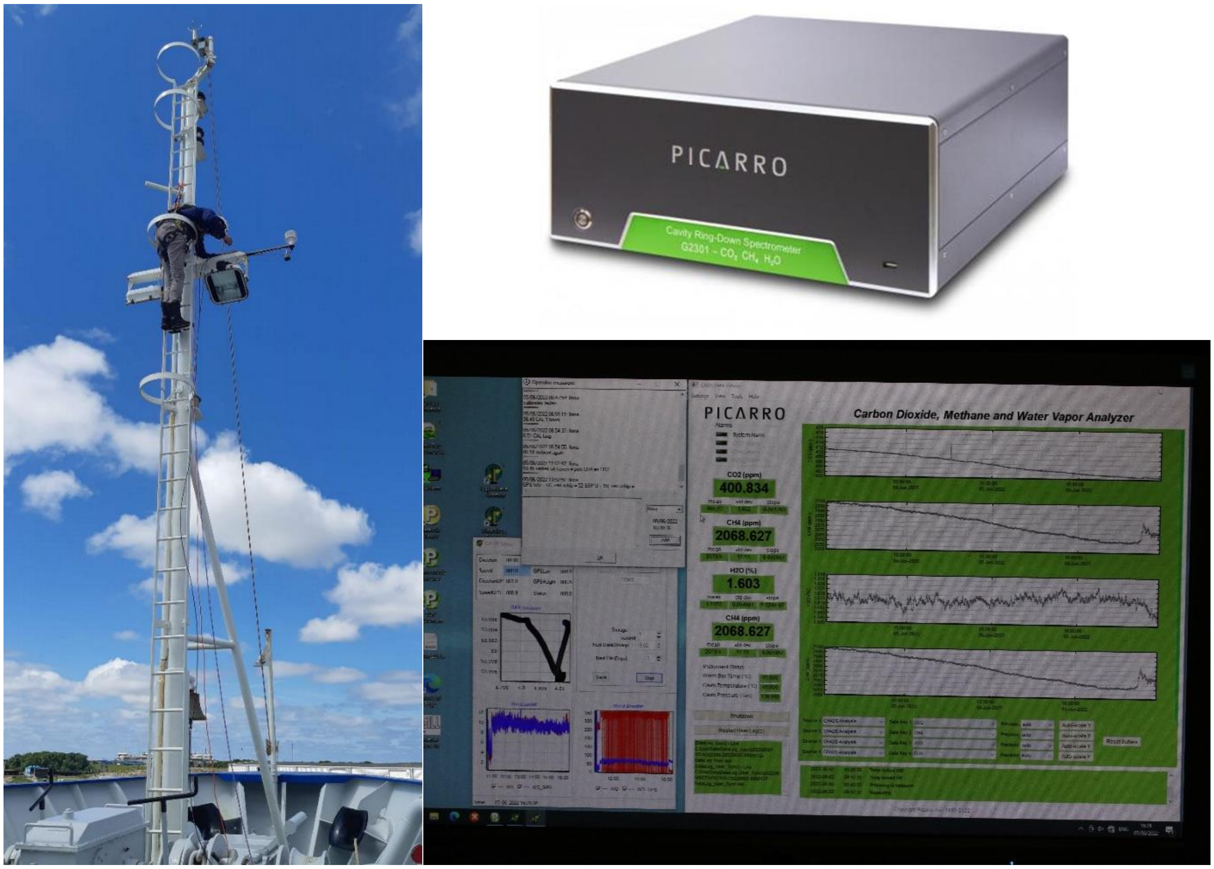

Figure 3.2.18: Set-up for atmospheric measurements during the full campaign. Left: Inlet and GPS corrected 2D sonic in fore mast. Right: Picarro and screen in wet lab, to follow the measurements continuously. Photos Ilona Velzeboer.

Plumefloc experiment

In the framework of the Plumefloc project, a collaborative project of Technical University Delft and NIOZ, CTD casts with water sampling were made to use for investigating acoustic and optical backscatter characteristics in relation to concentration of suspended particulate matter. Optical backscatter was measured in most of the casts with a JFE Advantech optical backscatter sensor (OBS) mounted facing downward at the base of the CTD-Rosette frame. Concentration of suspended particulate matter was determined by filtration of water samples collected simultaneously with the PRISTINE sampling bottles. From each PRISTINE water sample for SPM analysis, two subsamples were drawn off in 5 litre polyethylene bottles. While keeping the subsample well homogenized, between 2 and 3 litre was filtered on a pre-weighed 0.4 μm polycarbonate filter, applying approximately 0.3 Bar underpressure. After all the sample had passed through the filter, the filter was rinsed with a dash of milli-Q water to remove salt and then stored in plastic petri dishes and left to dry at ambient temperature for later analysis. In four CTD casts made in the last week of the campaign, a Nortek Aquadopp 2 MHz ADCP was mounted facing upward in the top of the CTD-Rosette frame, and four JFE Advantech optical backscatter sensors (OBS) were attached to the CTD cable with their sensor head at 0.85, 1.85, 2.85 and 3.85 m vertical distance relative to the transducer head of the ADCP (corresponding to measuring bin 1, 3, 5 and 7 of the ADCP) (Fig. 3.2.19). Instead of the standard 3 minutes that the CTD-Rosette was held stationary at each depth level before closing PRISTINE bottles, it was now held for 15 minutes to collect a fair number of measurements with the ADCP and OBSs. Water samples collected from each depth level with the PRISTINE bottles were filtered to determine concentration of suspended particulate matter. In the last CTD cast of the campaign, a second ADCP facing downward was lowered from the ship by means of a rope and intermittently dipped to about 1 m below the water surface. This time the CTD-Rosette was held stationary for no more than 6 minutes at each depth level for water sampling, while the downward looking ADCP was dipped in the water for 2.5 minutes and then pulled up above the water surface. The aim of this experiment was to test if the acoustic signal sent out by the upward and downward facing ADCPs would interfere, and at what distance this would be noticed in the data.

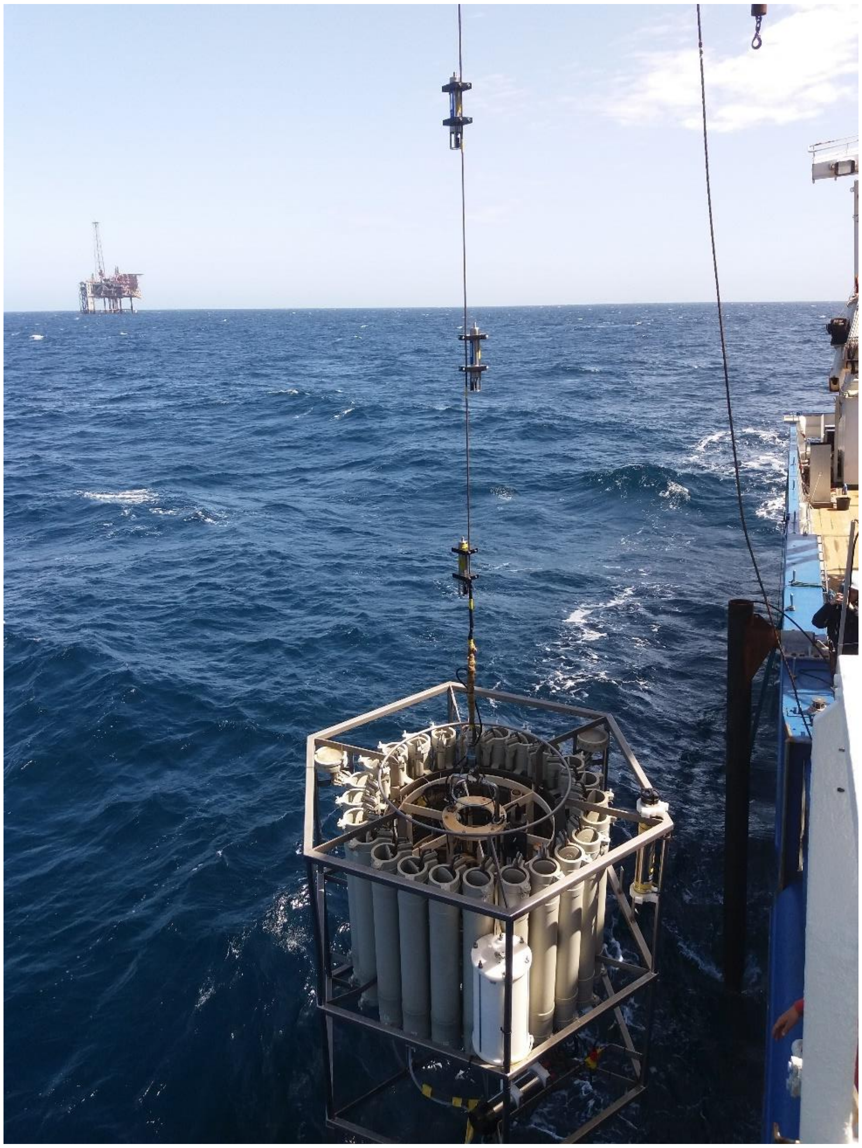

Figure 3.2.19: For the Plumefloc project, measurements of acoustic and optical backscatter with, respectively, an upward facing Nortek Aquadopp ADCP mounted in the CTD-Rosette frame and JFE Advantech optical backscatter sensors attached to the CTD cable, were made simultaneously with water sampling for determining concentration of suspended particulate matter. In the background the platform A02-Hanze. Photo Henko de Stigter.

4. Cruise narrative

The North Sea Methane campaign was conducted from 5 to 22 June 2022 on board research vessel Pelagia, with the NIOZ harbour on Texel as port of departure and return. Captain Henk Oenema held the overall command of the shipboard operations, with Henko de Stigter of NIOZ responsible for organisation of the science program. A list of all crew and members of the science team is given in Appendix 1. Thanks to the good state of maintenance of the ship and professionality of all crew and NIOZ technical staff, no delays due to any technical issues from the side of the ship occurred during the more than 400 hours and approximately 1100 nautical miles at sea. Weather and seastate conditions were generally favourable for carrying out the planned activities. Wind was variable with prevalence for southerly to northwesterly directions, and with mean magnitude of 7.0 m/s, only occasionally exceeding 10 m/s (Fig. 4.1). On some days a strong breeze in combination with strong currents made maneuvering of the ship along survey lines challenging. The worst weather and seastate conditions were encountered on the second and seventh day of the campaign, when overboard activities had to be suspended for a few hours.

Figure 4.1: Hourly averages of wind speed, wind direction, air temperature and pressure as recorded on board RV Pelagia for the period 5-22 June 2022.

A total of 68 locations of interest was surveyed during the campaign, comprising 57 abandoned wells, 7 locations where natural ebullition was expected, 2 ship wrecks, a section of pipeline, and one reference location (Fig. 4.2; Appendix 2).

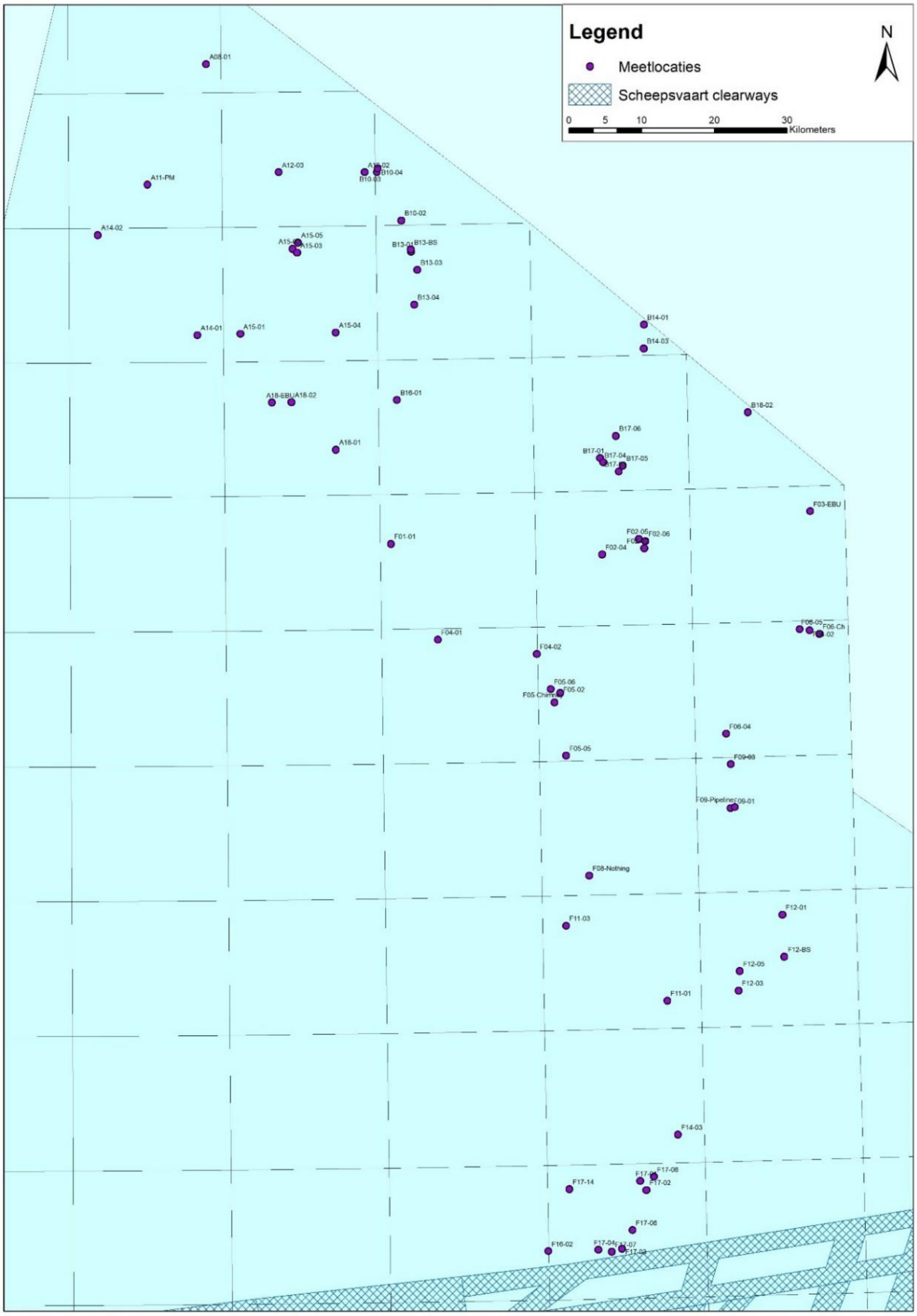

Figure 4.2: Locations of interest surveyed during RV Pelagia campaign 64PE503.

A day-to-day account of activities on board RV Pelagia is given below. A complete record of activities, with date and time (UTC), geographical positions and water depth, is given in Appendix 3.

Wednesday 1 June 2022
After two weeks docking for maintenance at Oudeschild, RV Pelagia is transferred in the early morning to NIOZ harbour at ‘t Horntje. While final maintenance works and technical testing continue the entire day, preparations for the oncoming campaign can begin.

Thursday 2 June 2022
Installation of scientific equipment for the oncoming campaign commences: the pole with MBES and SBP transducer heads on portside of the ship (Fig. 4.3), and all associated data acquisition hardware; meteorological sensors and air ducts for atmospheric sampling on the foremast, Picarro in the dry lab, labcontainer with TNO laser spectrometer on the aft deck, labcontainer for water sampling in the container shaft of the ship.

Friday 3 June 2022
Installation of scientific equipment is continued. The pole with GAPS USBL antenna on starboardside of the ship, and associated computer hardware; the magnetometer with deck unit in container 46 on the aft deck; the geometry of the hydroacoustic equipment on the portside and starboardside poles relative to the central GPS antenna of the ship is being measured.

Figure 4.3: RV Pelagia in NIOZ harbour. The portside pole is partly lowered in the water for testing the MBES and SBP. Photo Ilona Velzeboer.

Saturday 4 June 2022
A full working day's effort to solve a malfunction of the motion reference unit of the ship's EM302 MBES unfortunately remains fruitless. By the end of day it is concluded that it will not be possible to use the EM302 MBES. While the EM2040 MBES is the instrument of choice to perform high-resolution water column and seabed surveys at points of interest visited during the campaign, its use is limited by the maximum allowed ship speed through water of 3 nm/h imposed by the mechanical strength and stability of the portside pole on which the transducer head is mounted. The ship's EM302 MBES with transducer fixed to the ship's hull poses no mechanical constraints on ship speed and could therefore have been used for low-resolution water column surveys during transit between points of interest.

Sunday 5 June 2022
With the complete crew of 12 persons, 12 persons science team and 6 additional technical personnel on board, the morning and afternoon are spent on performance tests of all overboard equipment in the Wadden Sea just outside NIOZ harbour. After the mandatory safety instruction and introduction of the ship, the ship leaves port at 12:41 h LT and drops anchor in about 20 m water depth. While a moderate breeze blows from NE, the sheltered location makes that all necessary testing can be performed. First the SLURF for water sampling for gas analysis is lowered to about 6 m depth and the water sampling circuit and functionality of the laser spectrometer are tested to satisfaction. Then the portside pole with EM2040 and SBP transducer heads and starboard pole with GAPS antenna are lowered in the water and the functionality of the respective systems are tested. It is found that the signal of multibeam and SBP interfere with each other, and that synchronisation of the two signals is not possible with the given setup. The two systems can thus not be used simultaneously. The GAPS system is tested to satisfaction with a GAPS transponder mounted on the depressor weight of the SLURF. After recovery on board of the SLURF, the CTD-Rosette system is tested to satisfaction. Finally the magnetometer is lowered from the aft of the ship, together with the surface float used for controlling the flying depth of the sensor. The magnetometer functions to satisfaction, while the GAPS antenna promptly picks up the response of the transponder attached on the magnetometer data and towing cable (Fig. 4.4). Testing of the EM2040 multibeam continues until the late afternoon. When the tidal current has sufficiently subsided, RV Pelagia returns to port to drop off the technical personnel that assisted in the testing. At 20:06 h LT RV Pelagia leaves NIOZ harbour and sets course to open sea. Overnight the wind increases from moderate to strong breeze from NW.

Figure 4.4: Under the observant eye of the captain of RV Pelagia (left), launch of the magnetometer is practiced on the Wadden Sea. Photo Mélanie Diaz.

Monday 6 June 2022
After overnight transit, RV Pelagia arrives at well F12-03 around 08:00 h (Station 1). While a moderate to strong breeze blows from NW, seastate is still ok for lowering the CTD. During the upcast and closing of water sampling bottles, the CTD acquisition program produces an error as a result of which the cast has to be aborted. A new CTD cast is completed successfully. Before a multibeam survey can be performed at this site, first a so-called patch test must be done to allow correction of pitch, roll and heading of the system. A shipwreck marked on the nautical map 2 nm to NNE is chosen as fixed reference point for the patch test (Station 2). On the way to the site for the patch test, a mandatory abandon ship drill is done. The deteriorating sea state leads to considerable discomfort to some of the participants. Due to increasing wind turning from NW to SW it becomes increasingly difficult to maneuver the ship along the set of overlapping and parallel lines set out for the patch test. The recorded data appear of insufficient quality for the purpose of the patch test, but the water column signal is deemed good enough for detection of gas plumes. The ship thus returns to well F12-03 for a combined multibeam and SLURF survey (Station 3). With the GAPS antenna on the starboard pole lowered in the water the underwater position of the lower end of the SLURF, as marked by a transponder on the depressor weight, is recorded. However, with the given seastate and motion of the ship, forces exerted on the starboard pole and its pivot point on the railing are deemed to exceed what is acceptable. As wind and waves are expected to increase in the next hours, both poles and the SLURF are retrieved on board and further overboard operations are postponed. At the end of the afternoon, wind from SW direction peaks to gale force during passing showers of rain (Fig. 4.5), but the wind subsides in the evening while turning back to NW.

Figure 4.5: Rough sea as seen from the laser spectrometer lab container. Still from video by Sharyn Ossebaar.

Tuesday 7 June 2022
Over the night, the wind further subsides to a moderate breeze from NW. The swell that had built up the previous day flattens off sufficiently to allow activities to be resumed in the morning. A CTD cast with water sampling is made at well F12-05 (Station 4), followed by a combined multibeam and SLURF survey centred around that well, and subsequently one survey line with SBP. The launch of the magnetometer and surface float appear challenging at first, with the float landing several times upside down with the mast carrying the AIS beacon and GPS recorder under water. After the float has been

righted, practicing to fly the magnetometer at the desired altitude of 5-10 meter above bottom can start (Fig. 4.6). Even with the full length of data and towing cable paid out, the GAPS antenna picks up the position of the magnetometer behind the ship as given by the attached transponder. After performing two crossing lines over well F12-05 with the magnetometer, the sensor is left in the water and the survey is extended over well F12-03, located less than 2 nm further S (Station 5). In the course of the evening, the combined multibeam and SLURF survey at well F12-03, which due to deteriorating sea state had to be aborted the previous day, are completed successfully, followed by SBP survey. No bubble plume is observed at this well. As a last action of the day, the patch test at the nearby shipwreck is repeated (Station 06), this time with better result.

Figure 4.6: Preparations for launch of the magnetometer. Photo Henko de Stigter.

Wednesday 8 June 2022
While the wind further subsides to a moderate to gentle breeze variable between SW and SE, the night is spent in an extended multibeam survey over a large bright spot in block F12 (labeled F12-BS) (Station 7), comprising 4 lines of each 2 nm long and one crossing line of 1 nm. No bubble plumes are observed here. During daytime, a complete survey is carried out at well F12-01 (Station 8), comprising a CTD cast for measuring a water column sound velocity profile (SVP), a combined multibeam and SLURF survey followed by a SBP line, a CTD cast with water sampling, and a magnetometer survey. No bubble plumes are observed. The first two crossing magnetometer lines yield no conspicuous magnetic maximum, but a third line crossing diagonally from SE to NW over the location of a magnetic anomaly that had been previously measured by the Dutch Hydrographic Service and the given position of well F12-01 yields a distinct maximum at about 20 m SE of the given position. In the evening, a survey comprising a CTD cast for SVP, a combined multibeam and SLURF survey followed by a SBP line, and

a CTD cast with water sampling is carried out at well F09-01 (Station 9) (Fig. 4.7). The magnetometer survey is kept for another day when it can be done during daylight. No bubble plumes are observed at this well. The transit to F09-03 is made with multibeam and SLURF in the water, following a major gas pipeline in northerly direction. The pipeline is clearly visible on the multibeam seabed images in some parts where it lies exposed in a shallow trench or erosion moat in the seabed, while in other parts it lies covered beneath sediment and stones. At some point, enhanced concentration of methane and ethane is detected in water pumped up with the SLURF.

Figure 4.7: The CTD-Rosette retrieved back to deck. Photo Sharyn Ossebaar.

Thursday 9 June 2022

During the night, with moderate breeze turning to NW and good seastate, a survey comprising a CTD cast for SVP, a combined multibeam and SLURF survey followed by a SBP line, and a CTD cast with water sampling is carried out at well F09-03 (Station 10). During transit to well F06-04 (Station 11) located a bit more than 2 nm further to N, the ship follows the pipeline that extends in northerly direction, with the multibeam transducer head in the water to detect potential gas leaks. The survey at well F06-04, including a CTD cast for SVP, a combined multibeam and SLURF survey followed by a SBP line, and a CTD cast with water sampling, is completed after daybreak with a magnetometer survey. Weather and seastate conditions remain good during the day, allowing an extended survey over three points of interest comprising wells F06-05 and F06-02 and F06-CH (chimney) (Station 12). After a CTD cast for SVP at well F06-05, a combined multibeam and SLURF survey is started covering all three points of interest with a series of parallel lines of about 1 nm long. During the multibeam survey an issue with the recorded GPS position data is noticed, for which reason the survey is aborted. Before resuming the multibeam survey, first a CTD cast with water sampling is done at well F06-02 followed by a magnetometer survey across that well, and a CTD cast with water sampling at well F06-05. A magnetic position for well F06-05 was already known from surveys by the Dutch Hydrographic Service. Later in the evening the multibeam survey is resumed and completed, followed by one line with SBP covering all three points of interest. Like in the previous days, no bubble plumes were detected at any of the points surveyed during the day. In order to verify that the used settings of the EM2040 MBES are appropriate for detecting bubble plumes, it is decided to go to a location in block B13 where previous studies have demonstrated the presence of natural gas seeps with bubble plumes (labeled B13-BS).

Friday 10 June 2022
Overnight the ship moves to NW toward B13-BS. During the transit, the ship is made to pass at 1 km distance north of the active production platforms F3-FB and F2-A-Hanze. With the wind from SW, it is anticipated that traces of gas derived from the platforms may be picked up on the downwind side. After passing the platforms, the ship proceeds to NW following the gas pipeline to platform B13. Early in the morning the ship arrives at well B13-01 (Station 13). Weather and seastate on site appear good. After a CTD cast for SVP, an extensive combined multibeam and SLURF survey comprising 10 parallel lines of 500 m length each is carried out, covering well B13-01 and a number of known natural gas seepages. Whereas in the southern half of the surveyed area B13-BS, comprising also well B13-01, no bubble plumes are detected, numerous very distinct plumes are observed in the northern half (Fig. 4.8). In a combined SBP and magnetometer survey, comprising three crossings over the eastern half of the area and centred on well B13-01, bubble plumes also show up clearly in the SBP records.

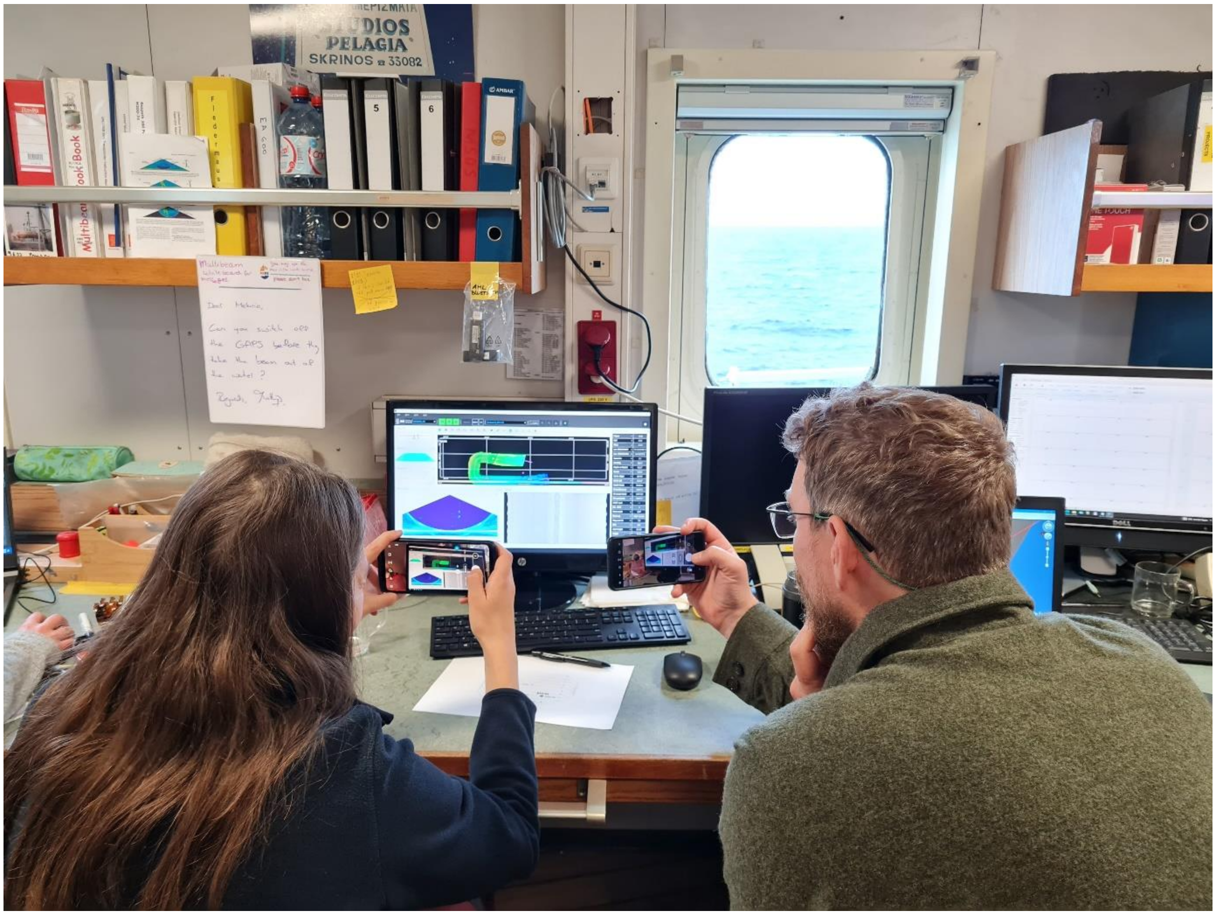

Figure 4.8: On day 6 of the campaign, the multibeam team finally has a first sighting of bubble plumes in the MBES water column data. Photo Sharyn Ossebaar.

The survey at this location is completed with a CTD cast with water sampling at one of the points where bubble plumes were most clearly observed. During the transit to well B10-02 located a bit more than 2 nm further to N, the multibeam transducer head remains in the water. At well B10-02 (Station 14), a complete survey is carried out. comprising a CTD cast for SVP, a combined multibeam and SLURF survey, a CTD cast with water sampling, and a combined SBP and magnetometer survey. No bubble plumes are detected. The transit to points of interest further to NW is briefly interrupted for a short multibeam survey over a shipwreck and a nearby site of potential natural gas leakage (Station 15). No bubble plumes are detected. In the late evening a survey is started covering wells B10-03 and B10-04 (Station 16), with a CTD cast for SVP at well B10-03, followed by a combined multibeam and SLURF survey over both wells. In view of the relatively shallow water depth at the edge of Doggerbank, the spacing between multibeam survey lines is reduced from 50 to 40 m to maintain sufficient overlap between adjacent swaths. No bubble plumes are detected here.

Saturday 11 June 2022
As a last action at Station 16, a CTD cast with water sampling is done in the early hours of the night at well B10-03. With the multibeam transducer head in the water but SLURF retrieved on deck, the ship proceeds to well A12-02 (Station 17), located about 1 nm further W. A survey is carried out, comprising a CTD cast for SVP, a multibeam survey but without the SLURF, and a CTD cast with water sampling. No bubble plumes are detected. In the first light of the morning, while weather and seastate are good to lower the starboard pole with GAPS antenna, a combined SBP and magnetometer survey is started, covering wells A12-02, B10-04 and B10-03 in one go. After that, the ship proceeds in westerly direction, passing at about 1 km N of the active production platform A12-A (Fig. 4.9). Downwind of the platform with the SW wind, a small increase in methane is detected in the atmospheric gas analysis.

Figure 4.9: Platform A12-A. Photo Henko de Stigter.

In the course of the morning the wind increases from moderate to strong breeze, and with it waves start to build up. Even so, a complete survey is done at well A12-03 (Station 18), with a CTD cast for SVP, a combined multibeam and SLURF survey, a CTD cast with water sampling, and a combined SBP and magnetometer survey. No bubble plumes are detected. At well A08-01 (Station 19) a CTD cast for SVP is made, followed by a combined multibeam and SLURF survey. For the first time during the campaign a bubble plume associated with a well is observed here. However, with the increased wind and waves it becomes impossible to keep the ship on course over the planned survey lines. Therefore the ship is held stationary over the bubble plume, and while waiting for a window of opportunity to complete the survey, the time is made to use to experiment with different EM2040 frequencies and tweak the display settings to optimise the detection and visualisation of bubble plumes. In the evening a CTD cast with water sampling is performed at the location where the bubble plume was observed. Since no improvement of weather and seastate is expected over the night, all overboard equipment is retrieved to deck and further activities are suspended until the next day.

Sunday 12 June 2022
Overnight the ship moves in NW direction to a pockmark in the A11 block (labeled A11-PM). In the morning the wind seems to have subsided a bit and seastate improved, sufficient to start a survey at A11-PM (Station 20), comprising a CTD cast for SVP, a combined multibeam and SLURF survey, and a CTD cast with water sampling. However, due to wind, waves and current it appears still difficult to keep the ship on course over the planned survey lines. No bubble plumes are detected. As seastate conditions are deemed unsuitable to lower the starboard pole with GAPS antenna and the magnetometer, the ship proceeds to the next location, leaving the SBP and magnetometer survey for a later occasion when seastate has improved. Around noon a new survey is started at well A14-02 (Station 21). Using the SVP recorded with the CTD cast at the previous station, one hour earlier and less than 4 nm to the N, a combined multibeam and SLURF survey is done, followed by a CTD cast with water sampling. Now for the second time during the campaign a bubble plume associated with a well is detected. As a last action on this station a CTD cast with water sampling is done. Late in the afternoon a survey is started covering wells A15-02 and A15-03 (Station 22). After a CTD cast for SVP at well A15-02, a combined multibeam and SLURF survey is carried out covering both wells with a series of lines of 1 km long. Once again, for the third time, a bubble plume associated with a well is detected when passing over A15-03. In the water pumped up with the SLURF an increase in methane is measured. After a CTD cast with water sampling at A15-03, an SBP survey line combined with SLURF is performed crossing over A15-03 and A15-02, and continued toward well A15-05 (Station 23) which is located less than 1 nm to NE. A combined multibeam and SLURF survey are carried out at this location, and a CTD cast with water sampling. No bubble plumes are observed.

Monday 13 June 2022
Shortly after midnight, the ship arrives at well B13-04 (Station 24), where a survey is carried out comprising a CTD cast for SVP, a combined multibeam and SLURF survey followed by a SBP line, and a CTD cast with water sampling. No bubble plumes are observed. With multibeam transducer head and SLURF in the water the ship proceeds to well B13-03, located a bit more than 2 nm further N and close to platform B13. The wind is gradually subsiding to a moderate breeze of variable directions between N and W, but sea state is still not good enough to use the starboard pole with GAPS antenna and the magnetometer. At well B13-03 (Station 25) a survey is carried out comprising a CTD cast for SVP, a combined multibeam and SLURF survey, a CTD cast with water sampling, and one line SBP survey. No bubble plumes are observed. At B16-01 (Station 26), a survey is carried out comprising a CTD cast for SVP, a combined multibeam and SLURF survey, two crossing lines with SBP, and a CTD cast with water sampling. No bubble plumes are observed. During transit to well A18-02, located a bit less than 3 nm further W, the ship passes S along the downwind side of platform A18. At A18-02 (Station 27) a survey is carried out comprising a CTD cast for SVP, a combined multibeam and SLURF survey, one line with SBP, and a CTD cast with water sampling. No bubble plumes are observed, but increases in methane content are observed in the water pumped up with the SLURF. To investigate whether the methane might be derived from a potential methane seepage site less than 2 nm to W, labeled A18-EBU (ebullition), the transit to that site is made with multibeam transducer head and SLURF in the water. However, while initially an increase in methane concentration is noted, the concentration falls back to background when arriving at A18-EBU. The survey at that location (Station 28), comprising a CTD cast

for SVP, a combined multibeam and SLURF survey, one line with SBP, and a CTD cast with water sampling, produces no evidence of any methane seepage in the form of bubble plumes or increased methane concentration. After completing the survey, the ship proceeds for about 1.5 nm in NE direction with multibeam transducer head and SLURF in the water in an attempt to catch the evasive trace of methane that was observed between well A18-02 and A18-EBU, but without evidence of enhanced methane concentration.

Tuesday 14 June 2022
With favourable weather and seastate forecasts for the next few days, the ship returns during the night to the northern part of the study area to carry out the magnetometer surveys that could not be done in the previous two days. In the two days that the starboard pole had been out of use, a roller block was constructed and welded halfway the pole such that in lowered position it rests against the side of the ship and prevents the sideways motion of the pole (Fig. 4.10). At daybreak a combined magnetometer and SBP survey is carried out at well A08-01 (Station 29, previous Station 19), the northernmost location investigated during this campaign, and later in the morning at well A14-02 (Station 30, previous Station 21) located almost 15 nm to SW. With the roller block the stability of the starboard pole is much improved. Around noon a complete survey is started at well A14-01 (Station 31) located about 10 nm to SE, comprising a CTD cast for SVP, a combined multibeam and SLURF survey, a combined magnetometer and SBP survey, and a CTD cast with water sampling. No bubble plumes are observed. Later in the afternoon wells A15-02 and A15-05 (Station 32, previous Stations 22 and 23) are revisited for a combined magnetometer and SBP survey and CTD cast with water sampling at A15-02. In the evening well B13-03 (Station 33, previous Station 25) is revisited for a combined magnetometer and SBP survey.

Figure 4.10: In between survey and sampling activities, a roller block has been constructed and welded to the starboard pole to improve the stability of the pole. Photo Henko de Stigter.

Wednesday 15 June 2022
Over the past day the wind has subsided from a moderate to a gentle breeze and the sea has considerably flattened off. In the night the wind drops further to a light breeze, turning from W to SE and later S. Conditions are ideal for the planned activities (Fig. 4.11). Shortly after midnight a survey is started at well A15-04 (Station 34), comprising a CTD cast for SVP, a combined multibeam and SLURF survey, and a CTD cast with water sampling. No bubble plumes are observed. The magnetometer survey is kept for a later moment during daytime. At well A15-01 (Station 35) a complete survey is carried out comprising a CTD cast for SVP, a combined multibeam and SLURF survey, a combined magnetometer and SBP survey, and a CTD cast with water sampling. After that, the ship returns to well A15-04 (Station 36, previous Station 34) to complete the work at that location with a combined magnetometer and SBP survey. At well A18-01 (Station 37), located almost 9 nm to S, a complete survey is carried out comprising a CTD cast for SVP, a combined multibeam and SLURF survey, a combined magnetometer and SBP survey, and a CTD cast with water sampling. While seastate conditions remain favourable for performing magnetometer surveys, the remaining daylight hours are spent in carrying out combined magnetometer and SBP surveys at F01-01 (Station 38), F04-01 (Station 39) and F04-02 (Station 40).

Figure 4.11: Daybreak on 15 June. Ideal weather and seastate conditions for the planned activities. Photo Mélanie Diaz.

Thursday 16 June 2022
During the night, two of the three locations surveyed the previous evening with magnetometer and SBP are revisited to complete the surveys with a CTD cast for SVP, a combined multibeam and SLURF survey, and a CTD cast with water sampling. At well F01-01 (Station 41, previous Station 38) the multibeam survey reveals a bubble plume associated with the well. No bubble plume is detected at well F04-01 (Station 42, previous Station 39). Since weather and seastate conditions remain favourable, with a gentle to moderate breeze blowing variably from S to NW, most of the day is spent in performing magnetometer surveys combined with SBP. First over two adjacent wells F05-02 and F05-06 (Station 43), then over the nearby well F05-05 (Station 44), and then over well F02-04 (Station 45). In the evening, wells F05-02 and F05-06 are revisited (Station 46, previous Station 43) for completing the surveys with a CTD cast for SVP at well F05-02, a combined multibeam and SLURF survey covering both wells, and shortly after midnight a CTD cast with water sampling at well F05-06. No bubble plumes are observed.

Friday 17 June 2022
In the night the ship proceeds to location F05-CH (Chimney) (Station 47), where a survey is carried out comprising a CTD cast for SVP, a combined multibeam and SLURF survey, and a CTD cast with water sampling. No bubble plumes are observed. Then well F05-05 is revisited (Station 48, previous Station 44) to complete the survey with a CTD cast for SVP, a combined multibeam and SLURF survey, and a CTD cast with water sampling. No bubble plumes are observed. Well F05-02 is revisited (Station 49, previous Station 43, 46) for a CTD cast with water sampling. Well F04-02 is revisited (Station 50, previous Station 40) to complete the survey with a CTD cast for SVP, a combined multibeam and SLURF survey, and a CTD cast with water sampling. No bubble plumes are observed. The ship then proceeds to wells B17-01 and B17-04 (Station 51) for a combined magnetometer and SBP survey over both wells. Then at well B17-06 (Station 52) a complete survey is carried out, comprising a CTD cast for SVP, a combined multibeam and SLURF survey, a combined magnetometer and SBP survey, and a CTD cast with water sampling. Of the three crossing lines of the magnetometer survey only one yields a clear magnetic anomaly.

Figure 4.12: Passing close by platform F02-Hanze while performing surveys at wells F02-03, F02-05 and F02-06. Photo Sharyn Ossebaar.

Saturday 18 June 2022
Shortly after midnight a survey is started at wells B17-03 and B17-05 (Station 53), starting with a CTD cast for SVP at well B17-03, then a combined multibeam and SLURF survey covering both wells with a series of lines of 1 km long, and a CTD cast with water sampling at well B17-05. At both wells bubble plumes are observed. Wells B17-01 and B17-04 are revisited (Station 54, previous Station 51) to complete the surveys there with a CTD cast for SVP at well B17-01, a combined multibeam and SLURF survey covering both wells with a series of lines of 1 km long, and a CTD cast with water sampling at well B17-04. Then half the day is spent with surveys at wells F02-03, F02-05 and F02-06 (Station 55) located in the vicinity of production platform F02-Hanze (Fig. 4.12). The first two wells are covered with

a combined magnetometer and SBP survey with two crossings lines over each well. The survey also passes once over F02-06, but no magnetic anomaly is recorded here, and due to the proximity of the platform there is no room for a crossing line. In the afternoon, further survey work is done at F02-05 (Station 56, previous Station 55), comprising a CTD for SVP, a combined multibeam and SLURF survey, and a CTD cast with water sampling. In the first CTD cast an Aquadopp ADCP and 5 optical backscatter sensors (OBSs) are mounted on the CTD frame and cable for an experiment for the PlumeFloc project. The transit to F02-03 is made with multibeam and SLURF in the water. In the late afternoon a combined multibeam and SLURF survey is started at well F02-03 (Station 57, previous Station 55), followed by a CTD cast with water sampling. The CTD cast is made to use for another PlumeFloc experiment with Aquadopp ADCP and OBSs. In the evening well F02-04 is revisited (Station 58, previous Station 45) to complete the work there with a CTD for SVP, a combined multibeam and SLURF survey, and a CTD cast with water sampling. No bubble plumes are observed.

Figure 4.13: Passing by platform F02-Hanze during nightly transit. Photo Sharyn Ossebaar.

Sunday 19 June 2022
Overnight the ship makes the transit to wells B17-05 and B17-03 with multibeam transducer head and SLURF in the water, starting from well F02-04, over well F02-05, then clockwise around platform F02-Hanze while maintaining a safe distance of 1 km to the platform (Fig. 4.13), and then along the pipeline in NNW direction until the B17 block. The nightly survey brings no evidence of bubble plumes or enhanced methane concentrations in water or atmosphere. In the morning a combined magnetometer and SBP survey is carried out over wells B17-05 and B17-03 (Station 59, previous station 53). On the first approach of well B17-05, the towing and data cables of the magnetometer get entangled with the float, and as a result the magnetometer does not reach the desired altitude above bottom while passing

over the target. The first survey line must therefore be repeated. The survey at this site is completed with a CTD cast with water samples at well B17-03. At well B14-03 (Station 60) a CTD cast is once again made to use for a PlumeFloc experiment with Aquadopp ADCP and OBSs similar to the previous two experiments. After that, a combined multibeam and SLURF survey, a combined magnetometer and SBP survey, and a CTD cast with water sampling are carried out. At well B14-01 (Station 61) a complete survey is carried out, comprising a CTD cast for SVP, a combined multibeam and SLURF survey, a combined magnetometer and SBP survey of which one line needs to be repeated, and a CTD cast with water sampling. No bubble plumes are observed. Late in the evening a combined magnetometer and SBP survey is started at well B18-02 (Station 62).

Figure 4.14: After a CTD-Rosette cast in the middle of night, the CTD night shift collects subsamples from the PRISTINE sampling bottles for chemical analysis. Photo Mélanie Diaz.

Monday 20 June 2022

During the night the survey at well B18-02 is completed with a CTD cast for SVP, a combined multibeam and SLURF survey, and a CTD cast with water sampling (Fig. 4.14). No bubble plumes are observed. In the early morning a survey comprising a CTD cast for SVP, a combined multibeam and SLURF survey, and a CTD cast with water sampling is carried out at a location where sidescan sonar data from industry showed water column reflections that might represent gas ebullition, here named F03-EBU (Station 63). No bubble plumes are observed this time. Next, a CTD cast with water sampling and a combined multibeam and SLURF survey are carried out over the section of gas pipeline where on 8 June enhanced concentration of methane and ethane were detected in the deep water (Station 64). The survey comprises three parallel lines of 1 km long, one along the E side of the pipeline, one directly over it, and one along the W side. This time only background concentrations of methane are measured with SLURF. As a background reference for water column chemistry, a CTD cast with water sampling is done at a site in the F08 block where with the best available knowledge no methane escape from the seabed can be expected, therefore named F08-Nothing (Station 65). At well F11-03 (Station 66) a survey comprising a CTD cast for SVP, a combined multibeam and SLURF survey, one line with SBP, and a CTD cast with water sampling is carried out. No bubble plumes are observed. With only one more day left for explorations, the rest of the day and the night are used for a continuous multibeam and SLURF survey across a number of locations of interest in the F16 and F17 blocks. Weather and seastate are good and getting better, with a moderate breeze from N subsiding to a gentle breeze from W. The survey starts late in the evening at well F17-14 (Station 67).

Tuesday 21 June 2022
Over the night and early morning, eight more wells are covered by the multibeam and SLURF survey: F16-02, F17-04, F17-07, F17-03, F17-06, F17-02, F17-01 and F17-08. At one of the wells crossed by the survey a bubble plume is observed. At well F14-03 (Station 68) a last complete survey is carried out comprising a CTD cast for SVP, a combined multibeam and SLURF survey, a combined magnetometer and SBP survey, and a CTD cast with water sampling. No bubble plumes are observed. As a last location of this campaign well F11-01 (Station 69) is visited. A survey comprising a CTD cast for SVP, a combined multibeam and SLURF survey, a CTD cast with water sampling, and one line SBP is carried out. The last CTD cast is made to use for another PlumeFloc experiment with Aquadopp ADCPs and OBSs. No bubble plumes are observed. Shortly after 17:00 h LT the ship starts to transit to Texel.

Wednesday 22 June 2022
With optimal weather and seastate conditions, the ship makes good progress during the night and morning. Around noon the ship rounds the southern tip of Texel and approaches NIOZ harbour through the Marsdiep (Fig. 4.15). After waiting about three hours for the ebb current to subside enough to allow safe entry into NIOZ harbour, RV Pelagia is moored off at 16:14 LT. All members of the science party disembark before 18:00 LT.

Figure 4.15: RV Pelagia approaching NIOZ harbour via Marsdiep. Photo Mélanie Diaz.

5. Preliminary results

CTD water column profiling

A recurrent feature in almost all CTD-Rosette casts was the distinct stratification, most clearly expressed in temperature, with a surface water layer of 15-25 m thick with temperature of 11.5-15°C, and a deeper water layer below 25 m with temperature of 7.5-9°C (Fig. 5.1). The two layers were separated by a smooth or more stepwise temperature gradient extending over 2-5 m. Over time, a warming of the uppermost meters of the surface water column was noticed, from around 12°C in the first days of the campaign to almost 15°C in the last days. The deeper water layer appeared more constant in temperature, except for the two southernmost stations, which happened to be also the last of the campaign, where the deeper water layer had a temperature around 11.5°C, at least 2.5°C warmer than in nearby stations. The temperature increase noted both in the surface and the deeper water layer was possibly caused by inflow of warmer water from the southern North Sea under influence of the prevailing wind from south and southwest.

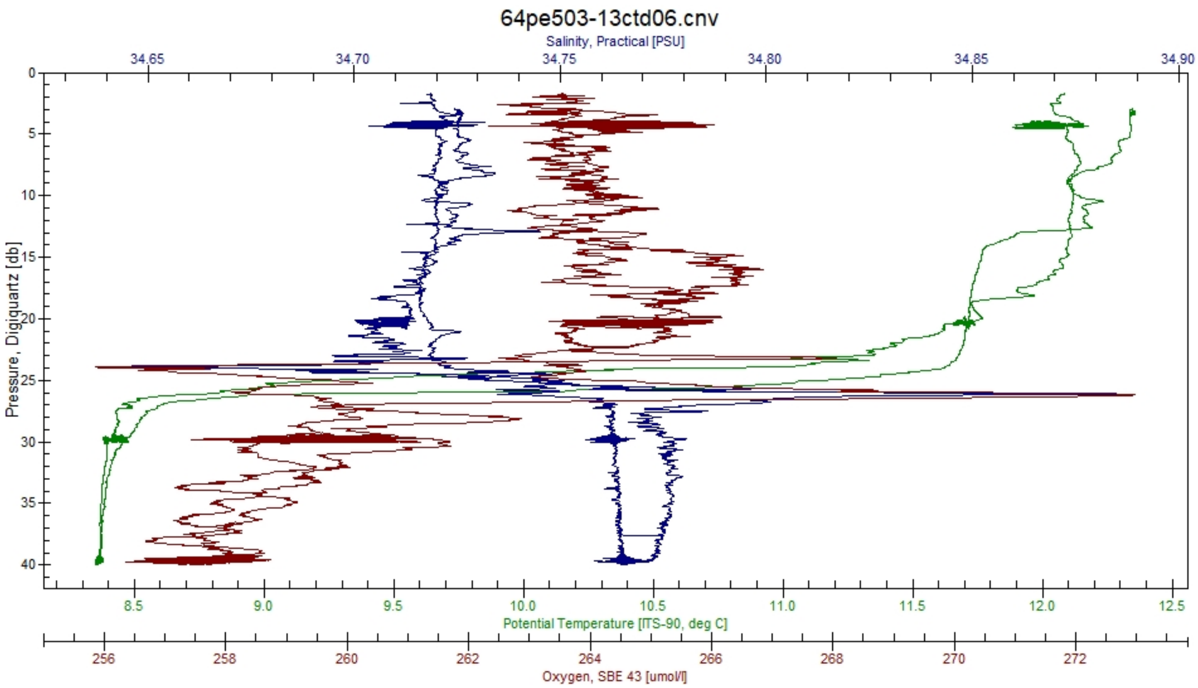

Figure 5.1: Example of raw CTD data recorded during down- and upcast at location B13-BS, showing distinct water mass stratification, with surface and deep water layers separated by steep gradients in temperature and salinity.

EM2040 multibeam

The EM2040 multibeam system performed very well during the entire duration of the campaign. However, as no calibration of the pitch, roll and heading had been performed at the start of the campaign, the acquired data was somewhat flawed especially for what concerns seabed bathymetry. It had no consequences for the detection of bubble plumes for which the EM2040 was used in the first place. While no signs of bubble plumes were observed at the first 8 locations surveyed during the first four days of the campaign, multiple and very distinct plumes were observed at the natural seep location

B13-BS. The plumes appeared in the EM2040 water column data as columns of distinctly higher acoustic backscatter, rising up from the seabed and reaching to the sea surface (Fig. 5.2).

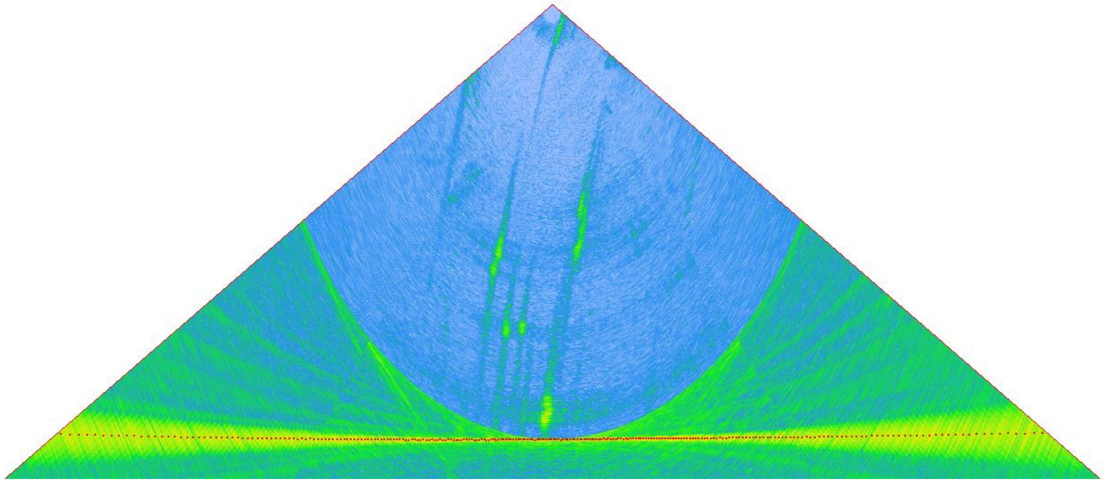

Figure 5.2: EM2040 water column acoustic backscatter data showing natural gas seepage at location B13-BS on Doggerbank. The triangle shape represents the section of the water column below the ship insonified by the fan-shaped array of acoustic beams. The blue colour represents relatively low backscatter in the water column, green and yellow represent higher backscatter from rising bubble plumes and from the seabed.

No bubble plume was seen at the nearby well B13-01, but during subsequent surveys at 59 subsequent locations distinct plumes were observed at A08-01, A14-02, A15-03, F01-01, B17-03 and B17-05 (Fig. 5.3), in all cases near the given location of the abandoned well head. The hypothesis for these wells is that they are caused by well leakage. In the vicinity of wells B17-04 and F17-14 bubble plumes were observed at considerable distance from the well-head. The hypothesis for these wells is that the bubble plumes are caused by natural seepage and not by well leakage.

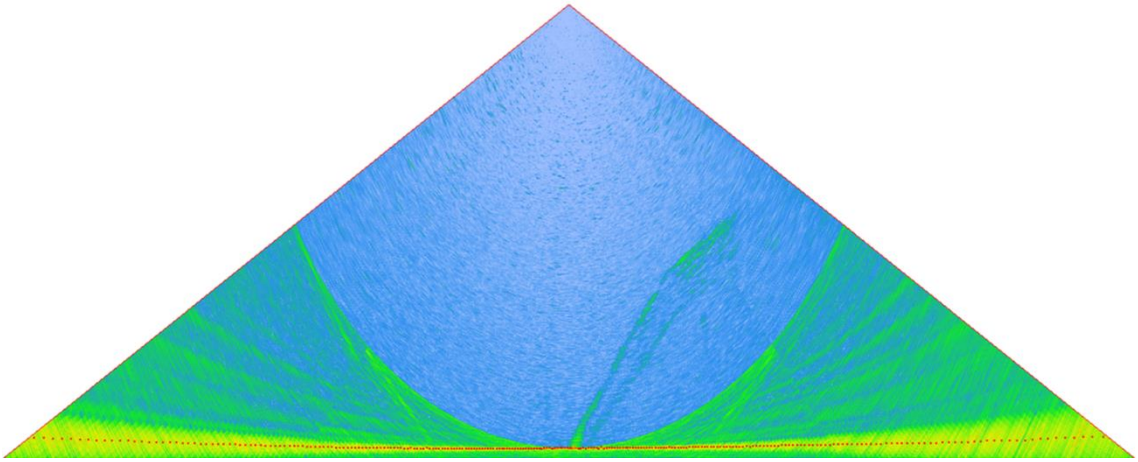

Figure 5.3: Bubble plume above well B17-05 at the well head location.

No plumes were observed at any of the locations where geomorphology (pockmark) or subsurface geophysical data (chimneys) suggest occurrence of methane seepage at present or in the past, nor were plumes found at places where ebullition had been inferred from sidescan sonar data. Further processing and analysis of all the collected multibeam data is needed to make sure that no plumes were missed. After that, the relationship between the occurrence of plumes and geological setting, well characteristics, and tidal amplitude and current will be evaluated.

Sub Bottom Profiler

With the Innomar Medium 100 Sub Bottom Profiler good quality profiles of shallow subsurface geological structure were obtained at all surveyed locations. Unfortunately, the Sub Bottom Profiler could not be synchronized with the EM2040 multibeam, and therefore the two systems could not be used simultaneously during the same survey, as this would result in interference of their signals. The obtained profiles reached to a depth of about 10 m below seabed, sufficient to reveal features of the late glacial and early Holocene landscape such as incised river valleys filled with peat or marine sediments, but not deep enough to fully complement exploration seismic profiles covering the ‘deeper’ subsurface (i.e. covering the interval up to 300 m below sea level, in which the exploration seismic surveys have relatively low resolution).

Magnetometer

The presence of buried well heads was clearly detected with the G882 magnetometer, towed 5-10 m above the seabed, as distinct positive anomalies in magnetic field against the background of around 50.10^3 nanoTesla. In most cases, two crossing survey lines with the magnetometer over the given position of the abandoned well head proved sufficient to confirm or adjust it’s position, but in some cases additional survey lines were needed to obtain a satisfying result. For well B17-06 no conclusive magnetic position could be determined within the available time.

Water sampling for Spectrometer analysis

During the campaign, methane enhancements in surface or deep water sampled with the Aquaflow or SLURF showed up directly in the spectrometer data displayed on the screen. Response checks were done regularly by injecting 5 mL natural gas into the waterflow (Fig. 5.4).

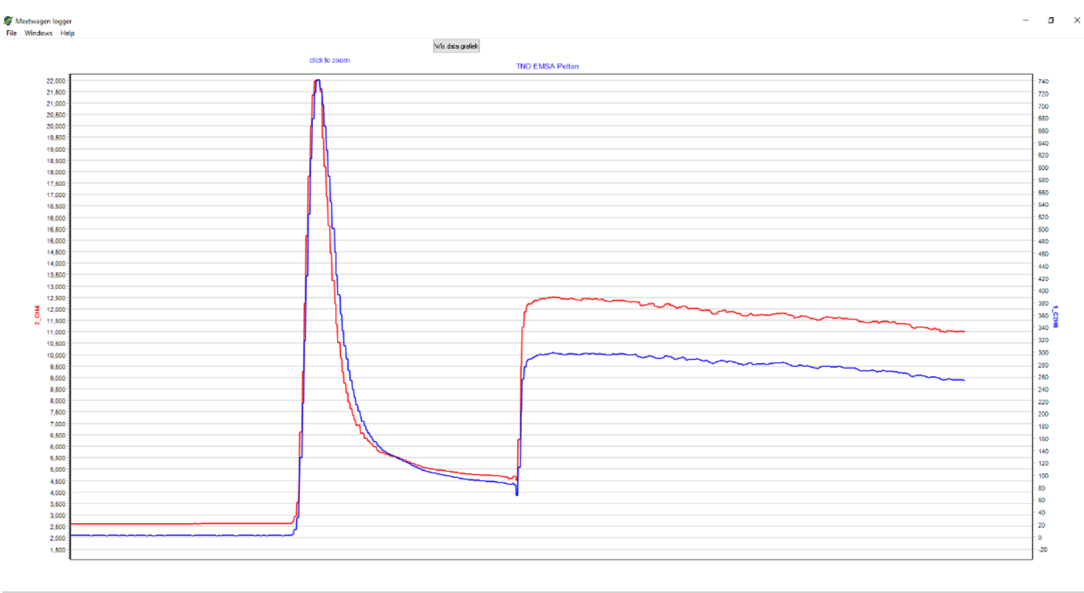

Figure 5.4: Response check of 3M membrane (first sharp peak) and Weiss equilibrator (second enhancement) for methane (red) and ethane (blue) when injecting 5 mL natural gas into the waterflow.

When bubble plumes were observed with the EM2040 multibeam at B13-BS, methane enhancements were also shown with the 3M membrane as well as with the Weiss equilibrator (Fig. 5.5 and 5.6). The peaks detected with the Weiss equilibrator were not as sharp as with the 3M membrane, but still clearly visible.

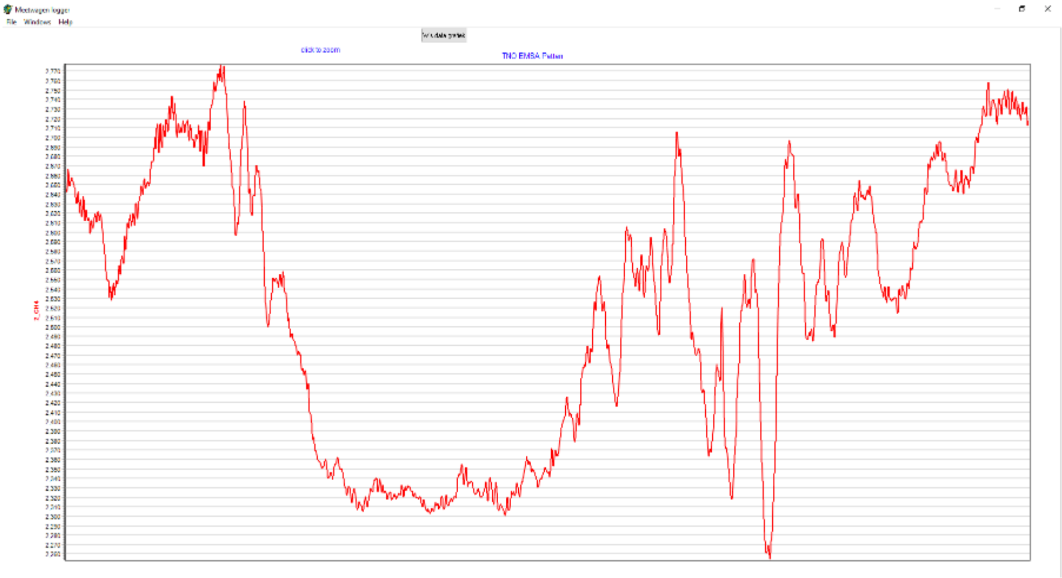

Figure 5.5: Methane enhancements at B13-BS, shown with the 3M membrane.

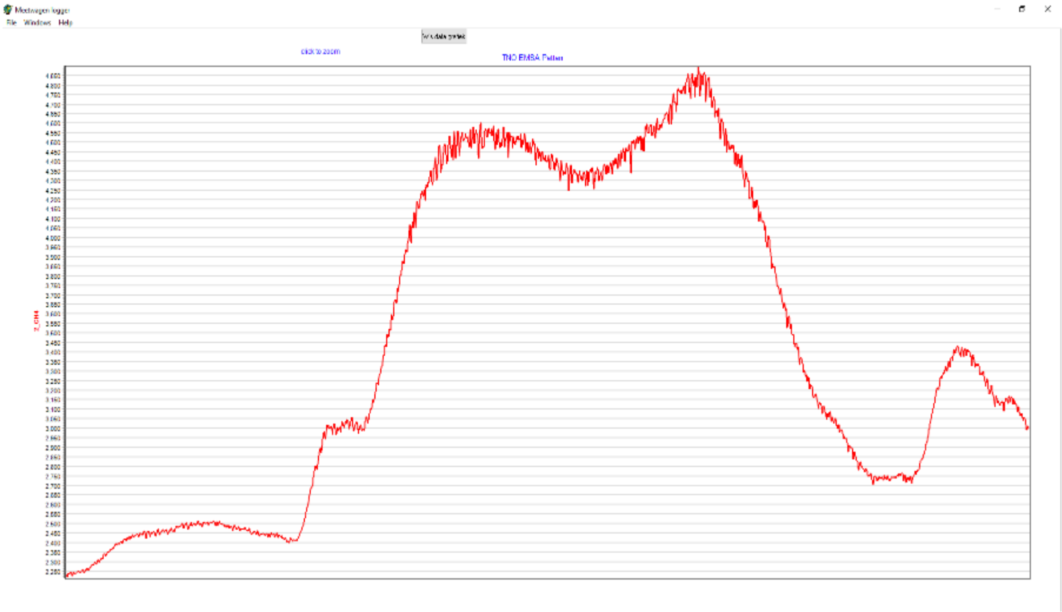

Figure 5.6: Methane enhancements at B13-BS, shown with the Weiss equilibrator.

Below some preliminary results are presented of the methane measurements with the laser spectrometer. The figures represent the raw concentration data not yet corrected for calibrations, water flow or temperature. The oscillating pattern, which is often shown when measuring via the 3M membrane, is a result of temperature fluctuations caused by the air-conditioning in the lab-container. Superimposed on this pattern, bubble plumes showed up when bubbles of methane passed through the system. Dissolved methane shows as broader enhancements instead of sharp peaks.

On 10 June between 04:15 and 08:10 the SLURF was sampling at 40 m below sea surface at location B13-BS. Methane plumes were detected continuously, with the 3M membrane (up to 600 ppb) as well as with the Weiss equilibrator (up to 3000 ppb) (Fig. 5.7).

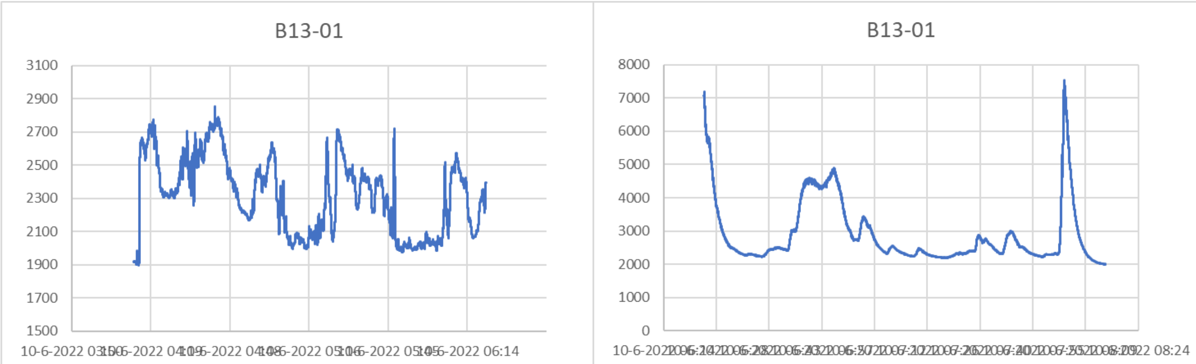

Figure 5.7: Methane plumes at B13-BS. Left: detected with 3M membrane; Right: detected with Weiss equilibrator.

On 11 June between 14:00 and 15:40 the SLURF was sampling at 30 m below sea surface at location A08-01. A methane plume of 27 ppb was detected at 14:20 (Fig. 5.8).

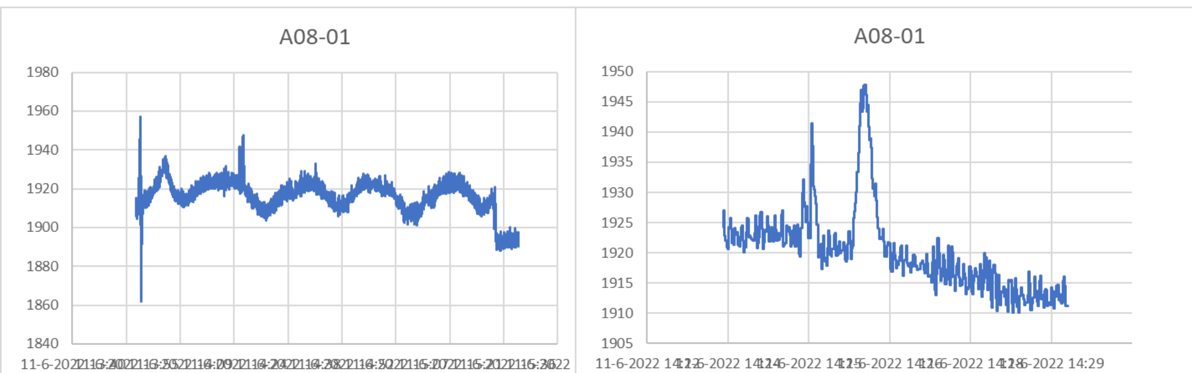

Figure 5.8: Methane plume at A08-01.

On 12 June between 10:00 and 12:00 the SLURF was sampling at 25 m below sea surface at location A14-02. A methane plume of 15 ppb was detected at 10:48 (Fig. 5.9).

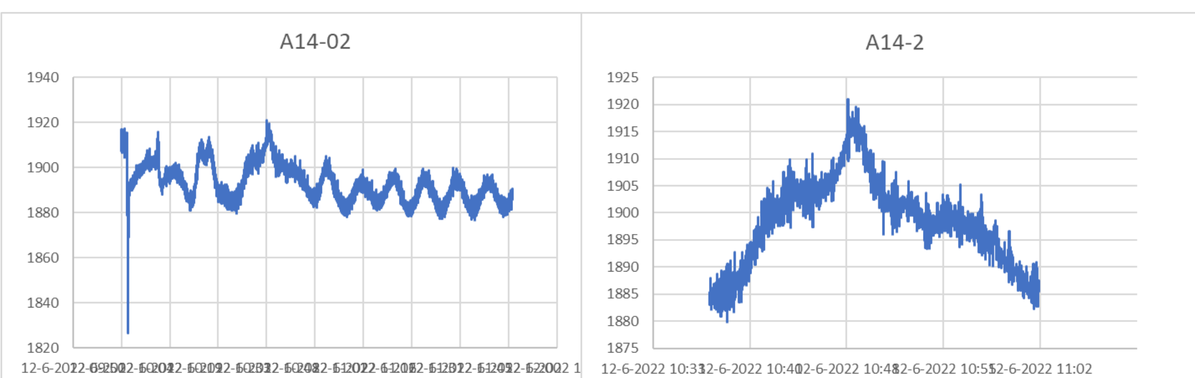

Figure 5.9: Methane plume at A14-02.

On 12 June between 15:00 and 17:40 the SLURF was sampling at 25 m below sea surface at location A15-03. Methane plumes up to 30 ppb were detected from 15:32 to 15:38 (Fig. 5.10).

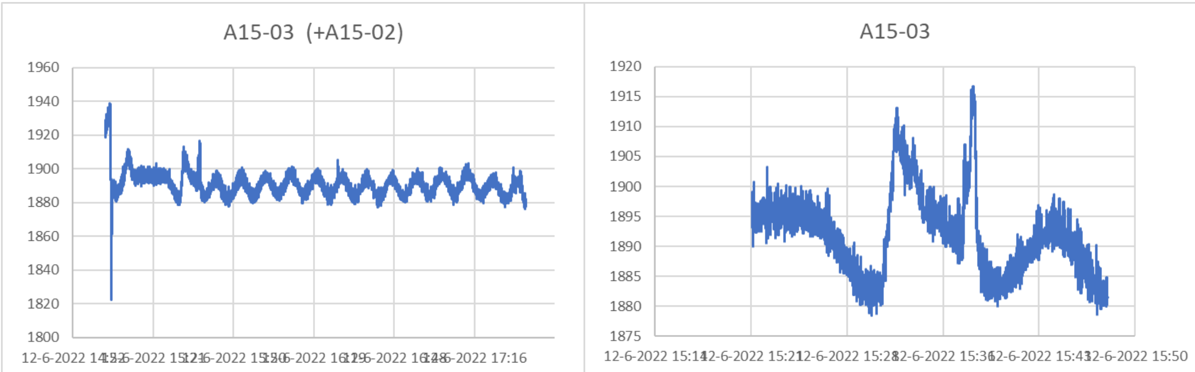

Figure 5.10: Methane plumes at A15-03.

On 16 June between 00:00 and 01:50 the SLURF was sampling at 40 m below sea surface at location F01-01. Here no methane plumes were detected with the laser spectrometer (Fig. 5.11).

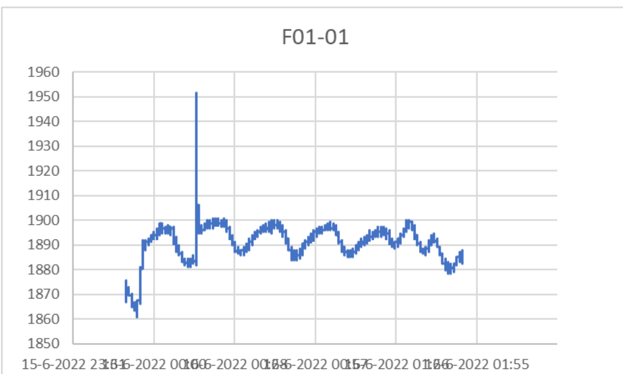

Figure 5.11: No methane plumes at F01-01. The spike is from switching between the Aquaflow and the SLURF.

On 17 June between 22:25 and 01:30 the SLURF was sampling at 30 m below sea surface at location B17-03 and B17-05. Methane plumes up to 30 ppb were detected from 22:46 to 00:58 (Fig. 5.12).

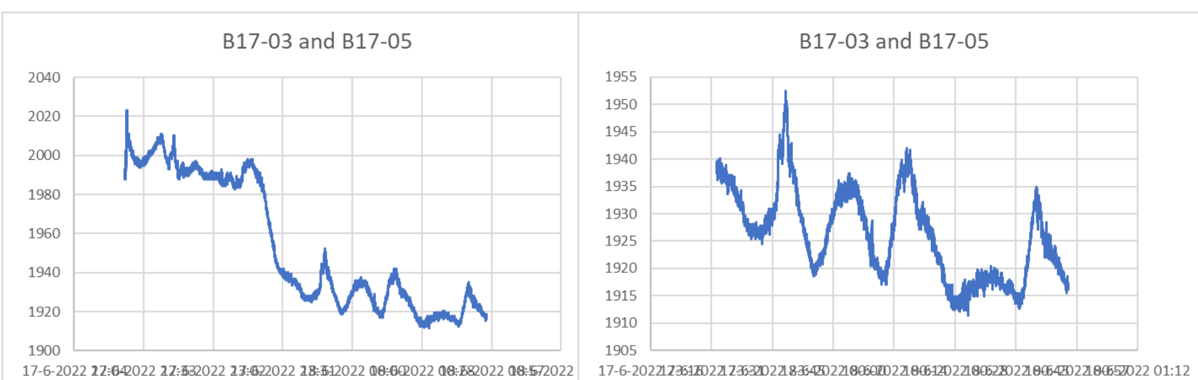

Figure 5.12: Methane plumes at B17-03 and B17-05.

On 18 June between 02:45 and 05:30 the SLURF was sampling at 30 m below sea surface at location B17-04. Several methane plumes were detected up to 30 ppb (Fig. 5.13).

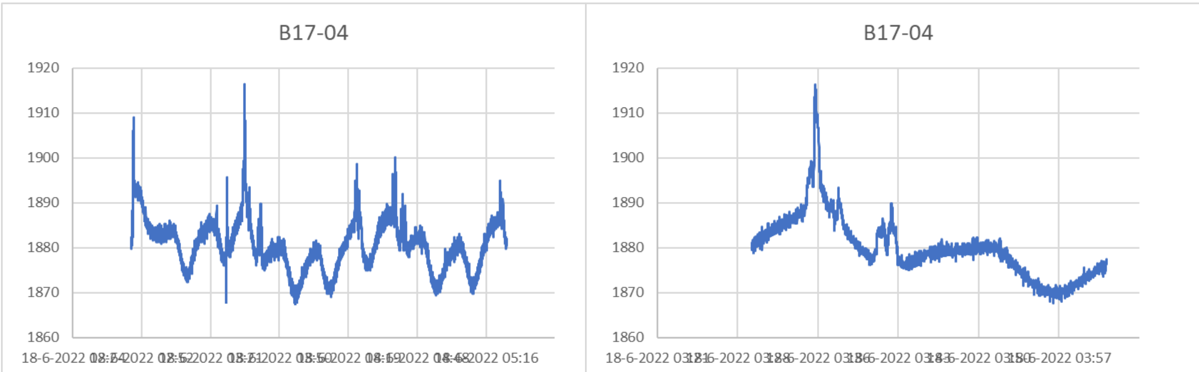

Figure 5.13: Methane plumes at B17-04.

Atmospheric measurements

Preliminary results of the atmospheric measurements with the Picarro for CH_4 and CO_2 are show in Figure 5.14. These results are not corrected for calibrations yet, only background concentrations were subtracted.

Figure 5.14: Atmospheric measurements of CH_4 (left) and CO_2 (right).

Water column sampling

Seawater sampling was carried out at 50 locations (Appendix 5). Except for pH measurements which were done on board, all other chemical analyses will be done on land in the NIOZ laboratory.

Acknowledgments

The RV Pelagia campaign 64PE503 was conducted with support by the Dutch State Supervision of the Mines via the scientific cooperation project “Meetcampagne Methaanemissie Offshore” (measurement campaign methane emissions offshore). We are indebted to Marck Smit for his contribution to the organization of the campaign, and to colleagues of the NIOZ National Marine Facilities department for technical support in preparation of the campaign. A special thanks to captain Henk Oenema and crew of RV Pelagia for the good-spirited and professional support provided at sea, which was essential for the success of this campaign.

The North Sea Methane science team and RV Pelagia crew. Standing left to right: Yasmina Ourradi, Hassan Shams, Vitalijs Maksimovs, Henko de Stigter, Jan-Dirk de Visser, Ilona Velzeboer, Linde Berbers, Jacco Heneweer, Edijs Puze, Chiel Suers, Kelly Kat, Roel van der Heide, Martin de Vries, Peter Lucassen, Henk Oenema; seated left to right: Stephan Rutten, Sander Asjes, Sharyn Ossebaar, Mélanie Diaz, Matylda Kordanska, Mathijs Schouten, Inno Meijer, Bert Hogewerf. Photo Geert de Bruin. Job Thijssen is missing in the photo but can be seen in action in Fig. 3.2.11 and 3.2.12.

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Appendix 1 – Science party and crew

Expedition leader
Henko de Stigter (NIOZ, marine geologist)

Science PI
Geert de Bruin (TNO & NIOZ, geologist)

MBES, SBP, magnetometer
Matylda Kordanska (surveyor)
Melanie Diaz (NIOZ, oceanographer)
Geert de Bruin (TNO & NIOZ, geologist)
Stephan Rutten (TU-Delft, student)

Spectrometer and air measurements
Ilona Velzeboer (TNO, environmental chemist)

CTD
Sander Asjes (NIOZ, electronic engineer)
Mathijs Schouten (SodM, oceanographer)

CTD Water sampling
Yasmina Ourradi (NIOZ, marine geochemist)
Sharyn Ossebaar (NIOZ, chemistry technician)
Job Thijssen (UvA, student)

Marine Facilities
Jan-Dirk de Visser (NIOZ, marine mechanics)

SodM representative
Linde Berbers (VU, student)

RV Pelagia crew
Henk Oenema (Captain)
Peter Lucassen (Chief officer)
Kelly Kat (Second officer)

Roel van der Heide (Bosun)
Jacco Heneweer (AB)
Chiel Suers (AB)
Martin de Vries (AB)
Edijs Puze (AB)

Bert Hogewerf (Chief engineer)
Inno Meijer (Second engineer)

Hassan Shams (Cook)
Vitalijs Maksimovs (Steward)

Appendix 2 – Locations of interest

	Station	Location	Type object	Typ	Bright Spot	Longitude WGS84	Latitude WGS84	MBES + Spectro meter	Magneto meter	SBP	CTD
1	1, 3, 5	F12-03	Well	Background	no data	4.74424318	54.37734165	Yes	Yes	Yes	Yes
2	2, 6	F12-Wrak	Wreck	Patch test	No			Yes	No	No	No
3	4	F12-05	Well	Shallow Gas	Confirmed SG	4.74805168	54.4014797	Yes	Yes	Yes	Yes
4	7	F12-BS	Bright Spot	Background	Unconfirmed SG	4.84289	54.41773	Yes	No	No	Yes
5	8	F12-01	Well	Near SG	Gas show	4.84124273	54.46979024	Yes	Yes	Yes	Yes
6	9	F09-01	Well	Near SG	Gas show	4.73673566	54.60309922	Yes	No	Yes	Yes
7	10	F09-03	Well	Background	No	4.73990462	54.65752098	Yes	No	Yes	Yes
8	11	F06-04	Well	Background	No	4.73137427	54.69551019	Yes	Yes	Yes	Yes
9	12	F06-02	Well	Near SG	Gas show	4.91557513	54.82063801	Yes	No	Yes	Yes
10	12	F06-05	Well	Near SG	Gas show	4.8946251	54.82238817	Yes	No	Yes	Yes
11	12	F06-Ch	Gas chimney	Background	No	4.93617	54.81601	Yes	No	Yes	No
12	13	B13-01	Well	Shallow Gas	Confirmed SG	4.07363935	55.29964342	Yes	Yes	Yes	?
13	13	B13-BS	Bright Spot	Background	Confirmed SG	4.073233	55.302505	Yes	No	?	Yes
14	14	B10-02	Well	Shallow Gas	Confirmed SG	4.05394299	55.33867235	Yes	Yes	Yes	Yes
15	15	B10-Wrak	Wreck	Patch test	No			Yes	No	No	No
16	16	B10-03	Well	Shallow Gas	Confirmed SG	4.00241173	55.39892385	Yes	Yes	No	Yes
17	16	B10-04	Well	Shallow Gas	Confirmed SG	4.00448416	55.40328703	Yes	Yes	No	Yes
18	17	A12-02	Well	Shallow Gas	Confirmed SG	3.97532772	55.39897915	Yes	Yes	Yes	Yes
19	18	A12-03	Well	Shallow Gas	Confirmed SG	3.78862835	55.40031038	Yes	Yes	Yes	Yes
20	19, 29	A08-01	Well	Shallow Gas	Confirmed SG	3.63318893	55.53488828	Yes	Yes	Yes	Yes
21	20	A11-PM	Pockmark	Background	No	3.50331972 2	55.38634833	Yes	No	No	Yes
22	21, 30	A14-02	Well	Shallow Gas	Unconfirmed SG	3.39488769	55.32443529	Yes	Yes	Yes	Yes
23	22, 32	A15-02	Well	Shallow Gas	Confirmed SG	3.81706291	55.30531022	Yes	Yes	Yes	Yes
24	22	A15-03	Well	Shallow Gas	Confirmed SG	3.82652445	55.30047042	Yes	No	Yes	Yes
25	23, 32	A15-05	Well	Shallow Gas	Confirmed SG	3.82888005	55.31302116	Yes	Yes	Yes	Yes
26	24	B13-04	Well	Shallow Gas	Confirmed SG	4.07925286	55.23422462	Yes	No	Yes	Yes
27	25, 33	B13-03	Well	Shallow Gas	Confirmed SG	4.08664047	55.27719839	Yes	Yes	Yes	Yes
28	26	B16-01	Well	Shallow Gas	Confirmed SG	4.03839471	55.11663672	Yes	No	Yes	Yes
29	27	A18-02	Well	Shallow Gas	Confirmed SG	3.81061649	55.11540361	Yes	No	Yes	Yes
30	28	A18-EBU	Pockmark	Background	No	3.768550	55.11530	Yes	No	Yes	Yes
31	31	A14-01	Well	Background	No	3.60921393	55.19960703	Yes	Yes	Yes	Yes
32	34, 36	A15-04	Well	Shallow Gas	Confirmed SG	3.9081659	55.20105816	Yes	Yes	Yes	Yes
33	35	A15-01	Well	Background	No	3.70168851	55.20069141	Yes	Yes	Yes	Yes
34	37	A18-01	Well	Shallow Gas	Confirmed SG	3.9054766	55.05607764	Yes	Yes	Yes	Yes
35	38, 41	F01-01	Well	Shallow Gas	Confirmed SG	4.02142801	54.93868602	Yes	Yes	Yes	Yes
36	39, 42	F04-01	Well	Shallow Gas	Confirmed SG	4.11857347	54.81915523	Yes	Yes	Yes	Yes
37	40, 50	F04-02	Well	Near SG	no data	4.33016306	54.799268	Yes	Yes	Yes	Yes
38	43, 46, 49	F05-02	Well	Shallow Gas	Confirmed SG	4.37858254	54.75068359	Yes	Yes	Yes	Yes

39	43, 46	F05-06	Well	Shallow Gas	Confirmed SG	4.35867376	54.75529525	Yes	Yes	Yes	Yes
40	44, 48	F05-05	Well	Shallow Gas	Unconfirmed SG	4.38895029	54.67280495	Yes	Yes	Yes	Yes
41	45, 58	F02-04	Well	Shallow Gas	Confirmed SG	4.47450718	54.92075436	Yes	Yes	Yes	Yes
42	47	F05-Chimney	Bright Spot	Background	Confirmed SG	4.365922	54.739052	Yes	No	No	Yes
43	51, 54	B17-01	Well	Near SG	No show	4.47401986	55.04016675	Yes	Yes	Yes	?
44	51, 54	B17-04	Well	Near SG	Gas Show	4.48072572	55.03470834	Yes	Yes	Yes	Yes
45	52	B17-06	Well	Shallow Gas	Confirmed SG	4.50937218	55.06718197	Yes	Yes	Yes	Yes
46	53, 59	B17-03	Well	Shallow Gas	Confirmed SG	4.5141048	55.02299991	Yes	Yes	Yes	Yes
47	53, 59	B17-05	Well	Shallow Gas	Confirmed SG	4.52318809	55.03025026	Yes	Yes	Yes	Yes
48	55, 57	F02-03	Well	Shallow Gas	Confirmed SG	4.56537534	54.92745293	Yes	Yes	Yes	Yes
49	55, 56	F02-05	Well	Shallow Gas	Confirmed SG	4.55400866	54.93901697	Yes	Yes	Yes	Yes
50	55	F02-06	Well	Shallow Gas	Confirmed SG	4.56752611	54.93621312	Yes	Yes	Yes	Yes
51	60	B14-03	Well	Background	Fair	4.57340954	55.17470309	Yes	Yes	Yes	Yes
52	61	B14-01	Well	Shallow Gas	Confirmed SG	4.57512809	55.20400682	Yes	Yes	Yes	Yes
53	62	B18-02	Well	Background	No	4.7954432	55.09247772	Yes	Yes	Yes	Yes
54	63	F03-EBU	Plume	Background	No	4.92408	54.967964	Yes	No	No	Yes
55	64	F09-Pipeline	Pipeline	Pipeline	Unconfirmed SG	4.7459	54.604536	Yes	No	No	No
56	65	F08-Nothing	As far away as possible	Background	No	4.432704	54.523828	No	No	No	Yes
57	66	F11-03	Well	Background	No	4.3816477	54.46220162	Yes	?	Yes	Yes
58	67	F16-02	Well	Shallow Gas	Unconfirmed SG	4.33051214	54.05991803	Yes	No	No	No
59	67	F17-01	Well	Background	No	4.52693949	54.14472023	Yes	No	No	No
60	67	F17-02	Well	Background	No	4.53941239	54.13310888	Yes	No	No	No
61	67	F17-03	Well	Background	No	4.48555219	54.06105037	Yes	No	No	No
62	67	F17-04	Well	Background	No	4.43563423	54.0603831	Yes	No	No	No
63	67	F17-06	Well	Background	No	4.50896867	54.08385689	Yes	No	No	No
64	67	F17-07	Well	Background	No	4.46416284	54.05777223	Yes	No	No	No
65	67	F17-08	Well	Background	No	4.55617442	54.14950902	Yes	No	No	No
66	67	F17-14	Well	Near SG		4.37759504	54.13622418	Yes	No	No	No
67	68	F14-03	Well	Shallow Gas	Unconfirmed SG	4.60860641	54.20091751	Yes	Yes	Yes	Yes
68	69	F11-01	Well	Background	No	4.59279517	54.36706184	Yes	No	Yes	Yes

Appendix 3 – List of stations and actions

Date & Time (UTC)	Station_Cast	Device	Action	Latitude	Longitude	Depth (m)	Site	Comment
05/06/2022 10:41	Port call	None	PHASE START	53,0068	4,7960		NIOZ harbour	Not logged in Shipdata
05/06/2022 17:38	Port call	None	PHASE START	53,0068	4,7960		NIOZ harbour	Not logged in Shipdata
05/06/2022 18:06	Port call	None	PHASE START	53,0068	4,7960		NIOZ harbour	Not logged in Shipdata
06/06/2022 06:14	1_1	CTD with Samples	BEGIN	54,3775	4,7440		F12-03	
06/06/2022 06:19	1_1	CTD with Samples	BOT	54,3773	4,7438	47	F12-03	
06/06/2022 06:38	1_1	CTD with Samples	END	54,3770	4,7437		F12-03	Aborted
06/06/2022 06:50	1_2	CTD with Samples	BEGIN	54,3775	4,7442		F12-03	
06/06/2022 06:53	1_2	CTD with Samples	BOT	54,3773	4,7443	46	F12-03	
06/06/2022 07:12	1_2	CTD with Samples	END	54,3777	4,7450		F12-03	
06/06/2022 09:38	2_1	Multibeam	BEGIN	54,4077	4,7670		F12-Wreck	
06/06/2022 12:16	2_1	Multibeam	END				F12-Wreck	GPS down
06/06/2022 12:22	Transit	Multibeam	BEGIN					GPS down
06/06/2022 14:54	Transit	Multibeam	END					GPS down, Shipdata correction
06/06/2022 14:54	3_1	Multibeam	BEGIN				F12-03	GPS down, Shipdata correction
06/06/2022 14:54	3_2	Slurf	BEGIN	54,3775	4,7463		F12-03	
06/06/2022 15:20	3_2	Slurf	END	54,3780	4,7433		F12-03	
06/06/2022 15:20	3_1	Multibeam	END	54,3778	4,7435		F12-03	
07/06/2022 06:09	4_1	CTD with Samples	BEGIN	54,4015	4,7485		F12-05	
07/06/2022 06:05	4_1	CTD with Samples	BOT	54,4018	4,7483	47	F12-05	Shipdata correction by bridge

07/06/2022 06:27	4_1	CTD with Samples	END	54,4012	4,7487		F12-05	
07/06/2022 07:47	4_2	Multibeam	BEGIN	54,4008	4,7498		F12-05	
07/06/2022 07:48	4_3	Slurf	BEGIN	54,4008	4,7497		F12-05	
07/06/2022 09:27	4_4	Subbottom profiler	BEGIN	54,4022	4,7462		F12-05	GPS down, LatLong interpolated, Shipdata correction by bridge
07/06/2022 09:31	4_4	Subbottom profiler	END	54,4011	4,7491		F12-05	GPS down, LatLong interpolated, Shipdata correction by bridge
07/06/2022 09:32	4_2	Multibeam	END	54,4007	4,7500		F12-05	
07/06/2022 09:32	4_3	Slurf	END	54,4007	4,7502		F12-05	
07/06/2022 11:19	4_5	Magnetometer	BEGIN	54,4002	4,7472		F12-05	
07/06/2022 14:35	4_5	Magnetometer	END	54,4012	4,7448		F12-05	
07/06/2022 15:18	5_1	Magnetometer	BEGIN	54,3793	4,7438		F12-03	
07/06/2022 17:10	5_1	Magnetometer	END	54,3768	4,7363		F12-03	
07/06/2022 18:17	5_2	Multibeam	BEGIN	54,3772	4,7463		F12-03	
07/06/2022 18:17	5_3	Slurf	BEGIN	54,3772	4,7463		F12-03	Shipdata correction
07/06/2022 19:19	5_3	Slurf	END	54,3765	4,7417		F12-03	Shipdata correction
07/06/2022 19:19	5_2	Multibeam	END	54,3765	4,7417		F12-03	
07/06/2022 19:27	5_4	Subbottom profiler	BEGIN	54,3773	4,7423		F12-03	Shipdata correction by bridge
07/06/2022 19:33	5_4	Subbottom profiler	END	54,3773	4,7467		F12-03	
07/06/2022 20:54	6_1	Multibeam	BEGIN	54,4085	4,7637		F12-Wreck	
07/06/2022 22:53	6_1	Multibeam	END	54,4080	4,7610		F12-Wreck	
07/06/2022 22:53	Transit	Multibeam	BEGIN	54,4080	4,7610			

08/06/2022 00:00	Transit	Multibeam	END	54,4025	4,8122			
08/06/2022 00:02	7_1	Multibeam	BEGIN	54,4028	4,8142		F12-BS	
08/06/2022 07:36	7_1	Multibeam	END	54,4258	4,8360		F12-BS	
08/06/2022 09:11	8_1	CTD	BEGIN	54,4698	4,8413		F12-01	
08/06/2022 09:15	8_1	CTD	BOT	54,4695	4,8415	46	F12-01	
08/06/2022 09:18	8_1	CTD	END	54,4698	4,8413		F12-01	
08/06/2022 10:22	8_2	Multibeam	BEGIN	54,4712	4,8382		F12-01	
08/06/2022 10:22	8_3	Slurf	BEGIN	54,4712	4,8382		F12-01	
08/06/2022 11:38	8_2	Multibeam	END	54,4685	4,8463		F12-01	
08/06/2022 11:47	8_4	Subbottom profiler	BEGIN	54,4683	4,8450		F12-01	
08/06/2022 12:04	8_4	Subbottom profiler	END	54,4725	4,8377		F12-01	
08/06/2022 12:04	8_3	Slurf	END	54,4725	4,8377		F12-01	
08/06/2022 12:22	8_5	CTD with Samples	BEGIN	54,4703	4,8413		F12-01	
08/06/2022 12:35	8_5	CTD with Samples	BOT	54,4698	4,8413	45	F12-01	
08/06/2022 12:52	8_5	CTD with Samples	END	54,4697	4,8413		F12-01	
08/06/2022 13:10	8_6	Magnetometer	BEGIN	54,4697	4,8495		F12-01	
08/06/2022 15:18	8_6	Magnetometer	END	54,4723	4,8350		F12-01	
08/06/2022 16:38	9_1	CTD	BEGIN	54,6033	4,7368		F09-01	
08/06/2022 16:41	9_1	CTD	BOT	54,6035	4,7368	49	F09-01	
08/06/2022 16:46	9_1	CTD	END	54,6030	4,7368		F09-01	
08/06/2022 16:55	9_2	Multibeam	BEGIN	54,5998	4,7362		F09-01	
08/06/2022 17:15	9_3	Slurf	BEGIN	54,6000	4,7363		F09-01	
08/06/2022 19:09	9_2	Multibeam	END	54,6083	4,7358		F09-01	
08/06/2022 19:16	9_4	Subbottom profiler	BEGIN	54,6052	4,7367		F09-01	

08/06/2022 19:25	9_4	Subbottom profiler	END	54,6005	4,7367		F09-01	Shipdata correction by bridge
08/06/2022 19:40	9_3	Slurf	END	54,6032	4,7360		F09-01	Shipdata correction by bridge
08/06/2022 19:47	9_5	CTD with Samples	BEGIN	54,6032	4,7362		F09-01	
08/06/2022 19:50	9_5	CTD with Samples	BOT	54,6028	4,7365	49	F09-01	
08/06/2022 20:10	9_5	CTD with Samples	END	54,6030	4,7370		F09-01	
08/06/2022 20:27	Transit	Slurf	BEGIN	54,6022	4,7400			
08/06/2022 20:30	Transit	Multibeam	BEGIN	54,6017	4,7413			Shipdata correction by bridge
08/06/2022 22:59	Transit	Slurf	END	54,6592	4,7400			
08/06/2022 22:59	Transit	Multibeam	END	54,6592	4,7400			
08/06/2022 23:00	10_1	CTD	BEGIN	54,6595	4,7400		F09-03	
08/06/2022 23:00	10_1	CTD	BOT	54,6598	4,7400	49	F09-03	
08/06/2022 23:00	10_1	CTD	END	54,6598	4,7400		F09-03	
08/06/2022 23:01	10_2	Slurf	BEGIN	54,6600	4,7400		F09-03	
08/06/2022 23:01	10_3	Multibeam	BEGIN	54,6602	4,7400		F09-03	
09/06/2022 00:09	10_3	Multibeam	END	54,6598	4,7383		F09-03	
09/06/2022 00:17	10_4	Subbottom profiler	BEGIN	54,6595	4,7400		F09-03	
09/06/2022 00:28	10_4	Subbottom profiler	END	54,6543	4,7398		F09-03	
09/06/2022 00:38	10_2	Slurf	END	54,6562	4,7397		F09-03	
09/06/2022 00:42	10_5	CTD with Samples	BEGIN	54,6577	4,7402		F09-03	
09/06/2022 00:47	10_5	CTD with Samples	BOT	54,6575	4,7400	50	F09-03	
09/06/2022 01:06	10_5	CTD with Samples	END	54,6575	4,7400		F09-03	
09/06/2022 01:08	Transit	Multibeam	BEGIN	54,6575	4,7397			

09/06/2022 02:29	Transit	Multibeam	END	54,6955	4,7278			
09/06/2022 02:48	11_1	CTD	BEGIN	54,6955	4,7317		F06-04	
09/06/2022 02:54	11_1	CTD	BOT	54,6955	4,7317	48	F06-04	
09/06/2022 02:57	11_1	CTD	END	54,6955	4,7318		F06-04	
09/06/2022 03:22	11_2	Multibeam	BEGIN	54,6932	4,7318		F06-04	
09/06/2022 04:58	11_2	Multibeam	END	54,6988	4,7298		F06-04	
09/06/2022 05:11	11_3	Subbottom profiler	BEGIN	54,6977	4,7312		F06-04	
09/06/2022 05:20	11_3	Subbottom profiler	END	54,6928	4,7315		F06-04	
09/06/2022 05:33	11_4	CTD with Samples	BEGIN	54,6955	4,7317		F06-04	
09/06/2022 05:40	11_4	CTD with Samples	BOT	54,6953	4,7317	48	F06-04	
09/06/2022 05:56	11_4	CTD with Samples	END	54,6955	4,7318		F06-04	
09/06/2022 06:25	11_5	Magnetometer	BEGIN	54,6938	4,7312		F06-04	Shipdata correction by bridge
09/06/2022 07:22	11_5	Magnetometer	END	54,6978	4,7213		F06-04	
09/06/2022 09:07	12_2	CTD	BEGIN	54,8225	4,8947		F06-05	Cast 1 erroneously logged as 2
09/06/2022 09:11	12_2	CTD	BOT	54,8228	4,8945	44	F06-05	
09/06/2022 09:13	12_2	CTD	END	54,8227	4,8948		F06-05	
09/06/2022 10:06	12_3	Multibeam	BEGIN	54,8235	4,8917		F06-05, F06-02, F06-Ch	
09/06/2022 10:07	12_4	Slurf	BEGIN	54,8235	4,8917		F06-05, F06-02, F06-Ch	
09/06/2022 14:31	12_3	Multibeam	END	54,8205	4,9122		F06-05, F06-02, F06-Ch	
09/06/2022 14:33	12_4	Slurf	END	54,8208	4,9132		F06-05, F06-02, F06-CH	
09/06/2022 14:42	12_5	CTD with Samples	BEGIN	54,8208	4,9153		F06-02	

	12_5	CTD with Samples	BOT			45	F06-02	Not logged in Shipdata
09/06/2022 15:11	12_5	CTD with Samples	END	54,8208	4,9158		F06-02	
09/06/2022 16:35	12_6	Magnetometer	BEGIN	54,8252	4,9158		F06-02	
09/06/2022 17:46	12_6	Magnetometer	END	54,8210	4,9092		F06-02	
09/06/2022 18:10	12_7	CTD with Samples	BEGIN	54,8225	4,8950		F06-05	
09/06/2022 18:13	12_7	CTD with Samples	BOT	54,8225	4,8947	44	F06-05	
09/06/2022 18:31	12_7	CTD with Samples	END	54,8225	4,8943		F06-05	
09/06/2022 19:07	12_8	Multibeam	BEGIN	54,8233	4,8893		F06-05, F06-02, F06-Ch	
09/06/2022 19:07	12_9	Slurf	BEGIN	54,8233	4,8893		F06-05, F06-02, F06-Ch	
09/06/2022 21:20	12_8	Multibeam	END	54,8217	4,8897		F06-05, F06-02, F06-Ch	
09/06/2022 21:24	12_10	Subbottom profiler	BEGIN	54,8225	4,8910		F06-05, F06-02, F06-Ch	
09/06/2022 22:37	12_9	Slurf	END	54,8150	4,9395		F06-05, F06-02, F06-Ch	
09/06/2022 22:52	12_10	Subbottom profiler	END	54,8147	4,9362		F06-05, F06-02, F06-Ch	
10/06/2022 03:52	13_1	CTD	BEGIN	55,3000	4,0737		B13-01	
10/06/2022 03:56	13_1	CTD	BOT	55,3003	4,0735	45	B13-01	
10/06/2022 04:00	13_1	CTD	END	55,3002	4,0735		B13-01	
10/06/2022 04:12	13_2	Slurf	BEGIN	55,3000	4,0738		B13-01, B13-BS	
10/06/2022 04:18	13_3	Multibeam	BEGIN	55,2995	4,0787		B13-01, B13-BS	
10/06/2022 08:03	13_3	Multibeam	END	55,3028	4,0760		B13-01, B13-BS	
10/06/2022 08:09	13_2	Slurf	END	55,3025	4,0785		B13-01, B13-BS	
10/06/2022 08:41	13_4	Magnetometer	BEGIN	55,3030	4,0727		B13-01, B13-BS	

10/06/2022 10:25	13_5	Subbottom profiler	BEGIN	55,2945	4,0737		B13-01, B13-BS	
10/06/2022 10:26	13_4	Magnetometer	END	55,2943	4,0737		B13-01, B13-BS	
10/06/2022 10:28	13_5	Subbottom profiler	END	55,2947	4,0740		B13-01, B13-BS	Shipdata correction by bridge
10/06/2022 11:06	13_6	CTD with Samples	BEGIN	55,3025	4,0728		B13-BS	
10/06/2022 11:07	13_6	CTD with Samples	BOT	55,3027	4,0728	45	B13-BS	
10/06/2022 11:27	13_6	CTD with Samples	END	55,3027	4,0728		B13-BS	
10/06/2022 11:31	Transit	Multibeam	BEGIN	55,3030	4,0728			
10/06/2022 12:56	Transit	Multibeam	END	55,3383	4,0553			
10/06/2022 13:06	14_1	CTD	BEGIN	55,3388	4,0540		B10-02	
10/06/2022 13:10	14_1	CTD	BOT	55,3387	4,0542	44	B10-02	
10/06/2022 13:13	14_1	CTD	END	55,3388	4,0543		B10-02	
10/06/2022 13:22	14_2	Slurf	BEGIN	55,3390	4,0585		B10-02	
10/06/2022 13:30	14_3	Multibeam	BEGIN	55,3390	4,0582		B10-02	
10/06/2022 15:06	14_3	Multibeam	END	55,3378	4,0508		B10-02	
10/06/2022 15:15	14_2	Slurf	END	55,3383	4,0470		B10-02	
10/06/2022 15:33	14_4	CTD with Samples	BEGIN	55,3387	4,0535		B10-02	
10/06/2022 15:41	14_4	CTD with Samples	BOT	55,3387	4,0547	45	B10-02	
10/06/2022 15:58	14_4	CTD with Samples	END	55,3385	4,0542		B10-02	
10/06/2022 16:45	14_5	Magnetometer	BEGIN	55,3408	4,0570		B10-02	
10/06/2022 16:45	14_6	Subbottom profiler	BEGIN	55,3408	4,0570		B10-02	Shipdata correction by bridge
10/06/2022 17:33	14_6	Subbottom profiler	END	55,3357	4,0622		B10-02	
10/06/2022 17:34	14_5	Magnetometer	END	55,3357	4,0622		B10-02	
10/06/2022 18:24	15_1	Multibeam	BEGIN	55,3718	4,0025		B10-Wreck	

10/06/2022 19:35	15_1	Multibeam	END	55,3723	4,0105		B10-Wreck	
10/06/2022 20:04	16_1	CTD	BEGIN	55,3993	4,0025		B10-03	
10/06/2022 20:06	16_1	CTD	BOT	55,3992	4,0023	29	B10-03	
10/06/2022 20:09	16_1	CTD	END	55,3992	4,0022		B10-03	
10/06/2022 20:58	16_2	Multibeam	BEGIN	55,3983	4,0018		B10-03, B10-04	Shipdata correction by bridge
10/06/2022 20:58	16_3	Slurf	BEGIN	55,3983	4,0018		B10-03, B10-04	Shipdata correction by bridge
10/06/2022 23:05	16_2	Multibeam	END	55,4045	4,0038		B10-03, B10-04	
10/06/2022 23:26	16_3	Slurf	END	55,4002	4,0032		B10-03, B10-04	
10/06/2022 23:32	16_4	CTD with Samples	BEGIN	55,3992	4,0025		B10-03	
10/06/2022 23:36	16_4	CTD with Samples	BOT	55,3990	4,0023	29	B10-03	
10/06/2022 23:50	16_4	CTD with Samples	END	55,3988	4,0025		B10-03	
10/06/2022 23:56	Transit	Multibeam	BEGIN	55,3990	3,9998			Shipdata correction
11/06/2022 00:21	Transit	Multibeam	END	55,3993	3,9758			Shipdata correction
11/06/2022 00:30	17_1	CTD	BEGIN	55,3990	3,9757		A12-02	
11/06/2022 00:34	17_1	CTD	BOT	55,3990	3,9757	29	A12-02	
11/06/2022 00:37	17_1	CTD	END	55,3990	3,9757		A12-02	
11/06/2022 00:43	17_2	Multibeam	BEGIN	55,3992	3,9775		A12-02	
11/06/2022 02:08	17_2	Multibeam	END	55,3983	3,9715		A12-02	
11/06/2022 02:25	17_3	CTD with Samples	BEGIN	55,3990	3,9755		A12-02	
11/06/2022 02:28	17_3	CTD with Samples	BOT	55,3992	3,9755	31	A12-02	
11/06/2022 02:40	17_3	CTD with Samples	END	55,3990	3,9758		A12-02	
11/06/2022 03:00	17_4	Magnetometer	BEGIN	55,4052	3,9773		A12-02, B10-04, B10-03	

11/06/2022 03:00	17_5	Subbottom profiler	BEGIN	55,4050	3,9773		A12-02, B10-04, B10-03	
11/06/2022 06:16	17_5	Subbottom profiler	END	55,3995	3,9972		A12-02, B10-04, B10-03	
11/06/2022 06:19	17_4	Magnetometer	END	55,3995	3,9958		A12-02, B10-04, B10-03	
11/06/2022 07:29	18_1	CTD	BEGIN	55,4005	3,7888		A12-03	
11/06/2022 07:32	18_1	CTD	BOT	55,4003	3,7887	33	A12-03	
11/06/2022 07:34	18_1	CTD	END	55,4003	3,7887		A12-03	
11/06/2022 07:56	18_2	Slurf	BEGIN	55,3997	3,7817		A12-03	
11/06/2022 07:58	18_3	Multibeam	BEGIN	55,3998	3,7808		A12-03	
11/06/2022 09:55	18_3	Multibeam	END	55,4010	3,7935		A12-03	
11/06/2022 10:02	18_2	Slurf	END	55,4010	3,7908		A12-03	
11/06/2022 10:11	18_4	CTD with Samples	BEGIN	55,4005	3,7887		A12-03	
11/06/2022 10:16	18_4	CTD with Samples	BOT	55,4003	3,7885	32	A12-03	
11/06/2022 10:31	18_4	CTD with Samples	END	55,4003	3,7890		A12-03	
11/06/2022 11:16	18_5	Magnetometer	BEGIN	55,4033	3,7887		A12-03	
11/06/2022 11:17	18_6	Subbottom profiler	BEGIN	55,4030	3,7888		A12-03	
11/06/2022 12:00	18_6	Subbottom profiler	END	55,3977	3,7892		A12-03	
11/06/2022 12:00	18_5	Magnetometer	END	55,3977	3,7892		A12-03	
11/06/2022 13:35	19_1	CTD	BEGIN	55,5350	3,6333		A08-01	
11/06/2022 13:39	19_1	CTD	BOT	55,5348	3,6333	37	A08-01	
11/06/2022 13:41	19_1	CTD	END	55,5350	3,6337		A08-01	
11/06/2022 13:51	19_2	Slurf	BEGIN	55,5348	3,6373		A08-01	
11/06/2022 13:51	19_3	Multibeam	BEGIN	55,5348	3,6375		A08-01	

11/06/2022 15:32	19_3	Multibeam	END	55,5355	3,6382		A08-01	
11/06/2022 15:46	19_2	Slurf	END	55,5352	3,6347		A08-01	
11/06/2022 16:33	19_4	CTD with Samples	BEGIN	55,5347	3,6330		A08-01	
11/06/2022 16:36	19_4	CTD with Samples	BOT	55,5348	3,6333	38	A08-01	
11/06/2022 16:56	19_4	CTD with Samples	END	55,5350	3,6328		A08-01	
11/06/2022 17:11	19_5	Subbottom profiler	BEGIN	55,5375	3,6363		A08-01	
11/06/2022 17:44	19_5	Subbottom profiler	END	55,5360	3,6303		A08-01	
12/06/2022 06:07	20_1	CTD	BEGIN	55,3862	3,5035		A11-PM	
12/06/2022 06:10	20_1	CTD	BOT	55,3863	3,5035	37	A11-PM	
12/06/2022 06:14	20_1	CTD	END	55,3862	3,5035		A11-PM	
12/06/2022 06:45	20_2	Multibeam	BEGIN	55,3863	3,5018		A11-PM	Shipdata correction by bridge
12/06/2022 06:45	20_3	Slurf	BEGIN	55,3863	3,5018		A11-PM	Shipdata correction by bridge
12/06/2022 08:44	20_2	Multibeam	END	55,3877	3,4998		A11-PM	
12/06/2022 08:47	20_3	Slurf	END	55,3875	3,5005		A11-PM	
12/06/2022 08:53	20_4	CTD with Samples	BEGIN	55,3872	3,5017		A11-PM	
12/06/2022 08:56	20_4	CTD with Samples	BOT	55,3872	3,5015	38	A11-PM	
12/06/2022 09:10	20_4	CTD with Samples	END	55,3873	3,5015		A11-PM	
12/06/2022 10:11	21_1	Slurf	BEGIN	55,3273	3,3953		A14-02	
12/06/2022 10:12	21_2	Multibeam	BEGIN	55,3273	3,3953		A14-02	
12/06/2022 11:44	21_2	Multibeam	END	55,3227	3,4005		A14-02	
12/06/2022 11:59	21_1	Slurf	END	55,3245	3,3965		A14-02	
12/06/2022 12:03	21_3	CTD with Samples	BEGIN	55,3245	3,3955		A14-02	
12/06/2022 12:11	21_3	CTD with Samples	BOT	55,3245	3,3952	32	A14-02	

12/06/2022 12:22	21_3	CTD with Samples	END	55,3247	3,3950		A14-02	
12/06/2022 14:45	22_1	CTD	BEGIN	55,3055	3,8175		A15-02	
12/06/2022 14:48	22_1	CTD	BOT	55,3055	3,8175	32	A15-02	
12/06/2022 14:52	22_1	CTD	END	55,3055	3,8172		A15-02	
12/06/2022 14:58	22_2	Slurf	BEGIN	55,3058	3,8152		A15-02, A15-03	
12/06/2022 14:58	22_3	Multibeam	BEGIN	55,3058	3,8150		A15-02, A15-03	
12/06/2022 17:38	22_2	Slurf	END	55,3005	3,8288		A15-02, A15-03	
12/06/2022 17:38	22_3	Multibeam	END	55,3005	3,8287		A15-02, A15-03	
12/06/2022 17:48	22_4	CTD with Samples	BEGIN	55,3005	3,8265		A15-03	
12/06/2022 17:59	22_4	CTD with Samples	BOT	55,3007	3,8267	33	A15-03	
12/06/2022 18:06	22_4	CTD with Samples	END	55,3005	3,8267		A15-03	
12/06/2022 18:27	22_5	Slurf	BEGIN	55,3007	3,8270		A15-03, A15-02	
12/06/2022 18:27	22_6	Subbottom profiler	BEGIN	55,3007	3,8270		A15-03, A15-02	
12/06/2022 18:50	22_6	Subbottom profiler	END	55,3073	3,8155		A15-03, A15-02	
12/06/2022 18:50	22_5	Slurf	END	55,3073	3,8155		A15-03, A15-02	
12/06/2022 18:50	Transit	Multibeam? SBP? Slurf?	BEGIN	55,3075	3,8157			Shipdata correction
12/06/2022 19:03	Transit	Multibeam? SBP? Slurf?	END	55,3130	3,8238			Shipdata correction
12/06/2022 19:05	23_1	Multibeam	BEGIN	55,3130	3,8267		A15-05	
12/06/2022 19:05	23_2	Slurf	BEGIN	55,3130	3,8268		A15-05	
12/06/2022 20:19	23_1	Multibeam	END	55,3137	3,8318		A15-05	
12/06/2022 20:27	23_2	Slurf	END	55,3132	3,8295		A15-05	
12/06/2022 20:32	23_3	CTD with Samples	BEGIN	55,3132	3,8290		A15-05	
12/06/2022 20:38	23_3	CTD with Samples	BOT	55,3132	3,8288	31	A15-05	
12/06/2022 20:49	23_3	CTD with Samples	END	55,3130	3,8288		A15-05	

12/06/2022 22:26	24_1	CTD	BEGIN	55,2342	4,0793		B13-04	
12/06/2022 22:29	24_1	CTD	BOT	55,2343	4,0792	47	B13-04	
12/06/2022 22:35	24_1	CTD	END	55,2343	4,0788		B13-04	
12/06/2022 22:47	24_2	Slurf	BEGIN	55,2327	4,0828		B13-04	
12/06/2022 22:47	24_3	Multibeam	BEGIN	55,2327	4,0828		B13-04	
13/06/2022 00:04	24_4	Subbottom profiler	BEGIN	55,2358	4,0738		B13-04	
13/06/2022 00:17	24_3	Multibeam	END	55,2333	4,0810		B13-04	
13/06/2022 00:23	24_4	Subbottom profiler	END	55,2323	4,0855		B13-04	
13/06/2022 00:26	24_2	Slurf	END	55,2312	4,0857		B13-04	
13/06/2022 00:44	24_5	CTD with Samples	BEGIN	55,2343	4,0795		B13-04	
13/06/2022 00:47	24_5	CTD with Samples	BOT	55,2343	4,0797	47	B13-04	
13/06/2022 01:05	24_5	CTD with Samples	END	55,2343	4,0790		B13-04	
13/06/2022 01:07	Transit	Multibeam	BEGIN	55,2345	4,0788			
13/06/2022 01:18	Transit	Slurf	BEGIN	55,2347	4,0773			
13/06/2022 03:06	Transit	Slurf	END	55,2772	4,0865			
13/06/2022 03:07	Transit	Multibeam	END	55,2772	4,0865			
13/06/2022 03:07	25_1	CTD	BEGIN	55,2772	4,0865		B13-03	
13/06/2022 03:13	25_1	CTD	BOT	55,2773	4,0867	48	B13-03	
13/06/2022 03:18	25_2	Multibeam	BEGIN	55,2773	4,0868		B13-03	
13/06/2022 03:18	25_1	CTD	END	55,2773	4,0868		B13-03	
13/06/2022 03:18	25_3	Slurf	BEGIN	55,2773	4,0868		B13-03	
13/06/2022 05:24	25_3	Slurf	END	55,2763	4,0905		B13-03	
13/06/2022 05:24	25_2	Multibeam	END	55,2763	4,0905		B13-03	
13/06/2022 05:40	25_4	CTD with Samples	BEGIN	55,2770	4,0870		B13-03	

13/06/2022 05:44	25_4	CTD with Samples	BOT	55,2773	4,0865	48	B13-03	
13/06/2022 06:02	25_4	CTD with Samples	END	55,2772	4,0870		B13-03	
13/06/2022 06:25	25_5	Subbottom profiler	BEGIN	55,2768	4,0898		B13-03	
13/06/2022 06:38	25_5	Subbottom profiler	END	55,2775	4,0813		B13-03	Shipdata correction by bridge
13/06/2022 08:14	26_1	CTD	BEGIN	55,1165	4,0395		B16-01	
13/06/2022 08:18	26_1	CTD	BOT	55,1165	4,0395	48	B16-01	
13/06/2022 08:22	26_1	CTD	END	55,1167	4,0395		B16-01	
13/06/2022 08:35	26_2	Multibeam	BEGIN	55,1202	4,0382		B16-01	Shipdata correction by bridge
13/06/2022 08:46	26_3	Slurf	BEGIN	55,1153	4,0390		B16-01	Shipdata correction
13/06/2022 09:52	26_3	Slurf	END	55,1155	4,0403		B16-01	Shipdata correction
13/06/2022 09:52	26_2	Multibeam	END	55,1155	4,0403		B16-01	
13/06/2022 10:03	26_4	Subbottom profiler	BEGIN	55,1158	4,0390		B16-01	
13/06/2022 10:35	26_4	Subbottom profiler	END	55,1163	4,0313		B16-01	
13/06/2022 11:07	26_5	CTD with Samples	BEGIN	55,1167	4,0392		B16-01	
13/06/2022 11:10	26_5	CTD with Samples	BOT	55,1167	4,0390	49	B16-01	
13/06/2022 12:14	26_5	CTD with Samples	END	55,1005	3,8918		B16-01	
13/06/2022 12:52	27_1	CTD	BEGIN	55,1150	3,8118		A18-02	
13/06/2022 12:56	27_1	CTD	BOT	55,1150	3,8118	47	A18-02	
13/06/2022 12:58	27_1	CTD	END	55,1150	3,8117		A18-02	
13/06/2022 13:01	27_2	Slurf	BEGIN	55,1148	3,8113		A18-02	
13/06/2022 13:08	27_3	Multibeam	BEGIN	55,1150	3,8108		A18-02	
13/06/2022 15:49	27_3	Multibeam	END	55,1175	3,8138		A18-02	
13/06/2022 15:57	27_4	Subbottom profiler	BEGIN	55,1172	3,8157		A18-02	

13/06/2022 16:06	27_4	Subbottom profiler	END	55,1135	3,8095		A18-02	
13/06/2022 16:36	27_2	Slurf	END	55,1152	3,8123		A18-02	
13/06/2022 16:38	27_5	CTD with Samples	BEGIN	55,1152	3,8122		A18-02	
13/06/2022 16:57	27_5	CTD with Samples	BOT	55,1150	3,8112	48	A18-02	
13/06/2022 17:01	27_5	CTD with Samples	END	55,1150	3,8117		A18-02	
13/06/2022 17:19	Transit	Slurf	BEGIN	55,1153	3,8093			
13/06/2022 17:19	Transit	Multibeam	BEGIN	55,1153	3,8093			Shipdata correction
13/06/2022 18:28	Transit	Multibeam	END	55,1145	3,7675			Shipdata correction
13/06/2022 18:28	Transit	Slurf	END	55,1145	3,7675			
13/06/2022 18:33	28_1	CTD	BEGIN	55,1145	3,7668		A18-EBU	
13/06/2022 18:36	28_1	CTD	BOT	55,1145	3,7672	46	A18-EBU	
13/06/2022 18:53	28_1	CTD	END	55,1143	3,7672		A18-EBU	
13/06/2022 19:11	28_2	Slurf	BEGIN	55,1137	3,7652		A18-EBU	
13/06/2022 19:21	28_3	Multibeam	BEGIN	55,1152	3,7638		A18-EBU	
13/06/2022 20:32	28_3	Multibeam	END	55,1152	3,7698		A18-EBU	
13/06/2022 20:43	28_4	Subbottom profiler	BEGIN	55,1142	3,7707		A18-EBU	
13/06/2022 20:50	28_4	Subbottom profiler	END	55,1150	3,7657		A18-EBU	Shipdata correction by bridge
13/06/2022 21:04	28_2	Slurf	END	55,1147	3,7678		A18-EBU	
13/06/2022 21:08	28_5	CTD with Samples	BEGIN	55,1147	3,7673		A18-EBU	
13/06/2022 21:11	28_5	CTD with Samples	BOT	55,1147	3,7670	45	A18-EBU	
13/06/2022 21:32	28_5	CTD with Samples	END	55,1148	3,7668		A18-EBU	
13/06/2022 21:49	Transit	Slurf	BEGIN	55,1143	3,7612			
13/06/2022 21:49	Transit	Multibeam	BEGIN	55,1143	3,7612			Shipdata correction

13/06/2022 23:02	Transit	Multibeam	END	55,1203	3,8053			Shipdata correction
13/06/2022 23:02	Transit	Slurf	END	55,1203	3,8053			
14/06/2022 02:43	29_1	Subbottom profiler	BEGIN	55,5350	3,6490		A08-01	
14/06/2022 03:01	29_2	Magnetometer	BEGIN	55,5350	3,6465		A08-01	
14/06/2022 04:48	29_2	Magnetometer	END	55,5355	3,6282		A08-01	
14/06/2022 04:48	29_1	Subbottom profiler	END	55,5355	3,6282		A08-01	
14/06/2022 07:15	30_1	Magnetometer	BEGIN	55,3237	3,4103		A14-02	Shipdata correction by bridge
14/06/2022 07:15	30_2	Subbottom profiler	BEGIN	55,3237	3,4103		A14-02	Shipdata correction by bridge
14/06/2022 08:20	30_2	Subbottom profiler	END	55,3235	3,3943		A14-02	Shipdata correction by bridge
14/06/2022 08:20	30_1	Magnetometer	END	55,3235	3,3943		A14-02	Shipdata correction by bridge
14/06/2022 10:14	31_1	CTD	BEGIN	55,1995	3,6097		A14-01	
14/06/2022 10:18	31_1	CTD	BOT	55,1995	3,6092	28	A14-01	
14/06/2022 10:19	31_1	CTD	END	55,1995	3,6093		A14-01	
14/06/2022 10:29	31_2	Slurf	BEGIN	55,1978	3,6112		A14-01	
14/06/2022 10:29	31_3	Multibeam	BEGIN	55,1978	3,6112		A14-01	
14/06/2022 11:33	31_3	Multibeam	END	55,2007	3,6067		A14-01	
14/06/2022 11:37	31_2	Slurf	END	55,2015	3,6058		A14-01	
14/06/2022 11:54	31_4	Magnetometer	BEGIN	55,1953	3,6085		A14-01	
14/06/2022 12:04	31_5	Subbottom profiler	BEGIN	55,1977	3,6082		A14-01	
14/06/2022 12:42	31_5	Subbottom profiler	END	55,2000	3,6020		A14-01	
14/06/2022 12:42	31_4	Magnetometer	END	55,2000	3,6020		A14-01	
14/06/2022 13:11	31_6	CTD with Samples	BEGIN	55,1998	3,6088		A14-01	

14/06/2022 13:15	31_6	CTD with Samples	BOT	55,1997	3,6090	29	A14-01	
14/06/2022 13:33	31_6	CTD with Samples	END	55,1997	3,6092		A14-01	
14/06/2022 15:00	32_1	Subbottom profiler	BEGIN	55,3065	3,8408		A15-05, A15-02	
14/06/2022 15:02	32_2	Magnetometer	BEGIN	55,3067	3,8410		A15-05, A15-02	
14/06/2022 17:16	32_2	Magnetometer	END	55,3053	3,8177		A15-05, A15-02	
14/06/2022 17:16	32_1	Subbottom profiler	END	55,3053	3,8177		A15-05, A15-02	
14/06/2022 17:41	32_3	CTD with Samples	BEGIN	55,3055	3,8168		A15-02	
14/06/2022 17:45	32_3	CTD with Samples	BOT	55,3053	3,8172	32	A15-02	
14/06/2022 17:55	32_3	CTD with Samples	END	55,3053	3,8168		A15-02	
14/06/2022 19:25	33_1	Magnetometer	BEGIN	55,2780	4,0988		B13-03	
14/06/2022 19:25	33_2	Subbottom profiler	BEGIN	55,2780	4,0988		B13-03	
14/06/2022 20:31	33_2	Subbottom profiler	END	55,2792	4,0857		B13-03	
14/06/2022 20:31	33_1	Magnetometer	END	55,2792	4,0857		B13-03	
14/06/2022 22:09	34_1	CTD	BEGIN	55,2008	3,9080		A15-04	
14/06/2022 22:14	34_1	CTD	BOT	55,2010	3,9082	45	A15-04	
14/06/2022 22:17	34_1	CTD	END	55,2008	3,9080		A15-04	
14/06/2022 22:24	34_2	Slurf	BEGIN	55,1998	3,9087		A15-04	
14/06/2022 22:34	34_3	Multibeam	BEGIN	55,1992	3,9093		A15-04	
14/06/2022 23:37	34_3	Multibeam	END	55,2018	3,9057		A15-04	
14/06/2022 23:43	34_2	Slurf	END	55,2028	3,9045		A15-04	
14/06/2022 23:54	34_4	CTD with Samples	BEGIN	55,2012	3,9083		A15-04	
14/06/2022 23:58	34_4	CTD with Samples	BOT	55,2010	3,9083	46	A15-04	
15/06/2022 00:19	34_4	CTD with Samples	END	55,2010	3,9082		A15-04	
15/06/2022 01:19	35_1	CTD	BEGIN	55,2003	3,7012		A15-01	

15/06/2022 01:24	35_1	CTD	BOT	55,2005	3,7015	42	A15-01	
15/06/2022 01:27	35_1	CTD	END	55,2007	3,7017		A15-01	
15/06/2022 01:35	35_2	Slurf	BEGIN	55,1987	3,7030		A15-01	
15/06/2022 01:41	35_3	Multibeam	BEGIN	55,1992	3,7028		A15-01	
15/06/2022 02:51	35_3	Multibeam	END	55,2032	3,6977		A15-01	
15/06/2022 02:52	35_2	Slurf	END	55,2032	3,6977		A15-01	
15/06/2022 03:14	35_4	Magnetometer	BEGIN	55,2065	3,7012		A15-01	
15/06/2022 03:15	35_5	Subbottom profiler	BEGIN	55,2062	3,7012		A15-01	
15/06/2022 04:45	35_4	Magnetometer	END	55,2038	3,7043		A15-01	
15/06/2022 04:45	35_5	Subbottom profiler	END	55,2038	3,7043		A15-01	
15/06/2022 05:29	35_6	CTD with Samples	BEGIN	55,2008	3,7037		A15-01	
15/06/2022 05:32	35_6	CTD with Samples	BOT	55,2008	3,7033	42	A15-01	
15/06/2022 05:50	35_6	CTD with Samples	END	55,2008	3,7037		A15-01	
15/06/2022 07:16	36_1	Magnetometer	BEGIN	55,2030	3,9047		A15-04	
15/06/2022 07:16	36_2	Subbottom profiler	BEGIN	55,2028	3,9048		A15-04	
15/06/2022 08:47	36_2	Subbottom profiler	END	55,2022	3,9053		A15-04	
15/06/2022 08:47	36_1	Magnetometer	END	55,2022	3,9053		A15-04	
15/06/2022 10:30	37_1	CTD	BEGIN	55,0563	3,9053		A18-01	
15/06/2022 10:34	37_1	CTD	BOT	55,0562	3,9053	48	A18-01	
15/06/2022 10:37	37_1	CTD	END	55,0558	3,9055		A18-01	
15/06/2022 10:46	37_2	Slurf	BEGIN	55,0537	3,9068		A18-01	
15/06/2022 11:11	37_3	Multibeam	BEGIN	55,0543	3,9075		A18-01	
15/06/2022 12:13	37_3	Multibeam	END	55,0570	3,9027		A18-01	
15/06/2022 12:20	37_2	Slurf	END	55,0585	3,9007		A18-01	

15/06/2022 12:29	37_4	Magnetometer	BEGIN	55,0565	3,8965		A18-01	
15/06/2022 12:37	37_5	Subbottom profiler	BEGIN	55,0562	3,8982		A18-01	
15/06/2022 13:28	37_5	Subbottom profiler	END	55,0578	3,9063		A18-01	
15/06/2022 13:39	37_4	Magnetometer	END	55,0613	3,9047		A18-01	
15/06/2022 13:58	37_6	CTD with Samples	BEGIN	55,0560	3,9057		A18-01	
15/06/2022 14:04	37_6	CTD with Samples	BOT	55,0560	3,9057	49	A18-01	
15/06/2022 14:23	37_6	CTD with Samples	END	55,0560	3,9058		A18-01	
15/06/2022 15:46	38_1	Subbottom profiler	BEGIN	54,9480	4,0200		F01-01	
15/06/2022 15:46	38_2	Magnetometer	BEGIN	54,9480	4,0200		F01-01	
15/06/2022 17:04	38_2	Magnetometer	END	54,9393	4,0280		F01-01	
15/06/2022 17:04	38_1	Subbottom profiler	END	54,9393	4,0280		F01-01	
15/06/2022 18:30	39_1	Subbottom profiler	BEGIN	54,8222	4,1130		F04-01	Shipdata correction by bridge
15/06/2022 18:30	39_2	Magnetometer	BEGIN	54,8222	4,1130		F04-01	Shipdata correction by bridge
15/06/2022 19:28	39_2	Magnetometer	END	54,8182	4,1162		F04-01	
15/06/2022 19:28	39_1	Subbottom profiler	END	54,8180	4,1162		F04-01	
15/06/2022 20:53	40_1	Subbottom profiler	BEGIN	54,8055	4,3197		F04-02	
15/06/2022 20:53	40_2	Magnetometer	BEGIN	54,8055	4,3197		F04-02	
15/06/2022 21:53	40_2	Magnetometer	END	54,7980	4,3278		F04-02	
15/06/2022 21:53	40_1	Subbottom profiler	END	54,7980	4,3278		F04-02	
15/06/2022 23:49	41_1	CTD	BEGIN	54,9388	4,0213		F01-01	
15/06/2022 23:52	41_1	CTD	BOT	54,9387	4,0213	50	F01-01	
15/06/2022 23:55	41_1	CTD	END	54,9387	4,0212		F01-01	
16/06/2022 00:05	41_2	Slurf	BEGIN	54,9367	4,0232		F01-01	

16/06/2022 00:14	41_3	Multibeam	BEGIN	54,9375	4,0225		F01-01	
16/06/2022 01:48	41_3	Multibeam	END	54,9392	4,0223		F01-01	
16/06/2022 01:55	41_2	Slurf	END	54,9390	4,0217		F01-01	
16/06/2022 01:57	41_4	CTD with Samples	BEGIN	54,9390	4,0212		F01-01	
16/06/2022 02:02	41_4	CTD with Samples	BOT	54,9387	4,0212	50	F01-01	
16/06/2022 02:21	41_4	CTD with Samples	END	54,9387	4,0212		F01-01	
16/06/2022 03:41	42_1	CTD	BEGIN	54,8193	4,1187		F04-01	
16/06/2022 03:44	42_1	CTD	BOT	54,8195	4,1187	50	F04-01	
16/06/2022 03:47	42_1	CTD	END	54,8193	4,1187		F04-01	
16/06/2022 03:48	42_2	Multibeam	BEGIN	54,8193	4,1187		F04-01	
16/06/2022 03:48	42_3	Slurf	BEGIN	54,8193	4,1187		F04-01	
16/06/2022 05:38	42_3	Slurf	END	54,8173	4,1220		F04-01	
16/06/2022 05:47	42_4	CTD with Samples	BEGIN	54,8193	4,1187		F04-01	
16/06/2022 05:50	42_4	CTD with Samples	BOT	54,8193	4,1188	51	F04-01	
16/06/2022 06:08	42_4	CTD with Samples	END	54,8190	4,1187		F04-01	
16/06/2022 06:11	42_2	Multibeam	END	54,8190	4,1188		F04-01	
16/06/2022 07:51	43_1	Magnetometer	BEGIN	54,7488	4,3900		F05-02, F05-06	
16/06/2022 07:51	43_2	Subbottom profiler	BEGIN	54,7488	4,3900		F05-02, F05-06	
16/06/2022 10:42	43_2	Subbottom profiler	END	54,7525	4,3808		F05-02, F05-06	
16/06/2022 10:52	43_1	Magnetometer	END	54,7555	4,3842		F05-02, F05-06	
16/06/2022 11:57	44_1	Magnetometer	BEGIN	54,6728	4,4022		F05-05	
16/06/2022 11:58	44_2	Subbottom profiler	BEGIN	54,6727	4,4020		F05-05	
16/06/2022 13:07	44_2	Subbottom profiler	END	54,6772	4,3883		F05-05	
16/06/2022 13:07	44_1	Magnetometer	END	54,6772	4,3883		F05-05	

16/06/2022 15:07	45_1	Subbottom profiler	BEGIN	54,9122	4,4730		F02-04	
16/06/2022 15:16	45_2	Magnetometer	BEGIN	54,9130	4,4738		F02-04	
16/06/2022 16:22	45_2	Magnetometer	END	54,9210	4,4808		F02-04	
16/06/2022 16:22	45_1	Subbottom profiler	END	54,9210	4,4808		F02-04	Shipdata correction
16/06/2022 18:02	46_1	CTD	BEGIN	54,7508	4,3783		F05-02	
16/06/2022 18:05	46_1	CTD	BOT	54,7507	4,3783	52	F05-02	
16/06/2022 18:08	46_1	CTD	END	54,7507	4,3783		F05-02	
16/06/2022 18:31	46_2	Multibeam	BEGIN	54,7502	4,3815		F05-02, F05-06	
16/06/2022 18:31	46_3	Slurf	BEGIN	54,7502	4,3815		F05-02, F05-06	
16/06/2022 22:02	46_2	Multibeam	END	54,7548	4,3562		F05-02, F05-06	
16/06/2022 22:09	46_3	Slurf	END	54,7558	4,3545		F05-02, F05-06	
16/06/2022 22:19	46_4	CTD with Samples	BEGIN	54,7553	4,3592		F05-06	
16/06/2022 22:24	46_4	CTD with Samples	BOT	54,7553	4,3588	52	F05-06	
16/06/2022 22:41	46_4	CTD with Samples	END	54,7555	4,3585		F05-06	
16/06/2022 23:14	47_1	CTD	BEGIN	54,7393	4,3658		F05-Ch	
16/06/2022 23:19	47_1	CTD	BOT	54,7392	4,3658	51	F05-Ch	
16/06/2022 23:22	47_1	CTD	END	54,7392	4,3660		F05-Ch	
16/06/2022 23:29	47_2	Slurf	BEGIN	54,7377	4,3678		F05-Ch	
16/06/2022 23:37	47_3	Multibeam	BEGIN	54,7375	4,3675		F05-Ch	
17/06/2022 00:39	47_3	Multibeam	END	54,7408	4,3622		F05-Ch	
17/06/2022 00:46	47_2	Slurf	END	54,7422	4,3610		F05-Ch	
17/06/2022 00:59	47_4	CTD with Samples	BEGIN	54,7392	4,3657		F05-Ch	
17/06/2022 01:03	47_4	CTD with Samples	BOT	54,7390	4,3658	52	F05-Ch	
17/06/2022 01:22	47_4	CTD with Samples	END	54,7390	4,3660		F05-Ch	

17/06/2022 02:12	48_1	CTD	BEGIN	54,6730	4,3883		F05-05	
17/06/2022 02:15	48_1	CTD	BOT	54,6728	4,3883	51	F05-05	
17/06/2022 02:20	48_1	CTD	END	54,6732	4,3888		F05-05	
17/06/2022 02:20	48_2	Slurf	BEGIN	54,6732	4,3888		F05-05	
17/06/2022 02:21	48_3	Multibeam	BEGIN	54,6732	4,3888		F05-05	
17/06/2022 04:01	48_2	Slurf	END	54,6740	4,3900		F05-05	
17/06/2022 04:03	48_3	Multibeam	END	54,6738	4,3897		F05-05	
17/06/2022 04:11	48_4	CTD with Samples	BEGIN	54,6727	4,3887		F05-05	
17/06/2022 04:15	48_4	CTD with Samples	BOT	54,6730	4,3887	51	F05-05	
17/06/2022 04:34	48_4	CTD with Samples	END	54,6728	4,3883		F05-05	
17/06/2022 06:02	49_1	CTD with Samples	BEGIN	54,7508	4,3785		F05-02	
17/06/2022 06:05	49_1	CTD with Samples	BOT	54,7508	4,3788	51	F05-02	
17/06/2022 06:22	49_1	CTD with Samples	END	54,7505	4,3787		F05-02	
17/06/2022 07:09	50_1	CTD	BEGIN	54,7993	4,3300		F04-02	
17/06/2022 07:12	50_1	CTD	BOT	54,7993	4,3302	53	F04-02	
17/06/2022 07:14	50_1	CTD	END	54,7992	4,3303		F04-02	
17/06/2022 07:36	50_2	Slurf	BEGIN	54,7995	4,3303		F04-02	
17/06/2022 08:00	50_3	Multibeam	BEGIN	54,8012	4,3302		F04-02	
17/06/2022 09:54	50_3	Multibeam	END	54,7978	4,3320		F04-02	
17/06/2022 09:54	50_2	Slurf	END	54,7978	4,3320		F04-02	
17/06/2022 10:10	50_4	CTD with Samples	BEGIN	54,7995	4,3305		F04-02	
17/06/2022 10:16	50_4	CTD with Samples	BOT	54,7993	4,3305	52	F04-02	
17/06/2022 10:34	50_4	CTD with Samples	END	54,7993	4,3308		F04-02	
17/06/2022 12:36	51_1	Magnetometer	BEGIN	55,0455	4,4845		B17-01, B17-04	

17/06/2022 12:54	51_2	Subbottom profiler	BEGIN	55,0423	4,4792		B17-01, B17-04	
17/06/2022 14:38	51_1	Magnetometer	END	55,0325	4,4765		B17-01, B17-04	
17/06/2022 14:39	51_2	Subbottom profiler	END	55,0325	4,4765		B17-01, B17-04	
17/06/2022 15:16	52_1	CTD	BEGIN	55,0673	4,5093		B17-06	
17/06/2022 15:22	52_1	CTD	BOT	55,0675	4,5097	45	B17-06	
17/06/2022 15:27	52_1	CTD	END	55,0672	4,5098		B17-06	
17/06/2022 15:28	52_2	Slurf	BEGIN	55,0670	4,5105		B17-06	
17/06/2022 15:28	52_3	Multibeam	BEGIN	55,0670	4,5105		B17-06	
17/06/2022 17:29	52_3	Multibeam	END	55,0715	4,5082		B17-06	
17/06/2022 17:29	52_2	Slurf	END	55,0715	4,5082		B17-06	
17/06/2022 17:44	52_4	Subbottom profiler	BEGIN	55,0745	4,5100		B17-06	
17/06/2022 17:45	52_5	Magnetometer	BEGIN	55,0743	4,5100		B17-06	
17/06/2022 18:45	52_4	Subbottom profiler	END	55,0670	4,5000		B17-06	
17/06/2022 18:48	52_5	Magnetometer	END	55,0672	4,4977		B17-06	
17/06/2022 19:55	52_5	Magnetometer	BEGIN	55,0595	4,5210		B17-06	Cast 5 continued
17/06/2022 19:56	52_3	Multibeam	BEGIN	55,0597	4,5207		B17-06	Cast 3 continued
17/06/2022 20:13	52_3	Multibeam	END	55,0643	4,5150		B17-06	
17/06/2022 20:13	52_4	Subbottom profiler	BEGIN	55,0643	4,5148		B17-06	Cast 4 continued
17/06/2022 20:40	52_4	Subbottom profiler	END	55,0682	4,5057		B17-06	
17/06/2022 20:40	52_5	Magnetometer	END	55,0682	4,5057		B17-06	
17/06/2022 20:58	52_6	CTD with Samples	BEGIN	55,0673	4,5093		B17-06	
17/06/2022 21:03	52_6	CTD with Samples	BOT	55,0673	4,5090	46	B17-06	
17/06/2022 21:20	52_6	CTD with Samples	END	55,0673	4,5093		B17-06	
17/06/2022 22:06	53_1	CTD	BEGIN	55,0232	4,5147		B17-03	

17/06/2022 22:09	53_1	CTD	BOT	55,0230	4,5143	45	B17-03	
17/06/2022 22:12	53_1	CTD	END	55,0230	4,5147		B17-03	
17/06/2022 22:20	53_2	Slurf	BEGIN	55,0213	4,5135		B17-03, B17-05	
17/06/2022 22:25	53_3	Multibeam	BEGIN	55,0212	4,5127		B17-03, B17-05	
18/06/2022 00:55	53_3	Multibeam	END	55,0323	4,5238		B17-03, B17-05	
18/06/2022 01:12	53_2	Slurf	END	55,0302	4,5233		B17-03, B17-05	
18/06/2022 01:14	53_4	CTD with Samples	BEGIN	55,0303	4,5230		B17-05	
18/06/2022 01:26	53_4	CTD with Samples	BOT	55,0302	4,5232	46	B17-05	
18/06/2022 01:49	53_4	CTD with Samples	END	55,0303	4,5228		B17-05	
18/06/2022 02:36	54_1	CTD	BEGIN	55,0400	4,4745		B17-01	
18/06/2022 02:39	54_1	CTD	BOT	55,0402	4,4742	46	B17-01	
18/06/2022 02:41	54_1	CTD	END	55,0402	4,4742		B17-01	
18/06/2022 02:43	54_2	Multibeam	BEGIN	55,0400	4,4743		B17-01, B17-04	
18/06/2022 02:44	54_3	Slurf	BEGIN	55,0400	4,4743		B17-01, B17-04	
18/06/2022 05:31	54_3	Slurf	END	55,0328	4,4825		B17-01, B17-04	
18/06/2022 05:31	54_2	Multibeam	END	55,0330	4,4823		B17-01, B17-04	
18/06/2022 05:34	54_4	CTD with Samples	BEGIN	55,0332	4,4822		B17-04	
18/06/2022 05:37	54_4	CTD with Samples	BOT	55,0333	4,4822	46	B17-04	
18/06/2022 05:54	54_4	CTD with Samples	END	55,0332	4,4822		B17-04	
18/06/2022 06:55	55_1	Magnetometer	BEGIN	54,9267	4,5787		F02-03, F02-06, F02-05	
18/06/2022 06:56	55_2	Subbottom profiler	BEGIN	54,9265	4,5790		F02-03, F02-06, F02-05	
18/06/2022 10:29	55_2	Subbottom profiler	END	54,9422	4,5548		F02-03, F02-06, F02-05	

18/06/2022 10:29	55_1	Magnetometer	END	54,9422	4,5548		F02-03, F02-06, F02-05	
18/06/2022 11:41	56_1	CTD with Samples	BEGIN	54,9388	4,5538		F02-05	
18/06/2022 11:46	56_1	CTD with Samples	BOT	54,9390	4,5540	45	F02-05	
18/06/2022 12:44	56_1	CTD with Samples	END	54,9392	4,5543		F02-05	
18/06/2022 12:51	56_2	Slurf	BEGIN	54,9378	4,5557		F02-05	
18/06/2022 13:00	56_3	Multibeam	BEGIN	54,9372	4,5567		F02-05	
18/06/2022 14:07	56_2	Slurf	END	54,9410	4,5543		F02-05	
18/06/2022 14:22	56_4	CTD with Samples	BEGIN	54,9390	4,5542		F02-05	
18/06/2022 14:26	56_4	CTD with Samples	BOT	54,9392	4,5542	45	F02-05	
18/06/2022 14:47	56_4	CTD with Samples	END	54,9392	4,5542		F02-05	
18/06/2022 14:48	56_3	Multibeam	END	54,9392	4,5542		F02-05	
18/06/2022 14:48	Transit	Multibeam	BEGIN	54,9392	4,5542			Shipdata correction
18/06/2022 14:48	Transit	Slurf	BEGIN	54,9392	4,5542			Shipdata correction
18/06/2022 15:41	Transit	Multibeam	END	54,9273	4,5650			
18/06/2022 15:41	Transit	Slurf	END	54,9273	4,5650			
18/06/2022 15:45	57_1	Multibeam	BEGIN	54,9273	4,5653		F02-03	
18/06/2022 15:45	57_2	Slurf	BEGIN	54,9273	4,5653		F02-03	
18/06/2022 17:19	57_2	Slurf	END	54,9248	4,5652		F02-03	
18/06/2022 17:19	57_1	Multibeam	END	54,9248	4,5652		F02-03	
18/06/2022 17:35	57_3	CTD with Samples	BEGIN	54,9277	4,5652		F02-03	
18/06/2022 17:40	57_3	CTD with Samples	BOT	54,9273	4,5652	44	F02-03	
18/06/2022 18:07	57_3	CTD with Samples	END	54,9277	4,5653		F02-03	
18/06/2022 18:52	58_1	CTD	BEGIN	54,9207	4,4748		F02-04	

18/06/2022 18:56	58_1	CTD	BOT	54,9205	4,4745	48	F02-04	
18/06/2022 19:00	58_1	CTD	END	54,9205	4,4740		F02-04	
18/06/2022 19:11	58_2	Slurf	BEGIN	54,9193	4,4745		F02-04	
18/06/2022 19:11	58_3	Multibeam	BEGIN	54,9193	4,4745		F02-04	
18/06/2022 20:28	58_3	Multibeam	END	54,9238	4,4748		F02-04	
18/06/2022 20:28	58_2	Slurf	END	54,9238	4,4748		F02-04	
18/06/2022 20:39	58_4	CTD with Samples	BEGIN	54,9208	4,4750		F02-04	
18/06/2022 20:44	58_4	CTD with Samples	BOT	54,9207	4,4747	48	F02-04	
18/06/2022 21:06	58_4	CTD with Samples	END	54,9207	4,4745		F02-04	
18/06/2022 21:26	58_5	Subbottom profiler	BEGIN	54,9193	4,4750		F02-04	
18/06/2022 21:32	58_5	Subbottom profiler	END	54,9220	4,4743		F02-04	
18/06/2022 21:32	Transit	Multibeam	BEGIN	54,9220	4,4743			
18/06/2022 21:32	Transit	Slurf	BEGIN	54,9222	4,4743			
19/06/2022 04:04	Transit	Multibeam	END	55,0238	4,5367			
19/06/2022 04:04	Transit	Slurf	END	55,0238	4,5367			
19/06/2022 04:14	59_1	Magnetometer	BEGIN	55,0238	4,5393		B17-05, B17-03	
19/06/2022 04:38	59_2	Subbottom profiler	BEGIN	55,0298	4,5248		B17-05, B17-03	
19/06/2022 06:45	59_2	Subbottom profiler	END	55,0237	4,5117		B17-05, B17-03	
19/06/2022 06:50	59_1	Magnetometer	END	55,0235	4,5095		B17-05, B17-03	
19/06/2022 07:05	59_4	CTD with Samples	BEGIN	55,0228	4,5143		B17-03	Cast 3 erroneously logged as 4
19/06/2022 07:09	59_4	CTD with Samples	BOT	55,0228	4,5143	45	B17-03	
19/06/2022 07:27	59_4	CTD with Samples	END	55,0230	4,5143		B17-03	
19/06/2022 08:56	60_1	CTD	BEGIN	55,1747	4,5740		B14-03	

19/06/2022 09:01	60_1	CTD	BOT	55,1747	4,5737	52	B14-03	
19/06/2022 09:51	60_1	CTD	END	55,1748	4,5733		B14-03	
19/06/2022 10:03	60_2	Slurf	BEGIN	55,1735	4,5762		B14-03	
19/06/2022 10:13	60_3	Multibeam	BEGIN	55,1732	4,5755		B14-03	
19/06/2022 11:20	60_3	Multibeam	END	55,1757	4,5712		B14-03	
19/06/2022 11:26	60_2	Slurf	END	55,1760	4,5708		B14-03	
19/06/2022 11:44	60_4	Magnetometer	BEGIN	55,1758	4,5840		B14-03	
19/06/2022 12:04	60_5	Subbottom profiler	BEGIN	55,1748	4,5760		B14-03	
19/06/2022 12:45	60_5	Subbottom profiler	END	55,1773	4,5742		B14-03	
19/06/2022 12:49	60_4	Magnetometer	END	55,1770	4,5740		B14-03	
19/06/2022 13:03	60_6	CTD with Samples	BEGIN	55,1747	4,5742		B14-03	
19/06/2022 13:08	60_6	CTD with Samples	BOT	55,1747	4,5738	52	B14-03	
19/06/2022 13:29	60_6	CTD with Samples	END	55,1748	4,5737		B14-03	
19/06/2022 13:57	61_1	CTD	BEGIN	55,2038	4,5757		B14-01	
19/06/2022 14:04	61_1	CTD	BOT	55,2040	4,5758	51	B14-01	
19/06/2022 14:12	61_1	CTD	END	55,2040	4,5753		B14-01	
19/06/2022 14:16	61_2	Slurf	BEGIN	55,2037	4,5758		B14-01	
19/06/2022 14:16	61_3	Multibeam	BEGIN	55,2037	4,5758		B14-01	
19/06/2022 15:57	61_2	Slurf	END	55,2022	4,5783		B14-01	
19/06/2022 15:57	61_3	Multibeam	END	55,2022	4,5783		B14-01	
19/06/2022 16:33	61_4	Magnetometer	BEGIN	55,1952	4,5762		B14-01	
19/06/2022 16:33	61_5	Subbottom profiler	BEGIN	55,1952	4,5762		B14-01	
19/06/2022 18:34	61_4	Magnetometer	END	55,2037	4,5717		B14-01	
19/06/2022 18:34	61_5	Subbottom profiler	END	55,2037	4,5717		B14-01	

19/06/2022 19:00	61_6	CTD with Samples	BEGIN	55,2035	4,5762		B14-01	
19/06/2022 19:04	61_6	CTD with Samples	BOT	55,2035	4,5760	51	B14-01	
19/06/2022 19:24	61_6	CTD with Samples	END	55,2040	4,5760		B14-01	
19/06/2022 21:07	62_1	Magnetometer	BEGIN	55,0868	4,7980		B18-02	
19/06/2022 21:07	62_2	Subbottom profiler	BEGIN	55,0868	4,7980		B18-02	
19/06/2022 22:20	62_1	Magnetometer	END	55,0932	4,7938		B18-02	
19/06/2022 22:20	62_2	Subbottom profiler	END	55,0932	4,7938		B18-02	
19/06/2022 22:33	62_3	CTD	BEGIN	55,0923	4,7987		B18-02	
19/06/2022 22:42	62_3	CTD	BOT	55,0925	4,7992	42	B18-02	
19/06/2022 22:44	62_3	CTD	END	55,0927	4,7993		B18-02	
19/06/2022 22:47	62_4	Slurf	BEGIN	55,0925	4,8000		B18-02	
19/06/2022 22:52	62_5	Multibeam	BEGIN	55,0925	4,8005		B18-02	
20/06/2022 00:07	62_5	Multibeam	END	55,0912	4,7937		B18-02	
20/06/2022 00:12	62_4	Slurf	END	55,0917	4,7938		B18-02	
20/06/2022 00:18	62_6	CTD with Samples	BEGIN	55,0922	4,7960		B18-02	
20/06/2022 00:21	62_6	CTD with Samples	BOT	55,0922	4,7963	44	B18-02	
20/06/2022 00:40	62_6	CTD with Samples	END	55,0923	4,7963		B18-02	
20/06/2022 01:58	63_1	CTD	BEGIN	54,9680	4,9243		F03-EBU	
20/06/2022 02:01	63_1	CTD	BOT	54,9682	4,9245	43	F03-EBU	
20/06/2022 02:05	63_1	CTD	END	54,9678	4,9245		F03-EBU	
20/06/2022 02:06	63_2	Multibeam	BEGIN	54,9678	4,9248		F03-EBU	
20/06/2022 02:06	63_3	Slurf	BEGIN	54,9678	4,9248		F03-EBU	
20/06/2022 04:27	63_2	Multibeam	END	54,9678	4,9325		F03-EBU	
20/06/2022 04:29	63_3	Slurf	END	54,9673	4,9325		F03-EBU	

20/06/2022 04:50	63_4	CTD with Samples	BEGIN	54,9672	4,9295		F03-EBU	
20/06/2022 04:55	63_4	CTD with Samples	BOT	54,9673	4,9298	43	F03-EBU	
20/06/2022 05:14	63_4	CTD with Samples	END	54,9672	4,9302		F03-EBU	
20/06/2022 08:05	64_1	CTD	BEGIN	54,6043	4,7460		F09-Pipeline	
20/06/2022 08:09	64_1	CTD	BOT	54,6043	4,7460	51	F09-Pipeline	
20/06/2022 08:12	64_1	CTD	END	54,6043	4,7460		F09-Pipeline	
20/06/2022 08:31	64_2	Slurf	BEGIN	54,6003	4,7467		F09-Pipeline	
20/06/2022 08:31	64_3	Multibeam	BEGIN	54,6003	4,7467		F09-Pipeline	
20/06/2022 10:00	64_3	Multibeam	END	54,6093	4,7450		F09-Pipeline	
20/06/2022 10:00	64_2	Slurf	END	54,6093	4,7450		F09-Pipeline	
20/06/2022 11:52	65_1	CTD with Samples	BEGIN	54,5238	4,4332		F08-Nothing	CTD not logged in Shipdata
20/06/2022 12:21	65_1	CTD with Samples	BOT	54,5242	4,4303	52	F08-Nothing	CTD not logged in Shipdata
20/06/2022 12:21	65_1	CTD with Samples	END	54,5242	4,4303		F08-Nothing	CTD not logged in Shipdata
20/06/2022 13:06	66_1	CTD	BEGIN	54,4622	4,3817		F11-03	
20/06/2022 13:09	66_1	CTD	BOT	54,4622	4,3817		F11-03	
20/06/2022 13:12	66_1	CTD	END	54,4620	4,3820		F11-03	
20/06/2022 13:18	66_2	Slurf	BEGIN	54,4613	4,3842		F11-03	
20/06/2022 13:24	66_3	Multibeam	BEGIN	54,4612	4,3848		F11-03	
20/06/2022 14:43	66_2	Slurf	END	54,4627	4,3777		F11-03	
20/06/2022 14:43	66_3	Multibeam	END	54,4627	4,3777		F11-03	
20/06/2022 14:44	66_4	Subbottom Profiler	BEGIN	54,4628	4,3773		F11-03	
20/06/2022 15:18	66_4	Subbottom Profiler	END	54,4620	4,3818		F11-03	

20/06/2022 15:19	66_5	CTD with Samples	BEGIN	54,4620	4,3818		F11-03	
20/06/2022 15:25	66_5	CTD with Samples	BOT	54,4623	4,3818		F11-03	
20/06/2022 15:48	66_5	CTD with Samples	END	54,4620	4,3813		F11-03	
20/06/2022 17:40	Transit (67)	Multibeam	BEGIN	54,2130	4,3755			
20/06/2022 17:40	Transit (67)	Slurf	BEGIN	54,2130	4,3755			
20/06/2022 17:50	Transit (67)	Slurf	START	54,2142	4,3733			
20/06/2022 18:26	Transit (67)	Multibeam	COCH	54,2042	4,3787			
20/06/2022 20:45	Transit (67)	Multibeam	COCH	54,1363	4,3775		F17-14	
20/06/2022 23:44	Transit (67)	Multibeam	COCH	54,0598	4,3305		F16-02	
21/06/2022 01:13	Transit (67)	Multibeam	COCH	54,0603	4,4362		F17-04	
21/06/2022 01:36	Transit (67)	Multibeam	COCH	54,0577	4,4642		F17-07	
21/06/2022 01:56	Transit (67)	Multibeam	COCH	54,0610	4,4858		F17-03	
21/06/2022 02:48	Transit (67)	Multibeam	COCH	54,0838	4,5090		F17-06	
21/06/2022 04:35	Transit (67)	Multibeam	COCH	54,1328	4,5393		F17-02	
21/06/2022 05:07	Transit (67)	Multibeam	COCH	54,1447	4,5267		F17-01	
21/06/2022 06:02	Transit (67)	Multibeam	COCH	54,1495	4,5563		F17-08	
21/06/2022 06:07	Transit (67)	Slurf	END	54,1495	4,5573			
21/06/2022 06:07	Transit (67)	Multibeam	END	54,1495	4,5573			
21/06/2022 06:45	68_1	CTD	BEGIN	54,2010	4,6055		F14-03	
21/06/2022 06:49	68_1	CTD	BOT	54,2008	4,6048		F14-03	
21/06/2022 06:51	68_1	CTD	END	54,2008	4,6047		F14-03	
21/06/2022 07:04	68_2	Slurf	BEGIN	54,2010	4,6038		F14-03	
21/06/2022 07:05	68_3	Multibeam	BEGIN	54,2010	4,6038		F14-03	
21/06/2022 08:16	68_3	Multibeam	END	54,2017	4,6110		F14-03	

21/06/2022 08:30	68_2	Slurf	END	54,2010	4,6178		F14-03	
21/06/2022 08:45	68_4	Subbottom Profiler	BEGIN	54,2008	4,6150		F14-03	
21/06/2022 08:46	68_5	Magnetometer	BEGIN	54,2008	4,6148		F14-03	
21/06/2022 09:39	68_5	Magnetometer	END	54,2042	4,6100		F14-03	
21/06/2022 09:39	68_4	Subbottom Profiler	END	54,2042	4,6100		F14-03	
21/06/2022 09:55	68_6	CTD with Samples	BEGIN	54,2012	4,6090		F14-03	
21/06/2022 10:03	68_6	CTD with Samples	BOT	54,2010	4,6087		F14-03	
21/06/2022 10:20	68_6	CTD with Samples	END	54,2008	4,6088		F14-03	
21/06/2022 11:48	69_1	CTD	BEGIN	54,3672	4,5940		F11-01	
21/06/2022 11:53	69_1	CTD	BOT	54,3672	4,5930		F11-01	
21/06/2022 12:20	69_1	CTD	END	54,3668	4,5932		F11-01	
21/06/2022 12:22	69_2	Slurf	BEGIN	54,3665	4,5935		F11-01	
21/06/2022 12:29	69_3	Multibeam	BEGIN	54,3655	4,5952		F11-01	
21/06/2022 13:36	69_3	Multibeam	END	54,3682	4,5898		F11-01	
21/06/2022 13:48	69_2	Slurf	END	54,3673	4,5935		F11-01	
21/06/2022 13:51	69_4	CTD with Samples	BEGIN	54,3672	4,5932		F11-01	
21/06/2022 14:21	69_4	CTD with Samples	BOT	54,3670	4,5932		F11-01	
21/06/2022 14:29	69_4	CTD with Samples	END	54,3672	4,5928		F11-01	
21/06/2022 14:45	69_5	Subbottom Profiler	BEGIN	54,3688	4,6000		F11-01	
21/06/2022 15:02	69_5	Subbottom Profiler	END	54,3663	4,5895		F11-01	
22/06/2022 14:13	Port call	None	PHASE START	53,0068	4,7960		NIOZ harbour	

Appendix 4 – Water samples taken for geochemical analysis

Station_Cast	Location	Latitude	Longitude	Sample depths (m)
1_2	F12-03	54.3775	4.7442	41, 29, 15, 5
4_1	F12-05	54.4015	4.7485	42, 30, 14, 4
8_5	F12-01	54.4703	4.8413	40, 30, 20, 5
9_5	F09-01	54.6032	4.7362	44, 26, 15, 5
10_5	F09-03	54.6577	4.7402	45, 31, 15, 5
11_4	F06-04	54.6955	4.7317	43, 26, 15, 5
12_5	F06-02	54.8208	4.9153	39, 28, 15, 5
12_7	F06-05	54.8225	4.8950	38, 25, 15, 5
13_6	B13-BS	55.3025	4.0728	39, 30, 20, 4
14_4	B10-02	55.3387	4.0535	40, 30, 14, 4
16_4	B10-03	55.3992	4.0025	24, 15, 5
17_3	A12-02	55.3990	3.9755	26, 15, 4
18_4	A12-03	55.4005	3.7887	27, 18, 5
19_4	A08-01	55.5347	3.6330	32, 25, 15, 4
20_4	A11-PM	55.3872	3.5017	33, 15, 4
21_3	A14-02	55.3245	3.3955	27, 15, 5
22_4	A15-03	55.3005	3.8265	28, 15, 4
23_3	A15-05	55.3132	3.8290	26, 12, 5
24_5	B13-04	55.2343	4.0795	42, 30, 20, 6
25_4	B13-03	55.2770	4.0870	42, 31, 24, 4
26_5	B16-01	55.1167	4.0392	44, 34, 15, 4
27_5	A18-02	55.1152	3.8122	43, 34, 15, 4
28_5	A18-EBU	55.1147	3.7673	40, 30, 15
31_6	A14-01	55.1998	3.6088	24, 5
32_3	A15-02	55.3055	3.8168	27, 5
34_4	A15-04	55.2012	3.9083	41, 32, 16, 5
35_6	A15-01	55.2008	3.7037	37, 24, 13, 5
37_6	A18-01	55.0560	3.9057	44, 30, 15, 5
41_4	F01-01	54.9390	4.0212	45, 30, 15, 5
42_4	F04-01	54.8193	4.1187	46, 31, 15, 5
46_4	F05-06	54.7553	4.3592	47, 30, 15, 2
47_4	F05-Ch	54.7392	4.3657	47, 26, 12, 5
48_4	F05-05	54.6727	4.3887	46, 26, 13, 5
49_1	F05-02	54.7508	4.3785	46, 26, 12, 4
50_4	F04-02	54.7995	4.3305	47, 29, 13, 5
52_6	B17-06	55.0673	4.5093	41, 30, 15, 5
53_4	B17-05	55.0303	4.5230	41, 26, 17, 6
54_4	B17-04	55.0332	4.4822	41, 27, 13, 5
56_1	F02-05	54.9388	4.5538	40, 26, 12, 4
56_4	F02-05	54.9390	4.5542	40, 30, 15, 5
57_3	F02-03	54.9277	4.5652	39, 29, 15, 4
58_4	F02-04	54.9208	4.4750	43, 30, 20, 5
59_4	B17-03	55.0228	4.5143	41, 28, 16, 5
60_6	B14-03	55.1747	4.5742	46, 31, 20, 5
61_6	B14-01	55.2035	4.5762	46, 30, 16, 5
62_6	B18-02	55.0922	4.7960	39, 26, 11, 5
63_4	F03-EBU	54.9672	4.9295	37, 26, 15, 5
65_1	F08-Nothing	54.5238	4.4332	47, 30, 23, 4
66_5	F11-03	54.4620	4.3818	46, 31, 20, 3
68_6	F14-03	54.2012	4.6090	44, 30, 15, 5
69_4	F11-01	54.3672	4.5932	45, 25, 12, 5

Appendix 5 – Water sampling for laser spectrometer analysis

Method: 0=other; 1=Weiss Aquaflow; 2= Membrane Aquaflow; 3=Weiss SLURF; 4=Membrane SLURF

Date & Time (UTC)	Latitude	Longitude	Method	Station	SLURF depth	Comments
05/06/2022 06:36	53,00687	4,79631	0			testday Wadden Sea
06/06/2022 05:39	54,31909	4,72961	0			
06/06/2022 06:06	54,37750	4,74520	1	STATION 1		F12-03
06/06/2022 06:42	54,37681	4,74446	1			
06/06/2022 07:13	54,37739	4,74514	0			
06/06/2022 07:14	54,37739	4,74515	2			
06/06/2022 07:23	54,38163	4,74697	1			
06/06/2022 09:06	54,40750	4,76730	1	STATION 2		wreck
06/06/2022 14:54	54,37750	4,74630	3	TRANSIT 3	40	SLURF from wreck to F12-03
06/06/2022 15:20	54,37800	4,74330	3	TRANSIT 3	40	SLURF from wreck to F12-03
06/06/2022 15:30	54,37784	4,74239	0			storm, everything off
07/06/2022 05:40	54,40080	4,75030	0	STATION 3		F12-03
07/06/2022 05:41	54,40120	4,74920	0	STATION 4		F12-05
07/06/2022 05:51	54,40101	4,74809	0			
07/06/2022 05:59	54,40148	4,74806	1			F12-05
07/06/2022 07:01	54,39981	4,75051	3			F12-05
07/06/2022 07:48	54,40080	4,74970	4	STATION 4	40	SLURF at F12-05
07/06/2022 09:32	54,40070	4,75020	4	STATION 4	40	SLURF at F12-05
07/06/2022 09:43	54,39897	4,75211	1			
07/06/2022 10:03	54,39970	4,74974	0			test settings
07/06/2022 15:18	54,37950	4,74380	0	STATION 5		F12-03
07/06/2022 17:10	54,37682	4,73663	1			
07/06/2022 18:51	54,37686	4,74132	0			CAL
07/06/2022 18:56	54,37763	4,74076	1			whole night
07/06/2022 20:51	54,40800	4,76130	1	STATION 6		wreck
08/06/2022 00:00	54,40250	4,81230	1	STATION 7		F12 Chimney
08/06/2022 07:51	54,43350	4,83598	0			CAL
08/06/2022 08:01	54,43872	4,83701	1			
08/06/2022 09:56	54,46943	4,84525	3			F12-01
08/06/2022 10:03	54,46921	4,84382	4			
08/06/2022 10:22	54,47120	4,83820	4	STATION 8	40	SLURF at F12-01
08/06/2022 12:03	54,47230	4,83750	4	STATION 8	40	SLURF at F12-01
08/06/2022 12:01	54,47162	4,83816	0			
08/06/2022 12:08	54,47276	4,83745	1			
08/06/2022 17:15	54,59989	4,73600	4			
08/06/2022 17:47	54,60030	4,73670	4	STATION 9	40	SLURF at F09-01
08/06/2022 19:40	54,60320	4,73620	4	STATION 9	40	SLURF at F09-01
08/06/2022 20:27	54,60220	4,74000	4	TRANSIT 7	40	SLURF from F09-01 to F09-03
08/06/2022 20:27	54,60200	4,74030	4	TRANSIT 7	40	SLURF from F09-01 to F09-03
08/06/2022 22:15	54,65827	4,73932	3	TRANSIT 7	40	SLURF from F09-01 to F09-03
08/06/2022 22:17	54,65816	4,73956	1			
08/06/2022 22:51	54,65551	4,73997	3			F03-09
08/06/2022 23:01	54,66020	4,74000	4	STATION 10	40	SLURF at F09-03
09/06/2022 00:36	54,65500	4,73980	4	STATION 10	40	SLURF at F09-03
09/06/2022 00:37	54,65516	4,73992	1			
09/06/2022 02:36	54,69600	4,73100	1	STATION 11		F06-04
09/06/2022 07:47	54,70092	4,72815	0			CAL
09/06/2022 07:51	54,70622	4,73437	1			
09/06/2022 08:59	54,82230	4,89530	1	STATION 12		F06-05, F06-02, F06-Chimney
09/06/2022 09:43	54,82247	4,89523	3			
09/06/2022 09:49	54,82257	4,89152	4			

09/06/2022 10:07	54,82350	4,89170	4	STATION 12	40	SLURF at F06-05
09/06/2022 14:29	54,82020	4,91180	4	STATION 12	40	SLURF at F06-05
09/06/2022 14:29	54,82005	4,91218	2			
09/06/2022 15:13	54,82078	4,91636	1			F06 cluster
09/06/2022 19:06	54,82350	4,88917	4			
09/06/2022 19:07	54,82330	4,88930	4	STATION 12	40	SLURF at F06-02
09/06/2022 22:29	54,81530	4,93850	4	STATION 12	40	SLURF at F06-02
09/06/2022 22:29	54,81547	4,93825	0			
09/06/2022 22:30	54,81545	4,93837	2			
10/06/2022 03:56	55,30042	4,07376	0			CAL
10/06/2022 04:00	55,30035	4,07372	2			
10/06/2022 04:14	55,30000	4,07452	4			
10/06/2022 04:49	55,29880	4,06630	4	STATION 13	40	SLURF at B13-01
10/06/2022 06:21	55,30208	4,06813	3		40	
10/06/2022 08:08	55,30250	4,07850	3	STATION 13	40	SLURF at B13-01
10/06/2022 08:14	55,30298	4,07744	1			
10/06/2022 08:16	55,30293	4,07754	2			
10/06/2022 10:30	55,29506	4,07449	1			
10/06/2022 11:32	55,30320	4,07270	0			Filter switch
10/06/2022 11:46	55,30853	4,07071	1			
10/06/2022 13:30	55,33906	4,05840	4			
10/06/2022 13:30	55,33900	4,05820	4	STATION 14	40	SLURF at B10-02
10/06/2022 15:15	55,33830	4,04700	4	STATION 14	40	SLURF at B10-02
10/06/2022 15:17	55,33847	4,04738	1			
10/06/2022 18:11	55,37230	4,00280	1	STATION 15		wreck
10/06/2022 20:34	55,39913	4,00102	4			
10/06/2022 21:01	55,40000	4,00280	4	STATION 16	40	SLURF at B10-03 and B10-04
10/06/2022 23:25	55,40020	4,00320	4	STATION 16	40	SLURF at B10-03 and B10-04
10/06/2022 23:29	55,39968	4,00291	1			
11/06/2022 00:21	55,39930	3,97580	1	STATION 17		A12-02
11/06/2022 06:22	55,39900	3,99509	0			filter and membrane switch
11/06/2022 06:28	55,39881	3,99431	2			new membrane
11/06/2022 06:34	55,39695	3,97747	0			CAL
11/06/2022 06:46	55,40014	3,92908	2			
11/06/2022 07:58	55,39988	3,78127	4			
11/06/2022 07:58	55,39980	3,78080	4	STATION 18	40	SLURF at A12-03
11/06/2022 09:55	55,40100	3,79350	4	STATION 18	40	SLURF at A12-03
11/06/2022 10:08	55,40041	3,78898	2			
11/06/2022 13:23	55,53463	3,63917	1			
11/06/2022 13:57	55,53500	3,63720	4	STATION 19	30	SLURF at A08-01
11/06/2022 15:34	55,53530	3,63930	4	STATION 19	30	SLURF at A08-01
11/06/2022 15:35	55,53544	3,63995	2			
11/06/2022 18:11	55,53430	3,62986	1			
12/06/2022 05:29	55,38650	3,50400	1	STATION 20		A11 Pockmark
12/06/2022 05:28	55,38658	3,50448	0			CAL
12/06/2022 05:37	55,38614	3,50362	1			
12/06/2022 06:46	55,38638	3,50272	4			
12/06/2022 06:49	55,38600	3,50730	4	STATION 20	28	SLURF at A11 Pockmark
12/06/2022 08:47	55,38750	3,50050	4	STATION 20	28	SLURF at A11 Pockmark
12/06/2022 08:48	55,38757	3,50085	2			
12/06/2022 09:23	55,38042	3,49073	1			
12/06/2022 10:07	55,32723	3,39596	2			
12/06/2022 10:14	55,32721	3,39540	4			
12/06/2022 10:33	55,32700	3,39150	4	STATION 21	25	SLURF at A14-02
12/06/2022 11:44	55,32270	3,40050	4	STATION 21	25	SLURF at A14-02
12/06/2022 12:01	55,32441	3,39636	2			
12/06/2022 12:19	55,32444	3,39515	1			
12/06/2022 15:05	55,30630	3,81180	4	STATION 22	25	SLURF at A15-02
12/06/2022 17:34	55,30030	3,83030	4	STATION 22	25	SLURF at A15-02
12/06/2022 17:35	55,30049	3,83007	2			
12/06/2022 18:15	55,29993	3,82867	4			
12/06/2022 18:27	55,30070	3,82700	4	STATION 22	25	SLURF at A15-03

12/06/2022 18:50	55,30730	3,81550	4	STATION 22	25	SLURF at A15-03
12/06/2022 19:05	55,31300	3,82680	4	STATION 23	25	SLURF at A15-05
12/06/2022 20:19	55,31370	3,83180	4	STATION 23	25	SLURF at A15-05
12/06/2022 20:38	55,31322	3,82916	1			
12/06/2022 22:15	55,23891	4,07469	2			
12/06/2022 22:58	55,23305	4,08184	4			
12/06/2022 22:57	55,23300	4,08200	4	STATION 24	40	SLURF at B13-04
13/06/2022 00:17	55,23330	4,08100	4	STATION 24	40	SLURF at B13-04
13/06/2022 00:21	55,23298	4,08468	2			
13/06/2022 01:17	55,23460	4,07818	4			
13/06/2022 01:19	55,23470	4,07730	4	TRANSIT 21	35	SLURF from B13-04 to B13-03
13/06/2022 03:00	55,27697	4,08696	2			
13/06/2022 03:25	55,27715	4,08701	4			
13/06/2022 03:25	55,27720	4,08670	4	STATION 25		SLURF at B13-03
13/06/2022 05:22	55,27630	4,09030	4	STATION 25		SLURF at B13-03
13/06/2022 05:21	55,27601	4,09074	2			
13/06/2022 05:27	55,27654	4,09031	0			CAL
13/06/2022 05:35	55,27700	4,08739	2			
13/06/2022 08:02	55,11650	4,04050	2	STATION 26		B16-01
13/06/2022 13:11	55,11552	3,81173	4	STATION 27	36	SLURF at A18-02
13/06/2022 13:57	55,11925	3,83310	4		36	pineline
13/06/2022 16:31	55,11500	3,81120	4	STATION 27	36	SLURF at A18-02
13/06/2022 16:32	55,11488	3,81159	2			
13/06/2022 17:12	55,11502	3,81038	4		36	SLURF from A18-02 to A18-Seepage
13/06/2022 17:19	55,11530	3,80930	4	TRANSIT 24	36	SLURF from A18-02 to A18-Seepage
13/06/2022 18:28	55,11450	3,76750	4	TRANSIT 24	36	SLURF from A18-02 to A18-Seepage
13/06/2022 18:27	55,11458	3,76816	2			
13/06/2022 19:13	55,11380	3,76430	4	STATION 28	35	SLURF at A18-Seepage
13/06/2022 21:04	55,11470	3,76780	4	STATION 28	35	SLURF at A18-Seepage
13/06/2022 21:01	55,11494	3,76906	2			
13/06/2022 21:44	55,11431	3,76266	4		35	
13/06/2022 21:49	55,11430	3,76120	4	STATION 28	35	SLURF at A18-Seepage
13/06/2022 22:57	55,11970	3,80420	4	STATION 28	35	SLURF at A18-Seepage
13/06/2022 22:58	55,11991	3,80423	2			
13/06/2022 23:22	55,14007	3,77929	1			
14/06/2022 02:43	55,53500	3,64900	1	STATION 29		A08-01
14/06/2022 07:14	55,32364	3,41097	0			CAL
14/06/2022 07:24	55,32423	3,40545	1			
14/06/2022 10:09	55,19955	3,60981	2			
14/06/2022 10:35	55,19817	3,61063	4			
14/06/2022 10:34	55,19800	3,61080	4	STATION 31	20	SLURF at A14-01
14/06/2022 11:33	55,20080	3,60670	4	STATION 31	20	SLURF at A14-01
14/06/2022 11:34	55,20077	3,60658	2			
14/06/2022 14:50	55,30630	3,84080	2	STATION 32		A15-05, A15-02
14/06/2022 17:52	55,30525	3,81707	1			
14/06/2022 19:14	55,27820	4,10070	1	STATION 33		B13-03 (of A13-03?)
14/06/2022 21:55	55,20224	3,91197	2	STATION 34		A15-01
14/06/2022 22:34	55,19920	3,90930	4	STATION 34	30	A15-04
14/06/2022 23:37	55,20180	3,90570	4	STATION 34	30	A15-04
14/06/2022 23:39	55,20228	3,90508	2			
15/06/2022 01:43	55,19919	3,70287	4	STATION 35	32	SLURF at A15-01
15/06/2022 02:52	55,20320	3,69770	4	STATION 35	32	SLURF at A15-01
15/06/2022 02:52	55,20304	3,69767	2			
15/06/2022 03:07	55,20577	3,69639	1			
15/06/2022 03:13	55,20730	3,69985	0			CAL

15/06/2022 03:23	55,20308	3,70158	1			
15/06/2022 06:40	55,20470	3,88820	1	STATION 36		A15-04
15/06/2022 10:28	55,05623	3,90539	2			
15/06/2022 10:57	55,05426	3,90748	4			
15/06/2022 11:11	55,05430	3,90750	4	STATION 37	35	SLURF at A18-01
15/06/2022 12:13	55,05700	3,90270	4	STATION 37	35	SLURF at A18-01
15/06/2022 12:15	55,05753	3,90188	2			
15/06/2022 12:31	55,05668	3,89618	1			
15/06/2022 14:02	55,05610	3,90564	0			
15/06/2022 14:04	55,05610	3,90551	1			
15/06/2022 15:30	54,94970	4,02070	1	STATION 38		F01-01
15/06/2022 17:57	54,82930	4,10020	1	STATION 39		F04-01
15/06/2022 20:39	54,80570	4,31200	1	STATION 40		F04-02
15/06/2022 23:50	54,93888	4,02132	2			
16/06/2022 00:16	54,93768	4,02258	4	STATION 41	40	SLURF at F01-01
16/06/2022 01:49	54,93920	4,02230	4	STATION 41	40	SLURF at F01-01
16/06/2022 01:51	54,93950	4,02279	0			switch
16/06/2022 02:03	54,93885	4,02103	1			
16/06/2022 03:31	54,81930	4,11830	1	STATION 42		F04-01
16/06/2022 03:31	54,81960	4,11822	2			
16/06/2022 03:57	54,81808	4,11889	4		40	
16/06/2022 03:55	54,81830	4,11920	4	STATION 42	40	SLURF at F04-01
16/06/2022 05:32	54,81720	4,12230	4	STATION 42	40	SLURF at F04-01
16/06/2022 05:37	54,81707	4,12245	0			switch
16/06/2022 05:45	54,81928	4,11884	1			
16/06/2022 05:51	54,81946	4,11918	0			CAL
16/06/2022 05:59	54,81910	4,11900	1			
16/06/2022 07:51	54,74880	4,39020	1	STATION 43		F05-02, F05-06
16/06/2022 11:39	54,67270	4,40330	1	STATION 44		F05-05
16/06/2022 15:03	54,91170	4,47400	1	STATION 45		F02-04
16/06/2022 17:57	54,75070	4,37870	1	STATION 46		F05-02, F05-06
16/06/2022 17:49	54,75776	4,38480	0			switch
16/06/2022 17:57	54,75081	4,37893	2			
16/06/2022 18:19	54,75071	4,37851	0			switch
16/06/2022 18:19	54,75070	4,37847	4			
16/06/2022 18:31	54,75020	4,38150	4	STATION 46	40	SLURF from F05-02 to F05-06
16/06/2022 22:04	54,75500	4,35500	4	STATION 46	40	SLURF from F05-02 to F05-06
16/06/2022 22:03	54,75498	4,35561	0			switch
16/06/2022 22:04	54,75512	4,35512	2			
16/06/2022 23:03	54,73900	4,36650	2	STATION 47		F05-Chimney
16/06/2022 23:37	54,73745	4,36787	4	STATION 47	40	SLURF at F05-Chimney
17/06/2022 00:34	54,73980	4,36320	4	STATION 47	40	SLURF at F05-Chimney
17/06/2022 00:41	54,74073	4,36241	2			
17/06/2022 02:00	54,67320	4,38850	2	STATION 48		F05-05
17/06/2022 02:28	54,67264	4,38626	4			
17/06/2022 02:26	54,67280	4,38730	4	STATION 48		SLURF at F05-05
17/06/2022 03:56	54,67450	4,39130	4	STATION 48		SLURF at F05-05
17/06/2022 04:12	54,67285	4,38843	0			switch and CAL
17/06/2022 04:20	54,67328	4,38866	1			
17/06/2022 04:30	54,67299	4,38823	0			NG check
17/06/2022 04:48	54,69747	4,38375	1			
17/06/2022 05:15	54,75100	4,37780	1	STATION 49		F05-02
17/06/2022 07:02	54,79970	4,33070	1	STATION 50		F04-02
17/06/2022 07:11	54,79960	4,33022	2			
17/06/2022 07:24	54,79908	4,33188	4		40	
17/06/2022 07:36	54,79950	4,33020	4	STATION 50	40	SLURF at F04-02
17/06/2022 09:54	54,79780	4,33200	4	STATION 50	40	SLURF at F04-02
17/06/2022 09:54	54,79791	4,33226	2			
17/06/2022 11:24	54,90813	4,39005	1			
17/06/2022 12:20	55,04500	4,47470	1	STATION 51		B17-04, B17-01
17/06/2022 15:06	55,06550	4,50487	0			filterswitch
17/06/2022 15:10	55,06820	4,50830	1	STATION 52		B17-06

17/06/2022 15:23	55,06748	4,50989	2			
17/06/2022 15:36	55,06644	4,51630	4			
17/06/2022 15:36	55,06630	4,51620	4	STATION 52	35	SLURF at B17-06
17/06/2022 17:22	55,06920	4,50800	4	STATION 52	35	SLURF at B17-06
17/06/2022 17:21	55,06858	4,50834	2			
17/06/2022 17:45	55,07443	4,51014	1			
17/06/2022 21:52	55,02494	4,51695	2			
17/06/2022 22:26	55,02117	4,51279	4		30	
17/06/2022 22:29	55,02200	4,51320	4	STATION 53	30	SLURF from B17-03 to B17-05
18/06/2022 01:11	55,03020	4,52330	4	STATION 53	30	SLURF from B17-03 to B17-05
18/06/2022 01:13	55,03017	4,52354	2			
18/06/2022 02:49	55,04009	4,47438	4			
18/06/2022 02:47	55,04000	4,47450	4	STATION 54	30	SLURF from B17-04 to B17-01
18/06/2022 03:00	55,04307	4,46924	4	STATION 55	35	SLURF from B17-04 to B17-01
18/06/2022 05:28	55,03270	4,48350	4	STATION 54	35	SLURF from B17-04 to B17-01
18/06/2022 05:37	55,03322	4,48246	0			switch
18/06/2022 05:45	55,03299	4,48243	1			
18/06/2022 06:55	54,92700	4,57830	1	STATION 55		F02-03, F02-05, F02-06
18/06/2022 09:58	54,93547	4,54557	0			CAL
18/06/2022 10:06	54,93458	4,55253	1			
18/06/2022 11:36	54,93880	4,55430	1	STATION 56		F02-05
18/06/2022 11:47	54,93891	4,55433	2			
18/06/2022 13:00	54,93701	4,55691	4		35	
18/06/2022 13:00	54,93720	4,55670	4	STATION 56	35	SLURF at F02-05
18/06/2022 14:02	54,94120	4,55130	4	STATION 56	35	SLURF at F02-05
18/06/2022 14:03	54,94117	4,55149	2			
18/06/2022 14:55	54,93958	4,55436	4	STATION 56	35	SLURF from F02-05 to F02-03
18/06/2022 15:40	54,92730	4,56500	4	STATION 56	35	SLURF from F02-05 to F02-03
18/06/2022 15:41	54,92725	4,56518	2			
18/06/2022 15:44	54,92720	4,56548	4		35	
18/06/2022 16:04	54,92930	4,56530	4	STATION 57	35	SLURF at F02-03
18/06/2022 17:17	54,92470	4,56630	4	STATION 57	35	SLURF at F02-03
18/06/2022 17:16	54,92471	4,56683	2			
18/06/2022 19:12	54,91931	4,47489	4		40	F02-04
18/06/2022 19:11	54,91930	4,47450	4	STATION 58	40	SLURF at F02-04
18/06/2022 20:28	54,92380	4,47480	4	STATION 58	40	SLURF at F02-04
18/06/2022 20:25	54,92312	4,47309	2			
18/06/2022 21:16	54,92007	4,47564	0			switch
18/06/2022 21:20	54,91949	4,47580	4	STATION 58?	35	SLURF from F02-04 to F02-05
19/06/2022 03:01	55,00250	4,49250	4	TRANSIT 54	35	SLURF from F02-04 to F02-05, via F02-HANZE and pipeline to B17-03
19/06/2022 04:04	55,02380	4,53670	4	TRANSIT 54	35	SLURF from F02-04 to F02-05, via F02-HANZE and pipeline to B17-03
19/06/2022 04:03	55,02370	4,53612	2			
19/06/2022 04:04	55,02380	4,53670	2	STATION 59		B17-03, B17-05
19/06/2022 04:23	55,02669	4,53204	1			
19/06/2022 08:53	55,17420	4,57500	1	STATION 60		B14-03
19/06/2022 09:13	55,17454	4,57396	0			CAL
19/06/2022 09:22	55,17467	4,57345	1			
19/06/2022 09:35	55,17493	4,57348	2			
19/06/2022 10:13	55,17320	4,57550	4	STATION 60	40	SLURF at B14-03
19/06/2022 11:20	55,17570	4,57120	4	STATION 60	40	SLURF at B14-03

19/06/2022 11:21	55,17580	4,57152	2			
19/06/2022 11:26	55,17596	4,57112	0			switch
19/06/2022 13:50	55,20220	4,57930	1	STATION 61		B14-01
19/06/2022 13:57	55,20395	4,57604	2			
19/06/2022 14:38	55,20580	4,57300	4	STATION 61	40	SLURF at B14-01
19/06/2022 15:51	55,20320	4,57850	4	STATION 61	40	SLURF at B14-01
19/06/2022 20:47	55,08670	4,80080	2	STATION 62		B18-02
19/06/2022 22:56	55,09220	4,80000	4	STATION 62	30	SLURF
20/06/2022 00:07	55,09120	4,79370	4	STATION 62	30	SLURF
20/06/2022 00:07	55,09100	4,79376	2			going to F03-EBU
20/06/2022 02:12	54,96830	4,92350	4	STATION 63	35	SLURF
20/06/2022 04:27	54,96780	4,93250	4	STATION 63	35	SLURF
20/06/2022 04:28	54,96776	4,93252	2			
20/06/2022 05:56	54,88179	4,87847	0			CAL
20/06/2022 08:25	54,60322	4,74622	4		40	F09-pipeline
20/06/2022 08:31	54,60030	4,74670	4	STATION 64	40	
20/06/2022 10:00	54,60930	4,74500	4	STATION 64	40	
20/06/2022 10:01	54,60981	4,74503	2			
20/06/2022 10:17	54,60548	4,72785	1			
20/06/2022 12:57	54,46124	4,38574	2			F13-03
20/06/2022 13:24	54,46096	4,38507	4		40	F11-03
20/06/2022 13:24	54,46120	4,38480	4	STATION 66	40	
20/06/2022 14:37	54,46250	4,37820	4	STATION 66	40	
20/06/2022 14:38	54,46238	4,37813	2			
20/06/2022 17:51	54,21378	4,37296	4		40	
20/06/2022 17:50	54,21420	4,37330	4	STATION 67	40	
21/06/2022 05:33	54,14731	4,54269	0		CAL en Weiss	
21/06/2022 05:48	54,14836	4,54972	3			
21/06/2022 06:07	54,14950	4,55730	2	STATION 67		F17-02 gepasseerd at 04:45
21/06/2022 06:38	54,19802	4,60497	2			
21/06/2022 07:05	54,20100	4,60380	4	STATION 68	40	
21/06/2022 08:16	54,20170	4,61100	4	STATION 68	40	
21/06/2022 12:29	54,36550	4,59520	4	STATION 69	40	F112-01
21/06/2022 13:36	54,36820	4,58980	4	STATION 69	40	
21/06/2022 13:50	54,36720	4,59361	2			
21/06/2022 14:58	54,36709	4,59358	0			checks
21/06/2022 15:36	54,31803	4,59063	1			
22/06/2022 05:35	53,15763	4,42686	0			CAL and checks
22/06/2022 08:58	52,98509	4,52695	0			stop water flow
22/06/2022 09:49	52,93004	4,55846	0			Stop all measurements