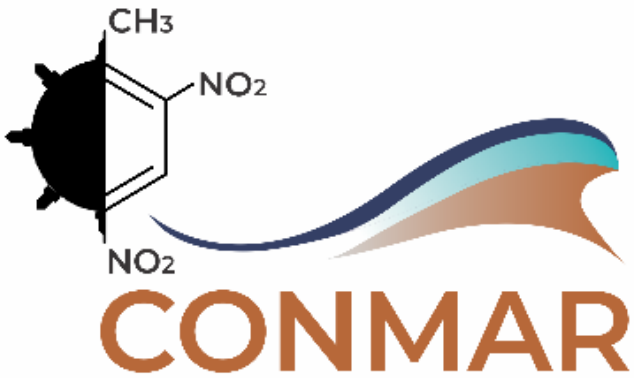
ALKOR–Berichte

Monitoring ecological consequences of marine munition in the Baltic Sea 2023

Cruise No. AL590

17th – 31st March 2023,
Kiel (Germany) – Kiel (Germany)
„MecoMM-BS - I“



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GEOMAR Helmholtz Centre for Ocean Research Kiel

2023

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1 Cruise Summary

1.1 Summary in English

ALKOR cruise AL590 took place as part of the project CONMAR (https://conmarmunition.eu/) which is part of the DAM mission sustainMare (https://www.sustainmare.de/). It was the continuation of the munition monitoring started within the BMBF-funded project UDEMM (Environmental Monitoring for the Delaboration of Munition in the Sea; https://udemm.geomar.de/), the EMFF (European Maritime and Fisheries Fund) -funded projects BASTA (Boost Applied munition detection through Smart data detection in and AI workflows; https://www.basta-munition.eu) and ExPloTect (Ex-situ, near-real-time detection compound detection in seawater).
ALKOR worked for two weeks in the Baltic Sea in the munition dumpsites Kolberger Heide, Falshöft, in Lübeck Bight and west of Rügen. Munition sites were mapped via hydroacoustic (multibeam and synthetic aperture sonar) and visual (ROV and towed camera) methods. Water samples were taken for explosive-type compounds and eDNA analysis and sediment samples for macro faunal distribution studies. A change of crew happened on 24th March in Neustadt i.H. with support of the Coast Guard t of the federal police.

1.2 Zusammenfassung

Die ALKOR-Fahrt AL590 fand im Rahmen des Projekts CONMAR (https://conmarmunition.eu/) als Teil der DAM-Mission sustainMare (https://www.sustainmare.de/) statt. Sie war die Fortsetzung der Munitionsüberwachung, die im Rahmen des BMBF-geförderten Projekts UDEMM (Umweltmonitoring für die Delaborierung von Munition im Meer; https://udemm.geomar.de/) und der vom EMFF (Europäischer Meeres- und Fischereifond) geförderten Projekte BASTA (Boost Applied munition detection through Smart data detection in and AI workflows; https://www.basta-munition.eu) und ExPloTect (Ex-situ, near-real-time detection compound detection in seawater) begonnen wurde.
ALKOR arbeitete zwei Wochen lang in der Ostsee in den Munitionsversenkungsgebieten Kolberger Heide, Falshöft, in der Lübecker Bucht und westlich von Rügen. Die Munitionsversenkungsgebiete wurden mit hydroakustischen- (Fächerlot und SAS - Sonar mit synthetischer Apertur), sowie visuellen (ROV und Schleppkamera) Methoden kartiert. Darüberhinaus wurden Wasserproben für die Untersuchung von explosiven Verbindungen und eDNA-Analysen sowie Sedimentproben für die Untersuchung der Verteilung von Makrofauna genommen. Der Wechsel der Besatzung fand am 24. März in Neustadt i.H. mit Unterstützung der Küstenwache der Bundespolizei statt.

2 Participants

2.1 Principal Investigators

Name	Institution
Beck, Aaron J., Dr.	GEOMAR
Greinert, Jens, Prof.	GEOMAR
Vedenin, Andrej, Dr.	Senckenberg
Schmaljohann, Holger, Dr.	WTD 71

2.2 Scientific Party

Name	Discipline	Institution
Greinert, Jens, Prof. Dr.	Marine Geology / Chief Scientist	GEOMAR
Kampmeier, Mareike	Marine Geology / Senior Scientist	GEOMAR
Vedenin, Andrey, Dr.	Biology/Ecology	Senckenberg
Henkel, Daniela, Dr.	Biology/Ecology	GEOMAR
Weiß, Tim	Data Management, Technical Support	GEOMAR
Mohrmann, Jochen	Photogrammetry	GEOMAR
Beck, Aaron J., Dr.	Marine Geochemistry	GEOMAR
Arinaitwe, Kenneth, Dr.	Marine Geochemistry	GEOMAR
Krüger, Marcus	Data Management	GEOMAR
Nolte, Gabriel	Technical Support	GEOMAR
Fleer, Jan	Technical Support	GEOMAR
Buck, Valentin	Photogrammetry	GEOMAR
Stäbler, Flemming	Photogrammetry	GEOMAR
Frey, Torsten	MBES, Photogrammetry	GEOMAR
Ensenbach, Samar, Dr.	Biology support	GEOMAR
Herzog, Molly	Biology support	GEOMAR
Schmaljohann, Holger, Dr.	Marine Geophysicist; SAS	WTD 71
Lademann, Paul Henry	Marine Geophysicist; SAS technical support	WTD 71

2.3 Participating Institutions

GEOMAR	GEOMAR Helmholtz Centre for Ocean Research Kiel, Kiel Germany
Senckenberg	Senckenberg am Meer, Wilhelsmhaven, Germany
WTD71	Wehrtechnische Dienststelle 71, Kiel, Germany

3 Research Program

3.1 Description of the Work Areas

In total eight working areas were investigated. Between these areas water samples were taken during transits as repetition of previous sampling during POS530, AL548, AL567 and AL583.

Area 1 – Falshöft: outer Flensburger Förde, appr. 3.5 nm north of Maasholm. Historic reports emphasize the dumping of grenades and cartridges by withdrawing German units. Because submarines were anchoring here during WWII, dumped torpedoes and depth charges can also be expected.

Area 2 – Kolberger Heide: Kolberger Heide is a munition dumpsite where munition was dumped after WWII and munition is stored by the EOD squad of the state of Schleswig-Holstein. All types of munition are found in the area, such as ground mines, torpedoes, torpedo heads, naval mines, depth charges and grenades. The seafloor is characterized by glacial lag sediments, such as fine to medium sands partly mixed with gravel and rocks (Mareike Kampmeier et al., 2020).

Area 3 – Lübeck Bay Haffkrug: Inner Lübeck Bay, appr. 3.5 nm of Neustadt. This area was used as a munition dumpsite after WWII. All types of German as well as Allied munition were dumped here.

Area 4 – Lübeck Bay Pelzerhaken: Inner Lübeck Bay, appr. 3.4 nm of Pelzerhaken. It was used as munition dumpsite after WWII where various types of German as well as Allied munition were dumped. In 1971 heavy metal rich blast furnace slag and fly ash was dumped from a metal smelter, possibly covering up some of the munition (Leipe et al., 2017; Leipe et al., 2005).

Area 5 – Großklützhöved: Appr. 3 nm north of Boltenhagen. Several barges loaded with munition were dumped within this area after WWII. Hand grenades and munition for grenades and handguns were reported.

Area 6 – Trollegrund: appr. 3 nm west of Kühlungsborn. This area was formerly in use as a shooting range area for military exercise. In addition to training munition, different kinds of dropping ammunition and dumped munition might be present.

Area 7 – Zingst: North of Zingst and westerly of Rügen. Investigations to determine the contamination, the distribution of the unexploded munitions and, if applicable, the actual limits have not been carried out. However, dropped munitions of all types are to be expected, even dumping in this area cannot be excluded.

Area 8 – Dranske: At the Dranske site there was a training facility for air defense. It was customary to fire the guns in the direction of the open sea. However, some of the shells did not explode as intended, but fell into the sea as UXO. All types of anti-aircraft ammunition, from 2 to 15.5 cm can be expected here.

3.2 Aims of the Cruise

- Continuation of spatial mapping of munition dumpsites outside of official borders to identify the extent of contamination
- Ground truthing of potential munition objects with visual means (XOFOS and ROV)
- Water-, sediment- and biological sampling for munition compound determination and physical properties characterisation
- Biological sampling in munition dumpsites

3.3 Agenda of the Cruise

The cruise started with a CTD transect to the munition dumpsite Falshöft. The hydroacoustic mapping of previous cruises was extended with multibeam and supplemented by the use of the SAS of the AUV SeaOtter of WTD 71. CTDs for water sampling continued into Flensburg Förde and back towards the east to Kolberger Heide, where MBES, ROV and vanVeen grabs were conducted. On the way to Lübeck Bight, more CTD water samples were taken, before mapping continued in Pelzerhaken and Haffkrug.

On the 24th March, crew was exchanged via shuttle boat from the Coast Guard in Neustadt. During the 2nd half of the cruise, mapping and sampling were continued along the CTD transect

within the dumpsites of Großklützhöved, Zingst and Dranske. The most easterly CTD station was close to the Polish border. Most of the CTD stations during the cruise were the same as on previous cruises, to continue monitoring.

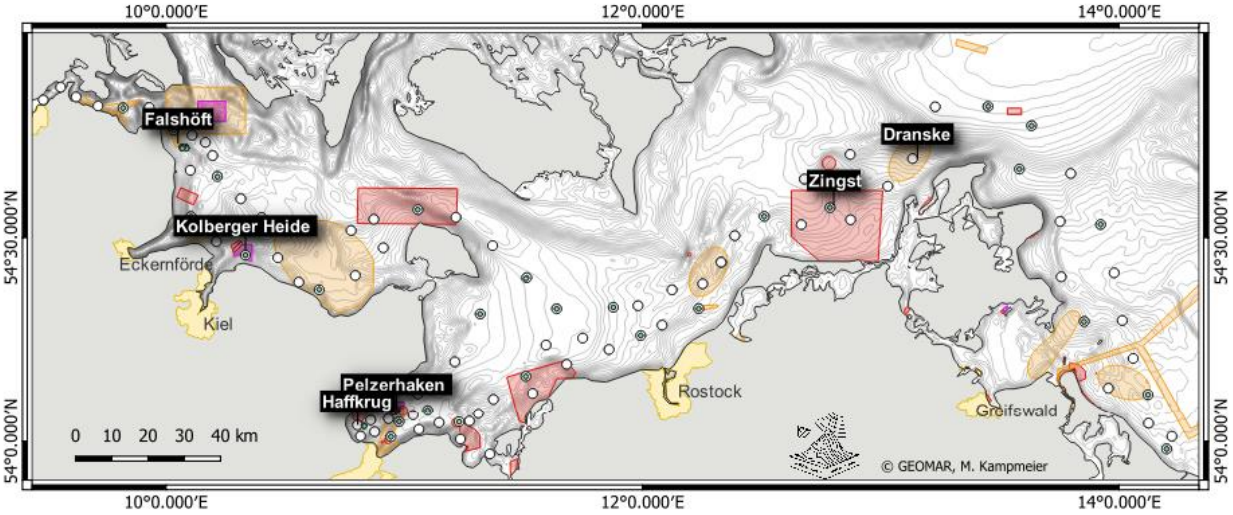

Fig. 3.1 Overall cruise track of AL603 in March 2023. Indicated are the CTD locations during the track (white dots) and grab samples (green dots), as well as munition contaminated areas (data source BSH).

Table 3.1 Cruise agenda and deployed scientific equipment.

Area	Date	Scientific Program
Transit to Falshöft	17.03.2023	CTD, VV-Grab
Falshöft	17. - 20.03.2023	CTD, VV-Grab, ROV, MBES, AUV, XOFOS
Transit to Flensburger Förde	20.03.2023	CTD, VV-Grab
Transit to Kolberger Heide	20.03.2023	CTD, VV-Grab
Kolberger Heide	20. – 21.03.2023	CTD, VV-Grab, ROV, MBES, AUV, XOFOS
Transit to Lübeck Bight	21. – 22.03.2023	CTD, VV-Grab
Lübeck Bight	22. – 25.03.2023	CTD, VV-Grab, ROV, MBES, AUV, XOFOS
Transit to Großklützhöved	25.03.2023	CTD
Großklützhöved	25.03.2023	CTD, VV-Grab
Transit to Lübeck Bight	25.03.2023	CTD
Lübeck Bight	25. – 26.03.2023	CTD, VV-Grab, ROV, MBES, AUV, XOFOS
Großklützhöved	26.03.2023	ROV
Lübeck Bight	26. – 27.03.2023	CTD, VV-Grab, ROV, MBES, XOFOS
Transit to Trollegrund	27.03.2023	CTD, VV-Grab
Trollegrund	27.03.2023	CTD
Transit to Zingst	27.03.2023	CTD, VV-Grab
Zingst	27.03.2023	CTD, VV-Grab
Transit to Dranske	27.03.2023	CTD, VV-Grab
Dranske	27.03.2023	CTD
Transit	28.03.2023	CTD, VV-Grab

Dranske	28. – 29.03.2023	MBES, ROV
Zingst	29. – 30.03.2023	MBES, ROV
Transit to Kiel	30.03.2023	CTD, VV-Grab

4 Narrative of the Cruise

Leg I: 17th – 24th March 2023:

The first leg of AL590 starts with CTD stations for watersampling. Those locations are repeatedly sampled during MineMoni cruises to continuously monitor the contamination by explosives and their degradation products. The combined system of *Xplotaker* and *Xplotector* allows a quasi-insitu water sampling and analysis via mass spectrometry on board. The mapping of the first research area Falshoeft starts on the first evening via multibeam to complete mapping of previous cruises. Maps of the new mapping results are the basis for XOFOS and ROV operations on the next day. Suspicious objects and locations are identified within the bathymetry and inspected via visual ground-truth methods. Unfortunately, previous storms and an early algae bloom cause very low visibilities and suspicious contacts can hardly be identified.

While the AUV *SeaOtter* from the WTD71 independently follows its underwater scanning mission, sediment samples are taken via vanVeen grab. A transect of samples shall give information about the distribution of macro fauna and will be analysed at the Senckenberg Institute in Wilhelmshaven.

According to this scheme the work continuous from Falshöft, over the Kolberg Heide to the Lübeck Bay. There is the visibility underwater much clearer, and work can go quickly through suspected munitions in the two dumping areas of Haffkrug and Pelzerhaken. The goal is to verify and identify suspected munitions from the multibeam mapping data. As a small change from the normal research routine, there is a visit from members of the Federal Police on Wednesday and Thursday. Two groups come on board to learn about the state of the art in marine technology for underwater mapping (hydroacoustic and optical) and to learn from our experiences.

On Friday, the German Coast Guard additionally supports the exchange of personnel and brings a group of new scientists, as well as a film team of the NDR and the Ocean Mind Foundation, and employees of the BMUV (Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection) to RV ALKOR. They want to get a picture of the dumped munitions and the technical possibilities to find them. In the afternoon, four scientists and the guests disembarked and were taken back to Neustadt i. Holstein.

Leg II: 24th – 31st March 2023:

On the second leg of the cruise, more sediment transects are taken and a number of contacts are inspected via XOFOS and ROV, but the main focus was on the CTD stations, which form a transect along the whole German Baltic Sea coast. Some initial mapping is performed within the munition areas Zingst and Dranske, but no contacts were detected. Between Lübeck Bay and Dranske there were 1 ½ days with non-stop CTD water sampling and grab samples. On the way back, the last stations were done within another full day.

5 Preliminary Results

5.1 Acoustic seafloor mapping via ship based multibeam

High-resolution mapping has been executed in the dumpsites Kolberger Heide and Lübeck Bay on previous cruises: POS530, L13-20, AL548, AL567 and AL583. The detailed description is not repeated here again.

The surveys were conducted with roughly 100 % overlap and included a calibration line. The working areas are close to Pelzerhaken, Zingst, Dranske, Falshoeft (named accordingly) and in Kolberger Heide. Before each multibeam station a sound velocity profile was obtained using the Valeport Swift SVP Profiler.

During survey potential munition targets were annotated using the acquisition software. On a second processing PC the data were parallel postprocessed using Qimera. As the multibeam plate in the moonpool needed to moved up and down to attach/detach the AUV USBL recalibration lines were run before/during every multibeam survey/station. The Patch Test Tool was used to correct for roll bias per area. The SVP was sufficient for all areas but Zingst. Here the Qimera Refraction Correction filter was applied at a refraction depth of 5 m and a speed of sound difference of -3m/s could be established. Artifacts were removed manually and the data exported as GeoTiffs. The size of the covered area is shown in Table 5.1. In Haffkrug additional survey lines were recorded during XOFOS operation. Those data are not yet processed.

Table 5.1 MBES Coverage per area.

Area	Coverage
Pelzerhaken	10.3 km²
Zingst	2.0 km²
Dranske	2.3 km²
Kolberger Heide	TODO: some surveys left to be conducted as of yet
Falshöft	4.3 km²

5.2 Detailed SAS mapping with AUV

The WTD 71 AUV SeaOtter MKII is equipped with a synthetic aperture sonar (SAS) in an interferometric configuration. The sonar was designed such that the area coverage rate is optimized. It can collect data up to 200 m range on port and starboard side. To increase the range and minimize the nadir gap two different frequency bands are used in the standard configuration. While the lower MF frequency band covers the short-range interval the image for the higher ranges is based on the higher frequency band HF. This decreases the impact of multipath on the imagery. For research studies the vehicle is equipped with an additional transmitter operating at low frequencies (LF) to be able to detect buried objects.

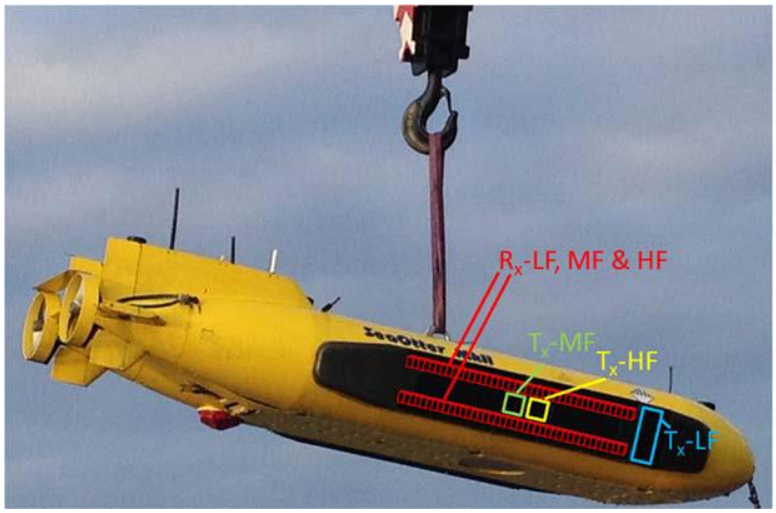

Fig. 5.1 AUV SeaOtter sonar components.

Table 5.2 Overview of the performed dives of the AUV SeaOtter.

Date	Location	Sonar	Mode	Pattern	Mission name
2023-03-17	Falshöft	passive	LF + HF	linear	SeaOtter_Mission_ Falshoeft_II
2023-03-19	Falshöft	active	MF + HF	linear	Falshoeft_Test_HF-MF
2023-03-19	Falshöft	active	MF + HF	linear	Falshoeft_20230319
2023-03-19	Falshöft	active	MF + HF	linear	Falshoeft_20230319_02
2023-03-21	Kolberger Heide	active	MF + HF	circular	Circle_R50_20230321
2023-03-22	Kolberger Heide	active	MF + HF	linear	Meander_20230321
2023-03-22	Lübeck bay / Haffkrug	active	MF + HF	linear	Meander_Neustadt_01
2023-03-22	Lübeck bay / Haffkrug	active	MF + HF	circular	Torpedo_Neustadt_01
2023-03-22	Lübeck bay / Haffkrug	active	MF + HF	circular	Torpedo_Neustadt_02
2023-03-23	Lübeck bay / Haffkrug	passive	MF + HF	linear	Meander_Neustadt_03
2023-03-23	Lübeck bay / Haffkrug	passive	MF + HF	circular	Neustadt_Torpedo_01
2023-03-23	Lübeck bay / Pelzerhaken	passive	MF + HF	circular	Neustadt_Torpedo_03
2023-03-23	Lübeck bay / Pelzeraken	passive	MF + HF	circular	Neustadt_Torpedoe_04
2023-03-24	Lübeck bay / Haffkrug	active	LF + HF	linear	Neustadt_03
2023-03-24	Lübeck bay / Haffkrug	active	LF + HF	circular	Torpedo_01_Circle_HF-LF

During missions two of the three available frequency bands can be selected for transmission. For SAS operations the vehicle can go between three up six knots. The battery capacity allows to collect SAS data for up to 20 h. All payload data (navigation data, hydrophone data, if selected SAS images and ATR results) are stored within a specific data unit. This unit can be removed/exchanged after vehicle recovery to be able to start the next mission with a minimized delay.

The vehicle size is 3.69 m length, 1.33 m width and 0.48 m height (excluding antennas) while the mass is 1200 kg. During AL590, the AUV SeaOtter went on 10 missions. These are listed in Table 5.2 below. It should be noted that due to a malfunction, the data on the 17th and 23rd do not contain a transmission signal and are therefore not suitable for image processing (sonar

on passive). Figures 5.3 to 5.5 show the positions of the tracks in the areas where the system operated as expected.

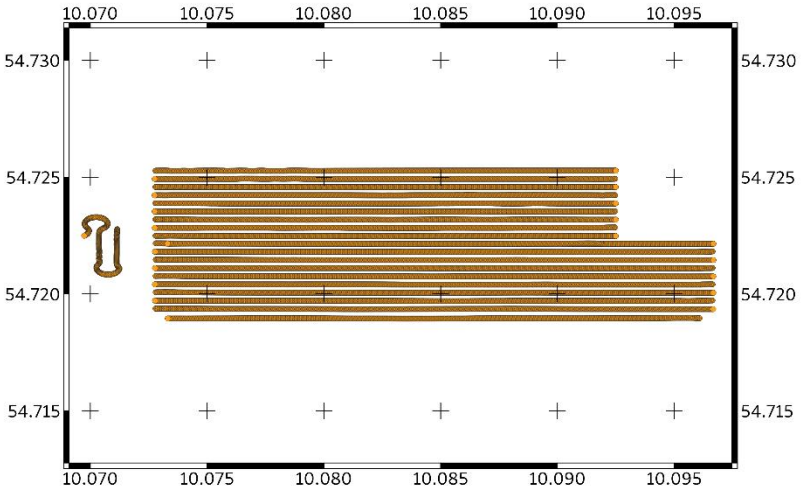

Fig. 5.2 Tracks of AUV operations in the Falshöft area.

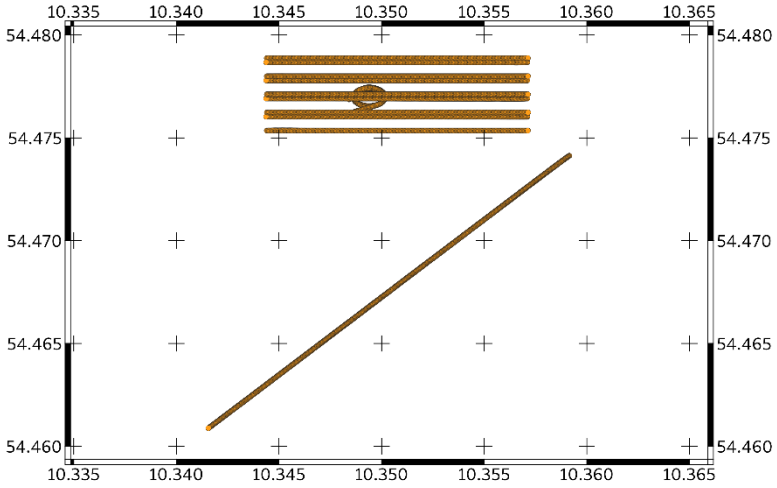

Fig. 5.3 Tracks of AUV operations in Kolberger Heide.

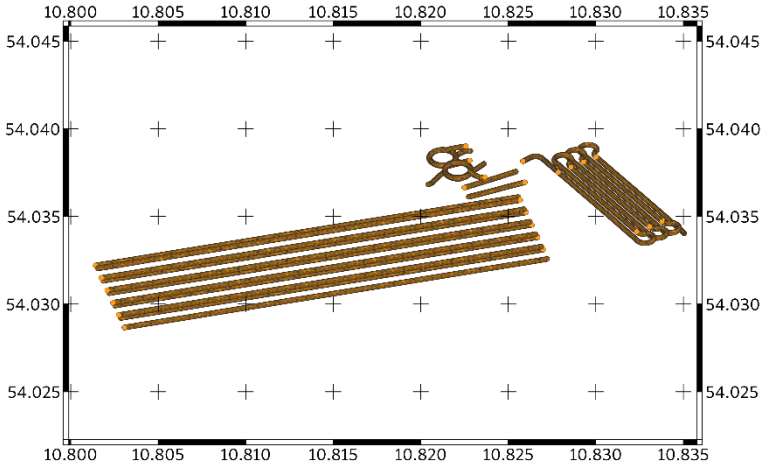

Fig. 5.4 Track of AUV operations in Lübeck Bay / Haffkrug.

5.3 Detailed optical and magnetic mapping with XOFOS

The XOFOS (eXtended Ocean Floor Observation System) was used to perform video observations of the seafloor with real-time annotation using the OFOP software. Live data is streamed through the fibre optic cable of the mobile winch from GEOMAR. The video was recorded in HD quality for online annotation and control. In addition to a USBL, a downward-facing ADCP enhances the positioning, which was calculated and recorded via OFOP. High-quality still images are recorded via an additional downward looking Ocean Imaging camera with flash system. Further a total of eight Niskin bottles can be closed individually by using OFOP to collect water samples.

5.4 Detailed optical mapping with ROV (BlueROV – Kapt'n Blaubär)

„Käpt'n Blaubär" is a small sized ROV (BlueROV 2) which was used for visual surveys of munition dump sites. The ROV is connected via a 300m long multi-line copper cable. It was deployed by hand using a quick release on a rope. During a survey one person controlled the winch manually on deck and observed the cable in the water, a second person controlled the navigation- and sonar software (OFOP, Pingviewer) and a third person was piloting the ROV. The pilot used the QGroundControl-software and a standard game pad to control the vehicle. It is powered by battery. One battery package supplies the ROV with energy for dive times between 30 to 60 minutes. An additional battery was used as a power supply for the USBL transponder. In addition the ROV is equipped to take four water samples of each 500ml. Open horizontally oriented tubes below the ROV electronics can be closed upon command from the control pad.

The ROV is equipped with a HD Camera (1920 x 1080 px). The video stream was recorded on the control laptop in h264-format (mkv-container). A 360° scanning sonar and an Evologics USBL transponder was installed on top of the vehicle for navigation purposes. Hence it was possible to precisely navigate to points of interest at different sites even in conditions of low visibility and reasonable far distances. The USBL signals were processed by Evologics Sinaps software package on a standard laptop. The calculated positions were forwarded to OFOP where they were logged together with the ships position and displayed in real-time on a background (multibeam) map.

During the cruise 37 dives were performed. At Falshöft, visibility was too poor for a ground survey. However, 24 sites were investigated in Lübeck Bay, which revealed a number of "new"

munitions contacts. Some piles marked as possible contacts in the MBES data turned out to contain mixed ammunition material, such as ammunition boxes containing shells and flak projectiles. Large closed ammunition boxes and scrap metal were also found. One striking observation was that cod appear to use ammunition piles as hiding places. During some ROV dives, up to 10 cods were observed hiding in open boxes and using them for shelter.

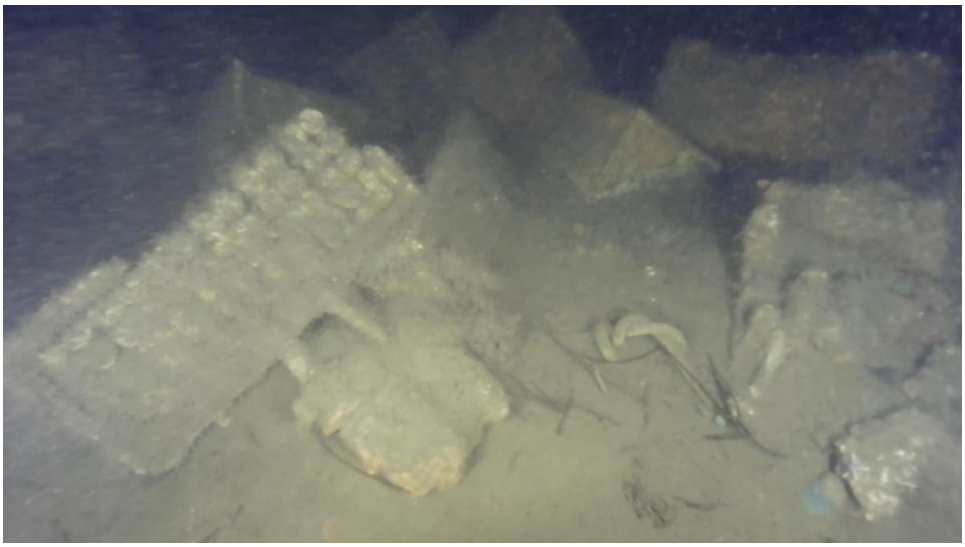

Fig. 5.5 Pile of mixed munition boxes in Pelzerhaken.

5.5 Water sampling for munition compound analyses

Water samples were collected across the entire length of the transits through German waters (Fig. **3.1**; Fig 5.6) to determine the spatial distribution of munition compounds (MCs) in the water column. AL590 was the first time Wismar Bight and the region east of Rügen have been investigated for MC contamination. Samples were collected from a total of 94 sampling stations using a CTD-Niskin rosette for sampling at two depths, close to the bottom (about 1-2 m above sediment) and near-surface (about 1.5 m below surface). Samples from the respective bottles were taken in duplicates. An extra sample was taken at selected CTD stations for MC method test experiments. Additional bottom samples were collected from 13 sites during XOFOS tows in Falshöft, Kolberger Heide and Lübeck Bay (Fig 5.6).

For analyses, all samples were spiked with internal standard to account for losses during the storage or sample processing. Solid phase extraction (SPE) cartridges were used to extract MCs from the water samples, kept frozen and brought back to GEOMAR for further processing. All samples were filtered (1.2 µm) prior to extraction onto SPE cartridges. The filters were also kept frozen, to be processed and analysed later to facilitate investigation of partitioning of MCs between water and suspended particles.

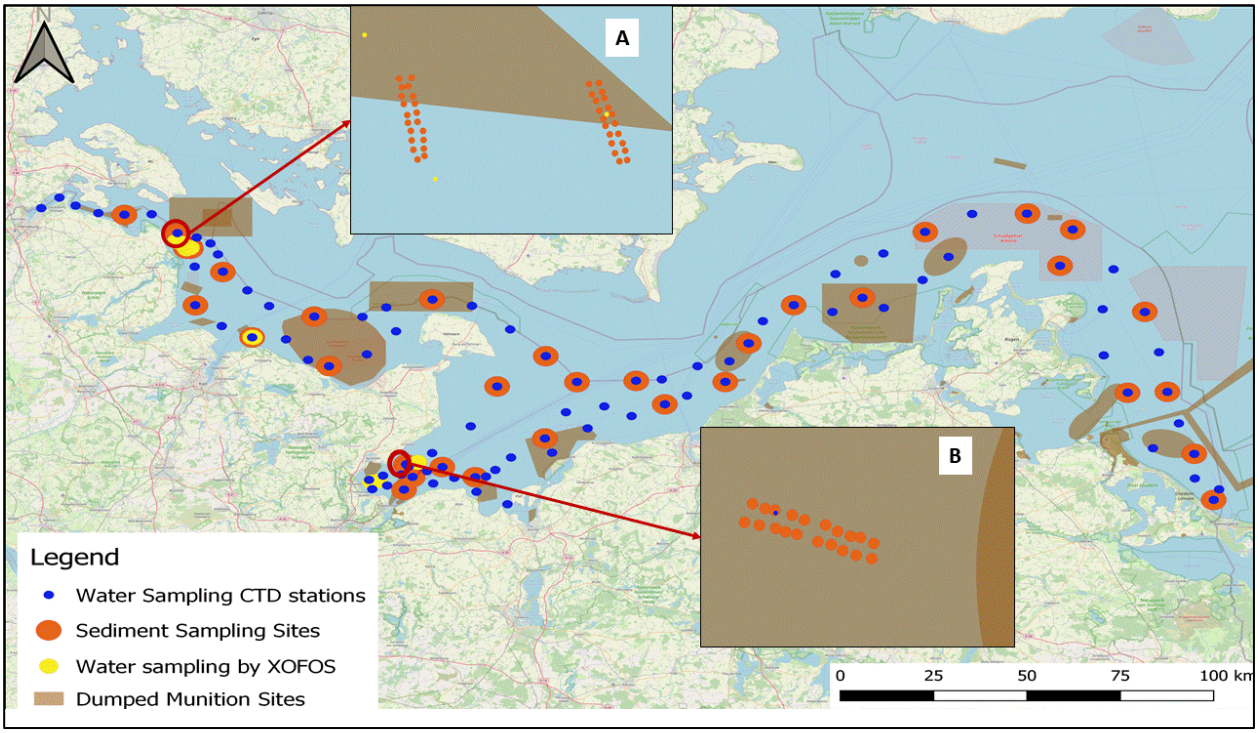

Fig 5.6 Map of sampling sites for sediment and water samples collected during AL590 cruise for munition compound analysis. 60 sediment samples for MC analysis, paired with sediments samples for biological screening were collected Falshöft and Lübeck Bay (Inset A and B, respectively) in order to support cross-correlational studies between biological communities and MCs,.

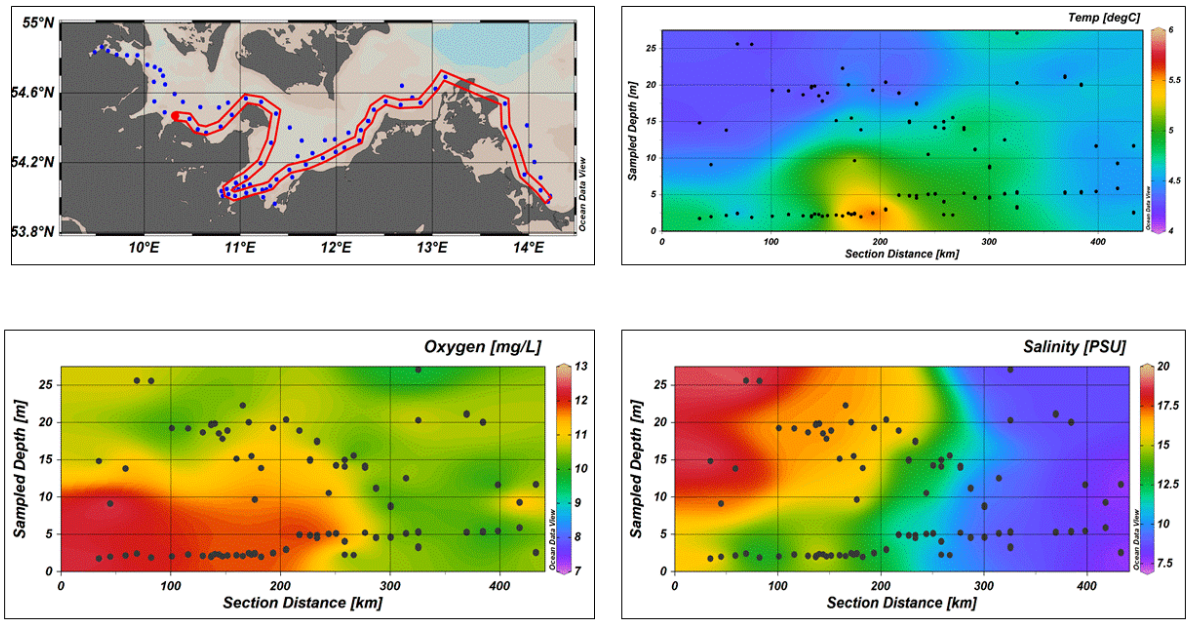

Fig. 5.7 Vertical profiles of temperature, oxygen and salinity for a section of the AL590 CTD transect.

Fig. 5.7 shows profiles of temperature, oxygen, and salinity along a Kolberger Heide – Lübeck Bay – Usedom nearshore section of the AL590 cruise track. The Usedom area receives fresh riverine water from the Oder River, hence the relatively lower salinity in this part of the section. The relatively lower oxygen in the Usedom part of the section is likely due to elevated primary

production in the riverine water. These profiles will be analysed further in conjunction with the MC profiles once the sample analysis has been completed.

5.6 Sediment sampling for MC analyses

Surface sediment samples were collected with a Van Veen-type grab sampler for spatial profiling of MCs (93 Van Veen Grabs; Fig 5.6). Some of the samples were collected in tandem with the sampling of biological communities in sediment in order to enable supportive MC analysis. The samples were stored frozen in Whirlpak sample bags and brought back to GEOMAR for further processing and analysis.

5.7 Munition compound degradation experiment

A degradation experiment was carried out onboard during the cruise. Duplicate surface seawater samples were collected from Kolberger Heide, Falshöft and Lübeck Bay, and spiked with a mixture of RDX, DNB and TNT to make a 1 ng/mL solution. The solutions were subsampled at 0 h, 24 h and every 48 h thereafter for at least 6 intervals. The following experimental conditions were set up for various spiked sample solutions:

(i) Light exposure constant temperature experiment, to investigate the effect of exposure to natural sunlight on the degradation of the three MCs: Spiked, unfiltered seawater (1 µg/L TNT, RDX, DNB; 1 L per bottle) in triplicate clear glass and amber glass bottles (the latter wrapped in aluminium foil, as dark controls) were exposed to natural sunlight in a flow-through (fresh seawater, ~5°C) water bath on the backdeck by the winch control cabin.

(ii) Microbial degradation experiment, comparing temperature and oxygen effects: Spiked, unfiltered seawater (1 µg/L TNT, RDX, DNB; 2.5 L per bottle) was incubated in triplicate amber glass bottles. Treatments examined the effect of temperature (4° and 22° C) and oxygen (oxic and suboxic/sulfidic). Suboxic conditions were achieved by adding 4 mM sodium sulfite (Na_2SO_3; Rothe and Thomm, 2000, Extremophiles 4: 247–252).

Some of the subsamples were analysed on board using the Xplotector. The rest were brought back to GEOMAR for further processing and analysis.

The initial time points of the degradation experiment were analysed immediately with the Xplotector. The results showed that TNT degraded more rapidly at 25°C than at 4°C. Surprisingly, degradation in sunlight was as fast as at high temperature, despite a water temperature of approximately 5°C. The degradation half-life was approximately 1 d at high temperature or light exposure. At cool temperatures in the dark, the degradation half-life was nearly 4 d.

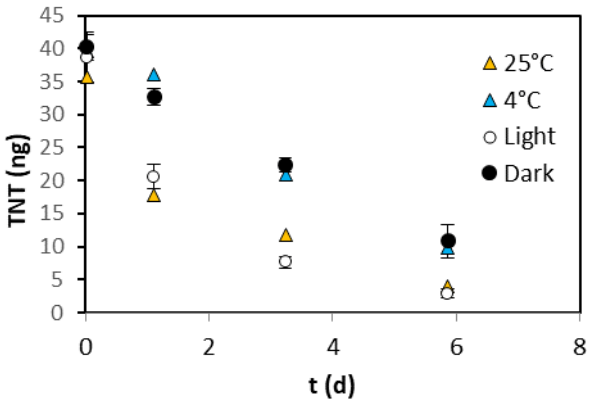

Fig. 5.8 Selected results from the onboard degradation experiment showing loss of TNT in natural sunlight vs. dark conditions (hollow and filled circles, respectively; 5°C), and at 4° vs. 25°C (blue and orange triangles, respectively; both kept in the dark).

5.8 Onboard munition chemical analyses with the Xplotector

Dissolved munition compounds were measured onboard during AL590 using the Xplotector lab-in-a-box system. The Xplotector was developed during the EMFF-supported ExPloTect project (2019-2022; Grant No. 863693) to enable at-sea monitoring of explosive chemical released from underwater relic munitions. The system consists of a fluidics module coupled to an analytical module. The fluidics module uses several HPLC pumps and switching valves to automate filtration and explosive chemical preconcentration from seawater. The preconcentrated sample is then injected into the analytical module, which performs HCPLC chromatography and analysis of target compounds by UV spectroscopy and mass spectrometry. Deep water samples from the CTD casts were collected for analysis with the Xplotector system.

Deep water samples from the first 31 CTD stations were measured with the Xplotector system. These stations represent coverage of the Kieler Bucht (including the Kolberger Heide munitions dumpsite), Flensburg Fjord, and a transect around Fehmarn and into the Lübecker Bucht. Unfortunately, the electrospray ionization source of the mass spectrometer failed at that point, and no further samples could be measured onboard with the Xplotector. Concentrations in all the samples were below the detection limit of the Xplotector (approximately 5 ng/L for TNT). These low concentrations are consistent with results from November 2020, but were lower than measured in 2018 and 2021.

Several transects were conducted with the XOFOS during the first week of the cruise, and water samples for Xplotector analysis were taken from the side-mounted Niskin bottles. Two transects at a location with exposed explosive material within the Kolberger Heide munitions dumpsite (AL590_82 and AL590_83) provided the only samples with positive TNT detection during the cruise. Concentrations in these samples ranged between 14 and 26 ng/L. Overall, these results indicated low levels of contamination during the cruise period, but await confirmation by laboratory analysis with the high-resolution Orbitrap mass spectrometer.

5.9 Macrofauna sampling with VanVeen Grab

During the expedition of AL590 a total of 60 stations were taken along two double transects in the Falshöft area near Flensburg Fjord and in the Pelzerhaken area in Lübeck Bay. Transects were chosen to match the collected data on multibeam surveys with all the munition objects mapped (Fig. 5.9 and Fig. 5.10).

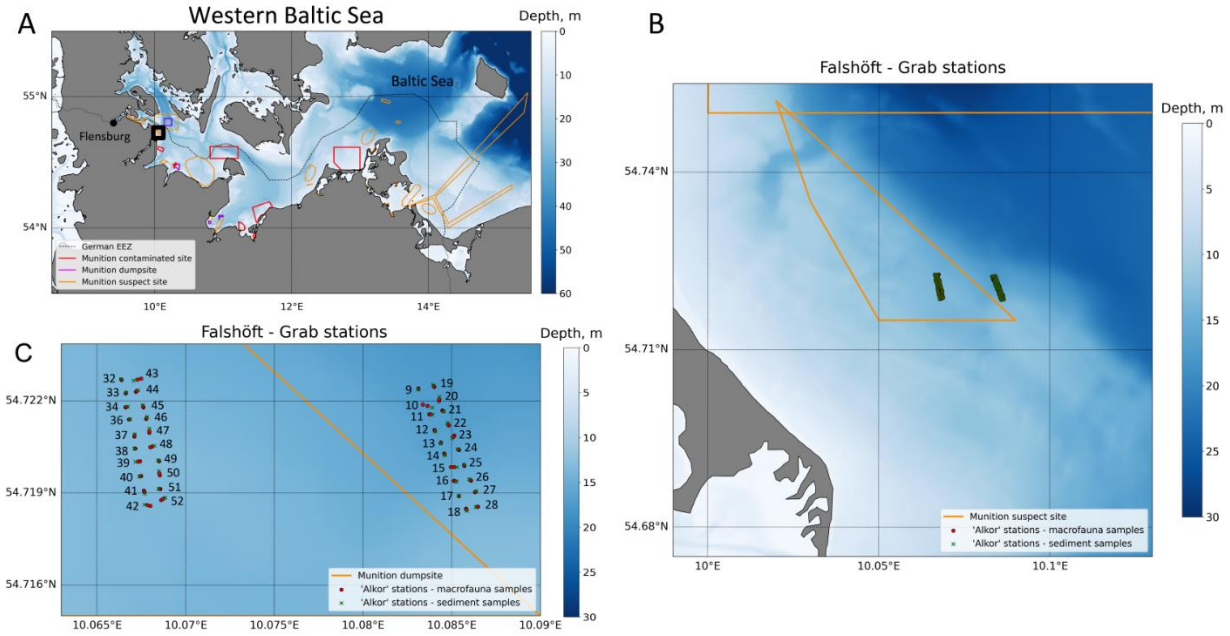

Fig. 5.9 Grab stations taken in Falshöft area from during AL590. A – Western Baltic Sea with munition dumpsites marked; B – Falshöft munition dumpsite with two double transects of stations; C – enclosed area with the stations. right – enclosed area with stations. Red dots mark the macrofauna samples; green crosses mark the sediment samples.

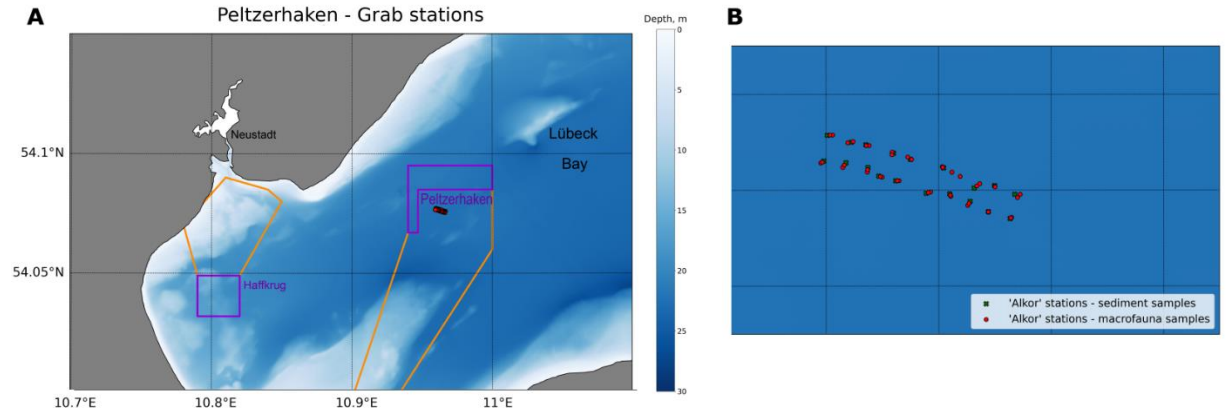

Fig. 5.10 Grab stations taken in Pelzerhaken area from during AL590. Left – position within the Lübeck Bay area; right – enclosed area with stations. Red dots mark the macrofauna samples; green crosses mark the sediment samples.

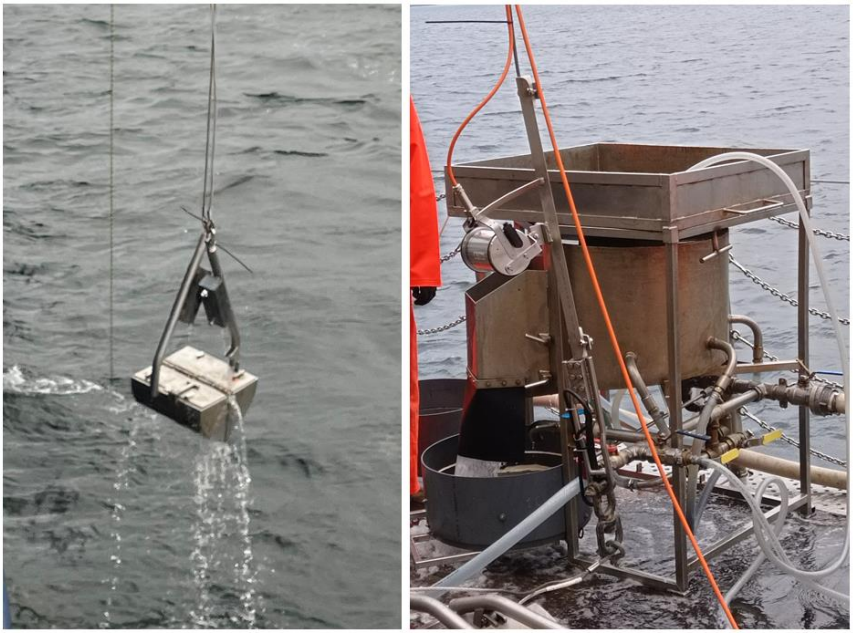

Fig. 5.11 VanVeen Grab sampling. Left – 0.1 m^2 van-Veen grab sample taken out of water; right – washing the sample through the washing machine to the sieve. The grab was live-video-guided with an OCTOPUS camera from GEOMAR.

Sampling was performed using 0.1 van-Veen grab, with three replicates per station. Two replicates were used for the biological analysis of macrofauna, and one for the sediment analysis.

Fig. 5.12 Dominant Taxa found in the Falshoeft and Pelzerhaken areas. Polychaetes Scoloplos armiger, Nephtys sp., Pygospio elegans; Mollusc Peringia ulvae.

The samples for macrofaunal analysis were sieved through 1-mm mesh size using a washing-machine with several cross-oriented water jets, capable of milling dense mud sediment. The washed fauna was fixed with 4% formaldehyde buffered with hexamethylentetramin. Further in the laboratory all the macrobenthic taxa will be identified, calculated and weighted to collect raw data on the macrofauna.

Samples for the sediment analysis were taken for further grain-size analysis and for the content of munition compounds. Specifically, small amount of sediment (~200 g) was taken from each sediment grab, packed in zip-bags and frozen. Grain size analyses and chemical analyses of munition compounds will be undertaken in GEOMARs onshore laboratories.

6 Station List AL590

6.1 Overall Station List

Working area	Event Time	Station	Latitude (deg)	Longitude (deg)	Depth (m)	Action	Comment	Device
CTD Transit	3/17/2023 8:23	AL590_001-1	54.4919	10.2111	20	in the water		CTD
	3/17/2023 8:28	AL590_001-1	54.4919	10.2118	20	on deck		CTD
	3/17/2023 9:14	AL590_002-1	54.5531	10.1042	26	in the water		CTD
	3/17/2023 9:20	AL590_002-1	54.5528	10.1054	25	on deck		CTD
	3/17/2023 9:26	AL590_002-2	54.5527	10.1052	26	in the water		VGRAB
	3/17/2023 9:29	AL590_002-2	54.5526	10.1050	26	on deck		VGRAB
	3/17/2023 10:40	AL590_003-1	54.6658	10.1022	16	in the water		CTD
	3/17/2023 10:44	AL590_003-1	54.6656	10.1022	16	on deck		CTD
Falshoeft	3/17/2023 11:58	AL590_004-1	54.7242	10.0710	15	in the water	SeaOtter MkII	AUV
	3/17/2023 16:35	AL590_004-1	54.7254	10.0683	15	on deck	SeaOtter MkII	AUV
	3/17/2023 13:27	AL590_005-1	54.7249	10.0633	14	in the water	XOFOS	UWV
	3/17/2023 13:38	AL590_005-1	54.7238	10.0647	14	profile start	XOFOS	UWV
	3/17/2023 14:23	AL590_005-1	54.7183	10.0692	14	profile end	XOFOS	UWV
	3/17/2023 14:28	AL590_005-1	54.7179	10.0691	14	on deck	XOFOS, adjust wing	UWV
	3/17/2023 14:50	AL590_006-1	54.7176	10.0696	14	in the water	XOFOS with wing	UWV
	3/17/2023 15:37	AL590_006-1	54.7140	10.0740	14	on deck	XOFOS with wing	UWV
	3/17/2023 17:14	AL590_007-1	54.7226	10.0850	17	in the water		ROV
	3/17/2023 18:30	AL590_007-1	54.7227	10.0852	17	on deck		ROV
	3/17/2023 19:06	AL590_008-1	54.7262	10.0729	17	profile start		MB
	3/18/2023 7:05	AL590_008-1	54.7303	10.0537	13	profile end		MB
	3/18/2023 7:41	AL590_009-1	54.7224	10.0831	17	in the water		VGRAB
	3/18/2023 7:53	AL590_009-1	54.7224	10.0831	17	on deck	3x grab	VGRAB

	3/18/2023 8:04	AL590_010-1	54.7219	10.0834	17	in the water		VGRAB
	3/18/2023 8:17	AL590_010-1	54.7218	10.0839	17	on deck	3x grab	VGRAB
	3/18/2023 8:23	AL590_011-1	54.7216	10.0837	17	in the water		VGRAB
	3/18/2023 8:32	AL590_011-1	54.7216	10.0839	17	on deck	3x grab	VGRAB
	3/18/2023 8:48	AL590_012-1	54.7211	10.0840	17	in the water		VGRAB
	3/18/2023 8:58	AL590_012-1	54.7210	10.0841	17	on deck	3x grab	VGRAB
	3/18/2023 9:08	AL590_013-1	54.7206	10.0844	17	in the water		VGRAB
	3/18/2023 9:17	AL590_013-1	54.7206	10.0844	17	on deck	3x grab	VGRAB
	3/18/2023 9:27	AL590_014-1	54.7203	10.0846	17	in the water		VGRAB
	3/18/2023 9:36	AL590_014-1	54.7202	10.0846	17	on deck	3x grab	VGRAB
	3/18/2023 9:42	AL590_015-1	54.7199	10.0850	16	in the water		VGRAB
	3/18/2023 9:54	AL590_015-1	54.7198	10.0853	16	on deck	3x grab	VGRAB
	3/18/2023 10:50	AL590_016-1	54.7194	10.0851	15	in the water	3x grab	VGRAB
	3/18/2023 10:58	AL590_016-1	54.7194	10.0853	15	on deck	3x grab	VGRAB
	3/18/2023 11:06	AL590_017-1	54.7189	10.0854	14	in the water		VGRAB
	3/18/2023 11:13	AL590_017-1	54.7189	10.0854	15	on deck	3x grab	VGRAB
	3/18/2023 11:22	AL590_018-1	54.7185	10.0858	14	in the water		VGRAB
	3/18/2023 11:29	AL590_018-1	54.7184	10.0859	14	on deck	3x grab	VGRAB
	3/18/2023 11:47	AL590_019-1	54.7225	10.0840	18	in the water		VGRAB
	3/18/2023 11:54	AL590_019-1	54.7225	10.0839	18	on deck	3x grab	VGRAB
	3/18/2023 12:06	AL590_020-1	54.7220	10.0843	18	in the water		VGRAB
	3/18/2023 12:15	AL590_020-1	54.7221	10.0843	17	on deck	3x grab	VGRAB
	3/18/2023 12:44	AL590_021-1	54.7217	10.0845	17	in the water		VGRAB
	3/18/2023 12:50	AL590_021-1	54.7217	10.0846	17	on deck	3x grab	VGRAB
	3/18/2023 12:57	AL590_022-1	54.7212	10.0848	17	in the water		VGRAB
	3/18/2023 13:04	AL590_022-1	54.7213	10.0847	17	on deck	3x grab	VGRAB
	3/18/2023 13:10	AL590_023-1	54.7209	10.0852	17	in the water		VGRAB
	3/18/2023 13:16	AL590_023-1	54.7208	10.0850	17	on deck	3x grab	VGRAB
	3/18/2023 13:21	AL590_024-1	54.7204	10.0854	17	in the water		VGRAB
	3/18/2023 13:28	AL590_024-1	54.7204	10.0853	17	on deck	3x grab	VGRAB

	3/18/2023 13:33	AL590_025-1	54.7199	10.0857	16	in the water		VGRAB
	3/18/2023 13:39	AL590_025-1	54.7199	10.0857	16	on deck	3x grab	VGRAB
	3/18/2023 13:44	AL590_026-1	54.7194	10.0861	15	in the water		VGRAB
	3/18/2023 13:49	AL590_026-1	54.7195	10.0860	15	on deck	3x grab	VGRAB
	3/18/2023 13:53	AL590_027-1	54.7190	10.0863	14	in the water		VGRAB
	3/18/2023 13:59	AL590_027-1	54.7191	10.0864	14	on deck	3x grab	VGRAB
	3/18/2023 14:03	AL590_028-1	54.7186	10.0865	14	in the water		VGRAB
	3/18/2023 14:24	AL590_028-1	54.7185	10.0863	14	on deck	3x grab	VGRAB
	3/18/2023 16:55	AL590_029-1	54.7115	10.0668	12	profile end		UWV
	3/18/2023 15:02	AL590_029-1	54.7209	10.0847	17	in the water	XOFOS with wing	UWV
	3/18/2023 17:27	AL590_030-1	54.7208	10.0843	17	profile start	Kapt. Blaubaer	ROV
	3/18/2023 18:28	AL590_030-1	54.7209	10.0844	17	profile end	Kapt. Blaubaer	ROV
	3/18/2023 19:18	AL590_031-1	54.7310	10.0602	15	profile start		MB
	3/19/2023 6:47	AL590_031-1	54.7315	10.0387	12	profile end		MB
	3/19/2023 8:13	AL590_032-1	54.7227	10.0664	14	in the water		VGRAB
	3/19/2023 8:19	AL590_032-1	54.7227	10.0663	14	on deck	3x grab	VGRAB
	3/19/2023 8:22	AL590_033-1	54.7222	10.0666	14	in the water		VGRAB
	3/19/2023 8:28	AL590_033-1	54.7223	10.0667	14	on deck	3x grab	VGRAB
	3/19/2023 8:31	AL590_034-1	54.7218	10.0666	14	in the water		VGRAB
	3/19/2023 8:38	AL590_034-1	54.7218	10.0667	14	on deck	3x grab	VGRAB
	3/19/2023 16:43	AL590_035-1	54.7283	10.0727	19	on deck	SeaOtter Mk II	AUV
	3/19/2023 8:46	AL590_035-1	54.7219	10.0667	14	in the water	SeaOtter Mk II	AUV
	3/19/2023 8:53	AL590_036-1	54.7214	10.0668	14	in the water		VGRAB
	3/19/2023 9:00	AL590_036-1	54.7214	10.0669	14	on deck	3x grab	VGRAB
	3/19/2023 9:03	AL590_037-1	54.7208	10.0671	14	in the water		VGRAB
	3/19/2023 9:09	AL590_037-1	54.7209	10.0671	14	on deck	3x grab	VGRAB
	3/19/2023 10:20	AL590_038-1	54.7204	10.0672	13	in the water		VGRAB
	3/19/2023 10:27	AL590_038-1	54.7205	10.0671	13	on deck	3x grab	VGRAB
	3/19/2023 10:29	AL590_039-1	54.7200	10.0674	13	in the water		VGRAB
	3/19/2023 10:36	AL590_039-1	54.7200	10.0672	13	on deck	3x grab	VGRAB

	3/19/2023 10:40	AL590_040-1	54.7196	10.0675	14	in the water		VGRAB
	3/19/2023 10:47	AL590_040-1	54.7195	10.0674	14	on deck	3x grab	VGRAB
	3/19/2023 10:51	AL590_041-1	54.7191	10.0676	14	in the water		VGRAB
	3/19/2023 10:58	AL590_041-1	54.7190	10.0677	14	on deck	3x grab	VGRAB
	3/19/2023 11:01	AL590_042-1	54.7186	10.0680	14	in the water		VGRAB
	3/19/2023 11:12	AL590_042-1	54.7186	10.0677	14	on deck	3x grab	VGRAB
	3/19/2023 11:26	AL590_043-1	54.7227	10.0675	14	in the water		VGRAB
	3/19/2023 11:32	AL590_043-1	54.7227	10.0671	14	on deck	3x grab	VGRAB
	3/19/2023 11:38	AL590_044-1	54.7223	10.0672	14	in the water		VGRAB
	3/19/2023 11:45	AL590_044-1	54.7224	10.0673	14	on deck	3x grab	VGRAB
	3/19/2023 11:55	AL590_045-1	54.7219	10.0676	14	on deck	3x grab	VGRAB
	3/19/2023 11:49	AL590_045-1	54.7218	10.0676	14	in the water		VGRAB
	3/19/2023 11:58	AL590_046-1	54.7214	10.0678	14	in the water		VGRAB
	3/19/2023 12:03	AL590_046-1	54.7215	10.0678	14	on deck	3x grab	VGRAB
	3/19/2023 12:09	AL590_047-1	54.7210	10.0679	14	in the water		VGRAB
	3/19/2023 12:16	AL590_047-1	54.7211	10.0679	14	on deck	3x grab	VGRAB
	3/19/2023 12:19	AL590_048-1	54.7205	10.0680	13	in the water		VGRAB
	3/19/2023 12:24	AL590_048-1	54.7205	10.0682	13	on deck	3x grab	VGRAB
	3/19/2023 12:28	AL590_049-1	54.7200	10.0685	13	in the water		VGRAB
	3/19/2023 12:33	AL590_049-1	54.7201	10.0685	13	on deck	3x grab	VGRAB
	3/19/2023 12:39	AL590_050-1	54.7196	10.0685	13	in the water		VGRAB
	3/19/2023 12:45	AL590_050-1	54.7197	10.0685	13	on deck	3x grab	VGRAB
	3/19/2023 12:48	AL590_051-1	54.7191	10.0686	14	in the water		VGRAB
	3/19/2023 12:54	AL590_051-1	54.7191	10.0685	14	on deck	3x grab	VGRAB
	3/19/2023 12:58	AL590_052-1	54.7188	10.0686	14	in the water		VGRAB
	3/19/2023 13:03	AL590_052-1	54.7188	10.0689	14	on deck	3x grab	VGRAB
	3/19/2023 13:46	AL590_053-1	54.7204	10.0699	13	in the water	Kapt. Blaubaer	ROV
	3/19/2023 14:23	AL590_053-1	54.7224	10.0698	15	on deck	Kapt. Blaubaer	ROV
	3/19/2023 15:00	AL590_054-1	54.7336	10.0516	14	profile start		UWV
	3/19/2023 15:30	AL590_054-1	54.7311	10.0486	12	on deck		UWV

	3/19/2023 16:04	AL590_055-1	54.7395	10.0282	11	in the water	UWV
	3/19/2023 16:20	AL590_055-1	54.7371	10.0258	11	on deck	UWV
	3/19/2023 15:47	AL590_056-1	54.7415	10.0305	13	profile start	UWV
	3/19/2023 16:19	AL590_056-1	54.7373	10.0262	11	profile end	UWV
	3/19/2023 17:17	AL590_057-1	54.7322	10.0372	12	profile start	MB
	3/20/2023 4:57	AL590_057-1	54.7523	10.0111	9	profile end	MB
CTD Transit	3/20/2023 7:44	AL590_058-1	54.8362	9.4854	13	in the water	CTD
	3/20/2023 7:48	AL590_058-1	54.8364	9.4849	14	on deck	CTD
	3/20/2023 8:15	AL590_059-1	54.8668	9.5583	12	in the water	CTD
	3/20/2023 8:20	AL590_059-1	54.8672	9.5579	11	on deck	CTD
	3/20/2023 9:06	AL590_060-1	54.8435	9.6233	16	in the water	CTD
	3/20/2023 9:13	AL590_060-1	54.8436	9.6229	16	on deck	CTD
	3/20/2023 9:39	AL590_061-1	54.8218	9.7150	22	in the water	CTD
	3/20/2023 9:44	AL590_061-1	54.8216	9.7148	22	on deck	CTD
	3/20/2023 10:26	AL590_062-1	54.8173	9.8196	23	in the water	CTD
	3/20/2023 10:30	AL590_062-1	54.8167	9.8198	23	on deck	CTD
	3/20/2023 10:33	AL590_062-2	54.8166	9.8199	23	in the water	VGRAB
	3/20/2023 10:35	AL590_062-2	54.8167	9.8199	23	on deck	VGRAB
	3/20/2023 11:10	AL590_063-1	54.8186	9.9293	25	in the water	CTD
	3/20/2023 11:14	AL590_063-1	54.8182	9.9300	24	on deck	CTD
Falshoeft	3/20/2023 11:54	AL590_064-1	54.7636	10.0330	27	in the water	CTD
	3/20/2023 11:59	AL590_064-1	54.7634	10.0332	27	on deck	CTD
	3/20/2023 12:00	AL590_065-1	54.7634	10.0331	27	in the water	VGRAB
	3/20/2023 12:02	AL590_065-1	54.7633	10.0331	26	on deck	VGRAB
CTD Transit	3/20/2023 12:24	AL590_066-1	54.7507	10.1104	23	in the water	CTD
	3/20/2023 12:28	AL590_066-1	54.7507	10.1097	23	on deck	CTD
	3/20/2023 12:46	AL590_067-1	54.7335	10.1657	23	in the water	CTD
	3/20/2023 12:49	AL590_067-1	54.7336	10.1655	23	on deck	CTD
	3/20/2023 13:08	AL590_068-1	54.7015	10.1961	23	in the water	CTD
	3/20/2023 13:11	AL590_068-1	54.7014	10.1956	23	on deck	CTD

	3/20/2023 13:34	AL590_069-1	54.6512	10.2161	20	in the water		CTD
	3/20/2023 13:38	AL590_069-1	54.6504	10.2153	20	on deck		CTD
	3/20/2023 13:41	AL590_069-2	54.6500	10.2154	20	in the water		VGRAB
	3/20/2023 13:47	AL590_069-2	54.6496	10.2166	20	on deck		VGRAB
	3/20/2023 14:21	AL590_070-1	54.5964	10.3141	16	in the water		CTD
	3/20/2023 14:24	AL590_070-1	54.5960	10.3139	16	on deck		CTD
	3/20/2023 14:53	AL590_071-1	54.5506	10.4014	18	in the water		CTD
	3/20/2023 14:57	AL590_071-1	54.5506	10.4012	18	on deck		CTD
Kolberger Heide	3/20/2023 15:40	AL590_072-1	54.4589	10.3335	11	in the water		CTD
	3/20/2023 15:44	AL590_072-1	54.4587	10.3334	11	on deck		CTD
	3/20/2023 15:46	AL590_073-1	54.4587	10.3335	11	in the water		VGRAB
	3/20/2023 15:47	AL590_073-1	54.4587	10.3335	11	on deck		VGRAB
	3/20/2023 16:38	AL590_074-1	54.4696	10.3551	17	in the water	Kapt. Blaubaer	ROV
	3/20/2023 16:52	AL590_074-1	54.4698	10.3552	17	on deck	Kapt. Blaubaer	ROV
	3/20/2023 17:11	AL590_075-1	54.4773	10.3506	19	in the water	Kapt. Blaubaer	ROV
	3/20/2023 17:28	AL590_075-1	54.4774	10.3507	19	on deck	Kapt. Blaubaer	ROV
	3/20/2023 18:15	AL590_076-1	54.4741	10.3119	18	profile start		MB
	3/21/2023 5:21	AL590_076-1	54.4802	10.3650	19	profile end		MB
CTD Transit	3/21/2023 6:44	AL590_077-1	54.3741	10.6424	11	in the water		CTD
	3/21/2023 6:49	AL590_077-1	54.3740	10.6434	11	on deck		CTD
	3/21/2023 6:52	AL590_077-2	54.3745	10.6433	11	in the water		VGRAB
	3/21/2023 6:56	AL590_077-2	54.3748	10.6432	11	on deck		VGRAB
	3/21/2023 7:23	AL590_078-1	54.3924	10.5582	14	in the water		CTD
	3/21/2023 7:27	AL590_078-1	54.3926	10.5574	14	on deck		CTD
	3/21/2023 8:02	AL590_079-1	54.4529	10.4694	12	in the water		CTD
	3/21/2023 8:06	AL590_079-1	54.4522	10.4696	12	on deck		CTD
Kolberger Heide	3/21/2023 13:20	AL590_080-1	54.4613	10.3430	14	on deck	SeaOtter Mk II	AUV
	3/21/2023 9:30	AL590_080-1	54.4751	10.3486	19	in the water	SeaOtter Mk II	AUV
	3/21/2023 10:03	AL590_081-1	54.4589	10.3314	11	profile start	XOFOS	UWV
	3/21/2023 10:34	AL590_081-1	54.4569	10.3349	10	profile end	XOFOS	UWV

	3/21/2023 10:40	AL590_081-1	54.4566	10.3356	10	on deck	XOFOS	UWV
	3/21/2023 9:59	AL590_081-1	54.4590	10.3315	11	in the water	XOFOS	UWV
	3/21/2023 11:00	AL590_082-1	54.4582	10.3383	13	in the water	XOFOS	UWV
	3/21/2023 11:03	AL590_082-1	54.4581	10.3374	13	profile start	XOFOS	UWV
	3/21/2023 11:36	AL590_082-1	54.4572	10.3324	9	profile end	XOFOS	UWV
	3/21/2023 11:40	AL590_082-1	54.4570	10.3323	9	on deck	XOFOS	UWV
	3/21/2023 12:28	AL590_083-1	54.4597	10.3351	13	in the water	XOFOS	UWV
	3/21/2023 12:31	AL590_083-1	54.4594	10.3351	13	profile start	XOFOS	UWV
	3/21/2023 12:55	AL590_083-1	54.4567	10.3338	9	profile end	XOFOS	UWV
	3/21/2023 13:02	AL590_083-1	54.4563	10.3344	10	on deck	XOFOS	UWV
	3/21/2023 13:34	AL590_084-1	54.4609	10.3379	14	in the water	Kapt. Blaubaer	ROV
	3/21/2023 13:44	AL590_084-1	54.4607	10.3377	14	on deck	Kapt. Blaubaer	ROV
CTD Transit	3/21/2023 15:04	AL590_085-1	54.5199	10.5831	16	in the water		CTD
	3/21/2023 15:07	AL590_085-1	54.5198	10.5827	16	on deck		CTD
	3/21/2023 15:09	AL590_086-1	54.5198	10.5827	16	in the water		VGRAB
	3/21/2023 15:10	AL590_086-1	54.5198	10.5829	16	on deck		VGRAB
	3/21/2023 15:57	AL590_087-1	54.5188	10.7770	16	in the water		CTD
	3/21/2023 16:01	AL590_087-1	54.5188	10.7769	16	on deck		CTD
	3/21/2023 16:50	AL590_088-1	54.4089	10.7949	16	in the water		CTD
	3/21/2023 16:54	AL590_088-1	54.4089	10.7946	16	on deck		CTD
	3/21/2023 17:45	AL590_089-1	54.4766	10.9120	11	in the water		CTD
	3/21/2023 17:48	AL590_089-1	54.4767	10.9118	11	on deck		CTD
	3/21/2023 18:22	AL590_090-1	54.5465	10.8725	17	in the water		CTD
	3/21/2023 18:25	AL590_090-1	54.5462	10.8724	17	on deck		CTD
	3/21/2023 19:11	AL590_091-1	54.5695	11.0588	16	in the water		CTD
	3/21/2023 19:15	AL590_091-1	54.5698	11.0572	16	on deck		CTD
	3/21/2023 19:16	AL590_091-2	54.5699	11.0567	16	in the water		VGRAB
	3/21/2023 19:18	AL590_091-2	54.5697	11.0566	16	on deck		VGRAB
	3/21/2023 19:59	AL590_092-1	54.5511	11.2173	28	in the water		CTD
	3/21/2023 20:05	AL590_092-1	54.5511	11.2166	28	on deck		CTD

	3/21/2023 20:54	AL590_093-1	54.4820	11.3708	27	in the water		CTD
	3/21/2023 20:58	AL590_093-1	54.4819	11.3710	27	on deck		CTD
	3/21/2023 21:46	AL590_094-1	54.4039	11.5140	24	in the water		CTD
	3/21/2023 21:48	AL590_094-1	54.4037	11.5141	24	on deck		CTD
	3/21/2023 21:51	AL590_094-2	54.4036	11.5140	24	in the water		VGRAB
	3/21/2023 21:56	AL590_094-2	54.4015	11.5111	24	on deck		VGRAB
	3/21/2023 23:02	AL590_095-1	54.3145	11.3185	20	in the water		CTD
	3/21/2023 23:07	AL590_095-1	54.3146	11.3186	20	on deck		CTD
	3/21/2023 23:08	AL590_095-2	54.3144	11.3183	21	in the water		VGRAB
	3/21/2023 23:10	AL590_095-2	54.3143	11.3185	20	on deck		VGRAB
	3/22/2023 0:04	AL590_096-1	54.1970	11.2123	20	in the water		CTD
	3/22/2023 0:08	AL590_096-1	54.1971	11.2123	20	on deck		CTD
Luebeck Bay	3/22/2023 0:57	AL590_097-1	54.1179	11.0570	20	in the water		CTD
	3/22/2023 1:01	AL590_097-1	54.1177	11.0572	21	on deck		CTD
	3/22/2023 1:35	AL590_098-1	54.0846	10.9521	21	in the water		CTD
	3/22/2023 1:39	AL590_098-1	54.0842	10.9521	21	on deck		CTD
	3/22/2023 1:41	AL590_098-2	54.0840	10.9520	22	in the water		VGRAB
	3/22/2023 1:43	AL590_098-2	54.0840	10.9520	21	on deck		VGRAB
	3/22/2023 7:05	AL590_099-1	54.0559	10.9276	23	profile end		MB
	3/22/2023 2:14	AL590_099-1	54.1000	10.9264	13	profile start		MB
	3/22/2023 14:46	AL590_100-1	54.0371	10.8316	20	on deck	SeaOtter Mk II	AUV
	3/22/2023 8:21	AL590_100-1	54.0376	10.8308	20	in the water	SeaOtter Mk II	AUV
	3/22/2023 8:51	AL590_101-1	54.0354	10.8413	20	in the water	XOFOS	UWV
	3/22/2023 9:05	AL590_101-1	54.0353	10.8404	19	profile start	XOFOS	UWV
	3/22/2023 9:13	AL590_101-1	54.0352	10.8395	19	profile end	XOFOS, Unterbrechung	UWV
	3/22/2023 9:15	AL590_101-1	54.0352	10.8398	19	on deck	XOFOS, neue Einstellung am Flügel	UWV
	3/22/2023 10:21	AL590_101-2	54.0352	10.8364	19	profile end	XOFOS	UWV

	3/22/2023 10:24	AL590_101-2	54.0349	10.8360	19	on deck	XOFOS	UWV
	3/22/2023 9:43	AL590_101-2	54.0352	10.8404	19	in the water	XOFOS	UWV
	3/22/2023 9:48	AL590_101-2	54.0352	10.8405	19	profile start	XOFOS	UWV
	3/22/2023 11:20	AL590_102-1	54.0319	10.8426	20	in the water	XOFOS	UWV
	3/22/2023 11:26	AL590_102-1	54.0317	10.8428	20	profile start	XOFOS	UWV
	3/22/2023 11:47	AL590_102-1	54.0298	10.8457	20	profile end	XOFOS	UWV
	3/22/2023 11:53	AL590_102-1	54.0291	10.8459	21	on deck	XOFOS	UWV
	3/22/2023 12:20	AL590_103-1	54.0353	10.8392	19	in the water	Kapt. Blaubaer	ROV
	3/22/2023 12:36	AL590_103-1	54.0355	10.8390	19	on deck	Kapt. Blaubaer	ROV
	3/22/2023 12:56	AL590_104-1	54.0338	10.8292	19	in the water	Kapt. Blaubaer	ROV
	3/22/2023 13:06	AL590_104-1	54.0339	10.8290	19	on deck	Kapt. Blaubaer	ROV
	3/22/2023 13:48	AL590_105-1	54.0510	10.8597	21	in the water		CTD
	3/22/2023 13:54	AL590_105-1	54.0506	10.8588	21	on deck		CTD
	3/22/2023 14:14	AL590_106-1	54.0387	10.8033	17	in the water		CTD
	3/22/2023 14:19	AL590_106-1	54.0381	10.8034	16	on deck		CTD
	3/22/2023 15:20	AL590_107-1	54.0109	10.8163	11	in the water		CTD
	3/22/2023 15:23	AL590_107-1	54.0108	10.8167	11	on deck		CTD
	3/22/2023 15:44	AL590_108-1	54.0216	10.8761	20	in the water		CTD
	3/22/2023 15:49	AL590_108-1	54.0218	10.8757	20	on deck		CTD
	3/22/2023 16:23	AL590_109-1	54.0096	10.9437	21	in the water		CTD
	3/22/2023 16:27	AL590_109-1	54.0093	10.9445	21	on deck		CTD
	3/22/2023 16:29	AL590_109-2	54.0092	10.9442	21	in the water		VGRAB
	3/22/2023 16:31	AL590_109-2	54.0091	10.9442	21	on deck		VGRAB
	3/22/2023 16:54	AL590_110-1	54.0473	10.9783	22	in the water		CTD
	3/22/2023 16:58	AL590_110-1	54.0466	10.9788	23	on deck		CTD
	3/22/2023 17:00	AL590_111-1	54.0467	10.9787	22	in the water		VGRAB
	3/22/2023 17:01	AL590_111-1	54.0467	10.9787	22	on deck		VGRAB
	3/22/2023 17:56	AL590_112-1	54.0332	10.8264	19	profile start	Kapt. Blaubaer	ROV
	3/22/2023 18:19	AL590_112-1	54.0331	10.8264	19	profile end	Kapt. Blaubaer	ROV
	3/22/2023 18:37	AL590_113-1	54.0315	10.8243	19	profile start	Kapt. Blaubaer	ROV

	3/22/2023 18:58	AL590_113-1	54.0310	10.8253	19	profile end	Kapt. Blaubaer	ROV
	3/22/2023 19:30	AL590_114-1	54.0295	10.8259	18	profile start	Kapt. Blaubaer	ROV
	3/22/2023 19:51	AL590_114-1	54.0296	10.8264	18	profile end	Kapt. Blaubaer	ROV
	3/22/2023 20:27	AL590_115-1	54.0322	10.8163	19	profile start	Kapt. Blaubaer	ROV
	3/22/2023 20:55	AL590_115-1	54.0321	10.8168	19	profile end	Kapt. Blaubaer	ROV
	3/22/2023 21:50	AL590_116-1	54.0576	10.9276	23	profile start		MB
	3/23/2023 6:40	AL590_116-1	54.0438	10.9195	23	profile end		MB
	3/23/2023 7:19	AL590_117-1	54.0367	10.8295	19	in the water		VGRAB
	3/23/2023 7:22	AL590_117-1	54.0368	10.8294	19	on deck		VGRAB
	3/23/2023 7:31	AL590_118-1	54.0372	10.8305	20	in the water		VGRAB
	3/23/2023 7:33	AL590_118-1	54.0370	10.8305	19	on deck		VGRAB
	3/23/2023 7:43	AL590_119-1	54.0351	10.8313	19	in the water		VGRAB
	3/23/2023 7:45	AL590_119-1	54.0351	10.8316	19	on deck		VGRAB
	3/23/2023 7:54	AL590_120-1	54.0355	10.8328	19	in the water		VGRAB
	3/23/2023 7:56	AL590_120-1	54.0356	10.8327	19	on deck		VGRAB
	3/23/2023 10:46	AL590_121-1	54.0376	10.8315	20	on deck	SeaOtter Mk II	AUV
	3/23/2023 8:39	AL590_121-1	54.0377	10.8307	20	in the water	SeaOtter Mk II	AUV
	3/23/2023 10:00	AL590_122-1	54.0357	10.8103	17	profile start	XOFOS	UWV
	3/23/2023 10:20	AL590_122-1	54.0344	10.8095	17	profile end	XOFOS	UWV
	3/23/2023 10:27	AL590_122-1	54.0328	10.8113	16	on deck	XOFOS	UWV
	3/23/2023 9:21	AL590_122-1	54.0379	10.8181	18	in the water	XOFOS	UWV
	3/23/2023 11:08	AL590_123-1	54.0342	10.8189	19	in the water	Kapt. Blaubaer	ROV
	3/23/2023 11:24	AL590_123-1	54.0341	10.8190	19	on deck	Kapt. Blaubaer	ROV
	3/23/2023 11:49	AL590_124-1	54.0365	10.8197	19	in the water	Kapt. Blaubaer	ROV
	3/23/2023 12:04	AL590_124-1	54.0362	10.8200	19	on deck	Kapt. Blaubaer	ROV
	3/23/2023 12:46	AL590_125-1	54.0489	10.9443	24	in the water	SeaOtter MkII	AUV
	3/23/2023 13:47	AL590_125-1	54.0492	10.9438	25	on deck	SeaOtter MkII	AUV
	3/23/2023 13:13	AL590_126-1	54.0551	10.9340	24	in the water	Kapt. Blaubaer	ROV
	3/23/2023 13:28	AL590_126-1	54.0552	10.9339	24	on deck	Kapt. Blaubaer	ROV
	3/23/2023 14:01	AL590_127-1	54.0541	10.9341	24	in the water	Kapt. Blaubaer	ROV

	3/23/2023 14:26	AL590_127-1	54.0541	10.9341	24	on deck	Kapt. Blaubaer	ROV
	3/23/2023 14:33	AL590_127-2	54.0543	10.9339	24	in the water		CTD
	3/23/2023 14:36	AL590_127-2	54.0542	10.9339	24	on deck		CTD
	3/23/2023 15:25	AL590_128-1	54.0903	10.9991	23	in the water	XOFOS	UWV
	3/23/2023 16:03	AL590_128-1	54.0868	10.9940	23	on deck	XOFOS	UWV
	3/23/2023 17:17	AL590_129-1	54.0906	10.9943	23	profile start	Kapt. Blaubaer	ROV
	3/23/2023 17:32	AL590_129-1	54.0905	10.9949	23	profile end	Kapt. Blaubaer	ROV
	3/23/2023 17:50	AL590_129-2	54.0909	10.9952	23	profile start	Kapt. Blaubaer	ROV
	3/23/2023 18:16	AL590_129-2	54.0906	10.9951	23	profile end	Kapt. Blaubaer	ROV
	3/23/2023 18:27	AL590_130-1	54.0925	10.9926	22	profile start	Kapt. Blaubaer	ROV
	3/23/2023 18:52	AL590_130-1	54.0922	10.9929	22	profile end	Kapt. Blaubaer	ROV
	3/23/2023 19:20	AL590_131-1	54.0910	10.9880	22	profile start	Kapt. Blaubaer	ROV
	3/23/2023 19:42	AL590_131-1	54.0909	10.9878	22	profile end	Kapt. Blaubaer	ROV
	3/23/2023 20:39	AL590_132-1	54.0441	10.9461	21	profile start		MB
	3/24/2023 6:19	AL590_132-1	54.0391	10.9158	23	profile end		MB
	3/24/2023 7:01	AL590_133-1	54.0382	10.8311	20	in the water	SeaOtter Mk II	AUV
	3/24/2023 7:29	AL590_133-1	54.0382	10.8317	20	on deck	SeaOtter Mk II	AUV
	3/24/2023 7:44	AL590_134-1	54.0377	10.8312	20	profile start	SeaOtter Mk II	AUV
	3/24/2023 9:53	AL590_134-1	54.0371	10.8371	20	on deck	SeaOtter Mk II	AUV
	3/24/2023 10:18	AL590_135-1	54.0319	10.8129	17	in the water	XOFOS	ROV
	3/24/2023 10:58	AL590_135-1	54.0304	10.8062	17	profile start	XOFOS	ROV
	3/24/2023 11:40	AL590_135-1	54.0304	10.8040	17	profile end	XOFOS	ROV
	3/24/2023 11:47	AL590_135-1	54.0304	10.8036	17	on deck	XOFOS	ROV
	3/24/2023 12:49	AL590_136-1	54.0769	10.9615	22	in the water		CTD
	3/24/2023 13:02	AL590_136-1	54.0767	10.9606	22	on deck		CTD
	3/24/2023 13:13	AL590_137-1	54.0772	10.9602	22	in the water		VGRAB
	3/24/2023 13:22	AL590_137-1	54.0771	10.9600	22	on deck	3x grab	VGRAB
	3/24/2023 15:08	AL590_138-1	54.0770	10.9608	22	in the water		VGRAB
	3/24/2023 15:09	AL590_138-1	54.0769	10.9607	22	on deck		VGRAB
	3/24/2023 15:12	AL590_138-2	54.0770	10.9610	22	in the water		VGRAB

	3/24/2023 15:12	AL590_138-2	54.0770	10.9610	22	on deck	VGRAB
	3/24/2023 15:14	AL590_138-3	54.0770	10.9609	22	in the water	VGRAB
	3/24/2023 15:15	AL590_138-3	54.0770	10.9608	22	on deck	VGRAB
	3/24/2023 15:20	AL590_139-1	54.0769	10.9615	22	in the water	VGRAB
	3/24/2023 15:22	AL590_139-1	54.0770	10.9615	22	on deck	VGRAB
	3/24/2023 15:23	AL590_139-2	54.0769	10.9614	22	in the water	VGRAB
	3/24/2023 15:25	AL590_139-2	54.0769	10.9614	22	on deck	VGRAB
	3/24/2023 15:27	AL590_139-3	54.0770	10.9614	22	in the water	VGRAB
	3/24/2023 15:28	AL590_139-3	54.0769	10.9614	22	on deck	VGRAB
	3/24/2023 15:34	AL590_140-1	54.0768	10.9623	22	in the water	VGRAB
	3/24/2023 15:38	AL590_140-1	54.0768	10.9623	22	on deck	VGRAB
	3/24/2023 15:40	AL590_140-2	54.0768	10.9624	22	in the water	VGRAB
	3/24/2023 15:41	AL590_140-2	54.0768	10.9623	22	on deck	VGRAB
	3/24/2023 15:43	AL590_141-1	54.0767	10.9623	22	in the water	VGRAB
	3/24/2023 15:45	AL590_141-1	54.0768	10.9624	22	on deck	VGRAB
	3/24/2023 15:47	AL590_142-1	54.0767	10.9629	22	in the water	VGRAB
	3/24/2023 15:49	AL590_142-1	54.0767	10.9630	22	on deck	VGRAB
	3/24/2023 15:51	AL590_142-2	54.0766	10.9630	22	in the water	VGRAB
	3/24/2023 15:52	AL590_142-2	54.0766	10.9630	22	on deck	VGRAB
	3/24/2023 15:55	AL590_142-3	54.0766	10.9630	22	in the water	VGRAB
	3/24/2023 15:57	AL590_142-3	54.0766	10.9630	22	on deck	VGRAB
	3/24/2023 16:32	AL590_143-1	54.0759	10.9669	22	in the water	VGRAB
	3/24/2023 16:33	AL590_143-1	54.0759	10.9668	22	on deck	VGRAB
	3/24/2023 16:35	AL590_143-2	54.0758	10.9668	22	in the water	VGRAB
	3/24/2023 16:36	AL590_143-2	54.0759	10.9667	22	on deck	VGRAB
	3/24/2023 16:38	AL590_143-3	54.0759	10.9667	22	in the water	VGRAB
	3/24/2023 16:39	AL590_143-3	54.0759	10.9667	22	on deck	VGRAB
	3/24/2023 16:42	AL590_144-1	54.0761	10.9660	22	in the water	VGRAB
	3/24/2023 16:44	AL590_144-1	54.0761	10.9660	22	on deck	VGRAB
	3/24/2023 16:47	AL590_144-2	54.0761	10.9660	22	in the water	VGRAB

	3/24/2023 16:49	AL590_144-2	54.0761	10.9660	22	on deck		VGRAB
	3/24/2023 16:50	AL590_144-3	54.0761	10.9660	22	in the water		VGRAB
	3/24/2023 16:52	AL590_144-3	54.0761	10.9660	22	on deck		VGRAB
	3/24/2023 17:29	AL590_145-1	54.0817	10.9672	22	profile start	Kapt. Blaubaer	ROV
	3/24/2023 17:44	AL590_145-1	54.0817	10.9675	22	profile end	Kapt. Blaubaer	ROV
	3/24/2023 17:55	AL590_146-1	54.0821	10.9617	22	profile start		ROV
	3/24/2023 18:33	AL590_146-1	54.0824	10.9617	22	profile end		ROV
	3/24/2023 18:44	AL590_147-1	54.0829	10.9588	22	profile start		ROV
	3/24/2023 19:05	AL590_147-1	54.0824	10.9585	22	profile end		ROV
	3/24/2023 20:06	AL590_148-1	54.0437	10.9194	23	profile start		MB
	3/25/2023 5:43	AL590_148-1	54.0581	10.9043	22	profile end		MB
CTD Transit	3/25/2023 7:22	AL590_149-1	54.1047	11.3744	16	in the water	CTD 47	CTD
	3/25/2023 7:30	AL590_149-1	54.1043	11.3744	16	on deck	CTD 47	CTD
	3/25/2023 8:50	AL590_150-1	53.9662	11.3598	8	in the water	CTD 42	CTD
	3/25/2023 8:53	AL590_150-1	53.9665	11.3593	8	on deck	CTD 42	CTD
	3/25/2023 10:36	AL590_151-1	54.0678	11.3111	12	in the water	CTD 46	CTD
	3/25/2023 10:40	AL590_151-1	54.0678	11.3113	12	on deck	CTD 46	CTD
	3/25/2023 11:01	AL590_152-1	54.0483	11.2737	19	in the water	CTD 45	CTD
	3/25/2023 11:05	AL590_152-1	54.0482	11.2737	19	on deck	CTD 45	CTD
Grosskluetzhoeved	3/25/2023 11:28	AL590_153-1	54.0465	11.2306	22	in the water	CTD 44	CTD
	3/25/2023 11:31	AL590_153-1	54.0465	11.2305	22	on deck	CTD 44	CTD
	3/25/2023 11:33	AL590_153-2	54.0464	11.2302	22	in the water		VGRAB
	3/25/2023 11:35	AL590_153-2	54.0462	11.2305	22	on deck		VGRAB
CTD Transit	3/25/2023 12:05	AL590_154-1	54.0033	11.2354	15	in the water	CTD 41	CTD
	3/25/2023 12:09	AL590_154-1	54.0033	11.2358	15	on deck	CTD 41	CTD
Luebeck Bay	3/25/2023 12:55	AL590_155-1	54.0444	11.1460	24	in the water	CTD 40	CTD
	3/25/2023 12:58	AL590_155-1	54.0442	11.1462	24	on deck	CTD 40	CTD
	3/25/2023 13:35	AL590_156-1	54.0277	11.0613	17	in the water	CTD 38	CTD
	3/25/2023 13:39	AL590_156-1	54.0277	11.0615	17	on deck	CTD 38	CTD
	3/25/2023 14:03	AL590_157-1	54.0644	11.0363	23	in the water	CTD 37	CTD

	3/25/2023 14:07	AL590_157-1	54.0639	11.0374	23	on deck	CTD 37	CTD
	3/25/2023 14:49	AL590_158-1	54.0941	10.9346	21	in the water	XOFOS	UWV
	3/25/2023 15:53	AL590_158-1	54.0936	10.9289	21	on deck	XOFOS	UWV
	3/25/2023 16:36	AL590_159-1	54.0951	10.9306	21	profile start	Kapt. Blaubaer	ROV
	3/25/2023 16:55	AL590_159-1	54.0951	10.9309	21	profile end	Kapt. Blaubaer	ROV
	3/25/2023 17:18	AL590_160-1	54.0885	10.9739	22	profile start	Kapt. Blaubaer	ROV
	3/25/2023 17:34	AL590_160-1	54.0886	10.9742	22	profile end	Kapt. Blaubaer	ROV
	3/25/2023 18:06	AL590_161-1	54.0899	10.9833	22	profile start	Kapt. Blaubaer	ROV
	3/25/2023 18:42	AL590_161-1	54.0896	10.9818	22	profile end		ROV
	3/25/2023 19:34	AL590_162-1	54.0504	10.9056	23	in the water	Kapt. Blaubaer	ROV
	3/25/2023 20:00	AL590_162-1	54.0502	10.9052	23	on deck	Kapt. Blaubaer	ROV
	3/25/2023 20:36	AL590_163-1	54.0439	10.9506	20	profile start		MB
	3/26/2023 5:41	AL590_163-1	54.0390	10.8939	22	profile end		MB
	3/26/2023 6:32	AL590_164-1	54.0761	10.9655	23	in the water		VGRAB
	3/26/2023 6:40	AL590_164-1	54.0760	10.9653	23	on deck	3x grab	VGRAB
	3/26/2023 6:45	AL590_165-1	54.0763	10.9648	23	in the water		VGRAB
	3/26/2023 6:56	AL590_165-1	54.0763	10.9645	23	on deck	3x grab	VGRAB
	3/26/2023 7:08	AL590_166-1	54.0765	10.9641	23	in the water		VGRAB
	3/26/2023 7:09	AL590_166-1	54.0765	10.9642	23	on deck	3x grab	VGRAB
	3/26/2023 7:40	AL590_167-1	54.0754	10.9666	23	in the water		VGRAB
	3/26/2023 7:47	AL590_167-1	54.0754	10.9665	23	on deck	3x grab	VGRAB
	3/26/2023 7:52	AL590_168-1	54.0755	10.9658	23	in the water		VGRAB
	3/26/2023 7:59	AL590_168-1	54.0756	10.9658	23	on deck	3x grab	VGRAB
	3/26/2023 8:03	AL590_169-1	54.0757	10.9650	23	in the water		VGRAB
	3/26/2023 8:09	AL590_169-1	54.0758	10.9651	23	on deck	3x grab	VGRAB
	3/26/2023 8:12	AL590_170-1	54.0759	10.9644	23	in the water		VGRAB
	3/26/2023 8:18	AL590_170-1	54.0759	10.9644	23	on deck	3x grab	VGRAB
	3/26/2023 8:22	AL590_171-1	54.0760	10.9637	23	in the water		VGRAB
	3/26/2023 8:30	AL590_171-1	54.0759	10.9636	23	on deck	3x grab	VGRAB
	3/26/2023 8:38	AL590_172-1	54.0762	10.9626	23	in the water		VGRAB

	3/26/2023 8:45	AL590_172-1	54.0762	10.9625	23	on deck	3x grab	VGRAB
	3/26/2023 8:48	AL590_173-1	54.0763	10.9620	23	in the water		VGRAB
	3/26/2023 8:56	AL590_173-1	54.0763	10.9619	23	on deck	3x grab	VGRAB
	3/26/2023 8:58	AL590_174-1	54.0764	10.9615	23	in the water		VGRAB
	3/26/2023 9:06	AL590_174-1	54.0765	10.9615	22	on deck	3x grab	VGRAB
	3/26/2023 10:16	AL590_175-1	54.0765	10.9606	22	in the water		VGRAB
	3/26/2023 10:25	AL590_175-1	54.0766	10.9607	22	on deck	3x grab	VGRAB
	3/26/2023 10:36	AL590_176-1	54.0766	10.9598	22	in the water		VGRAB
	3/26/2023 10:46	AL590_176-1	54.0766	10.9599	22	on deck	3x grab	VGRAB
	3/26/2023 11:13	AL590_177-1	54.0763	10.9602	22	in the water	Kapt. Blaubaer	ROV
	3/26/2023 11:26	AL590_177-1	54.0764	10.9602	22	on deck	Kapt. Blaubaer	ROV
	3/26/2023 11:54	AL590_178-1	54.0960	10.9574	22	in the water	XOFOS	UWV
	3/26/2023 12:03	AL590_178-1	54.0959	10.9569	22	profile start	XOFOS	UWV
	3/26/2023 13:06	AL590_178-1	54.0969	10.9541	22	profile end	XOFOS	UWV
	3/26/2023 13:15	AL590_178-1	54.0972	10.9523	22	on deck	XOFOS	UWV
	3/26/2023 13:35	AL590_179-1	54.0877	10.9818	22	in the water	XOFOS	UWV
	3/26/2023 13:42	AL590_179-1	54.0883	10.9823	22	profile start	XOFOS	UWV
	3/26/2023 14:15	AL590_179-1	54.0870	10.9820	22	on deck	XOFOS	UWV
	3/26/2023 14:37	AL590_180-1	54.0883	10.9824	22	profile start		UWV
	3/26/2023 15:06	AL590_180-1	54.0923	10.9825	22	on deck		UWV
Grosskluetzhoeved	3/26/2023 16:13	AL590_181-1	54.0444	11.2334	22	profile start	Kapt. Blaubaer	ROV
	3/26/2023 16:57	AL590_181-1	54.0446	11.2334	22	profile end	Kapt. Blaubaer	ROV
	3/26/2023 17:22	AL590_182-1	54.0461	11.2142	22	profile start	Kapt. Blaubaer	ROV
	3/26/2023 17:44	AL590_182-1	54.0459	11.2137	22	profile end	Kapt. Blaubaer	ROV
	3/26/2023 17:57	AL590_183-1	54.0491	11.2071	22	profile start	Kapt. Blaubaer	ROV
	3/26/2023 18:22	AL590_183-1	54.0493	11.2064	22	profile end	Kapt. Blaubaer	ROV
Luebeck Bay	3/26/2023 19:50	AL590_184-1	54.0593	10.8924	22	profile start		MB
	3/27/2023 5:27	AL590_184-1	54.0381	10.8822	22	profile end		MB
	3/27/2023 6:18	AL590_185-1	54.0775	10.9459	22	in the water	Kapt. Blaubaer	ROV
	3/27/2023 6:49	AL590_185-1	54.0776	10.9448	22	on deck	Kapt. Blaubaer	ROV

	3/27/2023 7:07	AL590_186-1	54.0796	10.9440	22	in the water	Kapt. Blaubaer	ROV
	3/27/2023 7:27	AL590_186-1	54.0796	10.9445	22	on deck	Kapt. Blaubaer	ROV
	3/27/2023 9:36	AL590_187-1	54.0765	11.0985	24	in the water	CTD 39	CTD
	3/27/2023 9:44	AL590_187-1	54.0764	11.0981	24	on deck	CTD 39	CTD
	3/27/2023 9:46	AL590_187-2	54.0765	11.0981	24	in the water		VGRAB
	3/27/2023 9:49	AL590_187-2	54.0766	11.0983	24	on deck		VGRAB
CTD Transit	3/27/2023 11:20	AL590_188-1	54.1191	11.5394	12	in the water		CTD
	3/27/2023 11:24	AL590_188-1	54.1189	11.5388	12	on deck		CTD
	3/27/2023 11:47	AL590_189-1	54.1612	11.5106	21	in the water		CTD
	3/27/2023 11:51	AL590_189-1	54.1612	11.5105	21	on deck		CTD
	3/27/2023 11:53	AL590_189-2	54.1609	11.5103	21	in the water		VGRAB
	3/27/2023 11:55	AL590_189-2	54.1609	11.5102	21	on deck		VGRAB
	3/27/2023 12:37	AL590_190-1	54.2385	11.5950	25	in the water		CTD
	3/27/2023 12:46	AL590_190-1	54.2384	11.5949	25	on deck		CTD
Trollegrund	3/27/2023 13:18	AL590_191-1	54.1910	11.6823	22	in the water		CTD
	3/27/2023 13:22	AL590_191-1	54.1909	11.6818	22	on deck		CTD
CTD Transit	3/27/2023 13:53	AL590_192-1	54.2558	11.7492	25	in the water		CTD
	3/27/2023 14:03	AL590_192-1	54.2554	11.7488	25	on deck		CTD
	3/27/2023 14:39	AL590_193-1	54.2271	11.8591	21	in the water		CTD
	3/27/2023 14:47	AL590_193-1	54.2274	11.8598	21	on deck		CTD
	3/27/2023 15:36	AL590_194-1	54.2620	11.9929	17	in the water		CTD
	3/27/2023 15:41	AL590_194-1	54.2616	11.9926	17	on deck		CTD
	3/27/2023 15:43	AL590_194-2	54.2617	11.9923	17	in the water		VGRAB
	3/27/2023 15:45	AL590_194-2	54.2618	11.9925	17	on deck		VGRAB
	3/27/2023 16:15	AL590_195-1	54.2872	12.0820	19	in the water		CTD
	3/27/2023 16:19	AL590_195-1	54.2872	12.0821	19	on deck		CTD
	3/27/2023 17:01	AL590_196-1	54.3282	12.2359	12	in the water		CTD
	3/27/2023 17:04	AL590_196-1	54.3278	12.2359	12	on deck		CTD
	3/27/2023 17:06	AL590_196-2	54.3275	12.2358	13	in the water		VGRAB
	3/27/2023 17:07	AL590_196-2	54.3274	12.2358	13	on deck		VGRAB

	3/27/2023 17:39	AL590_197-1	54.3885	12.2525	16	in the water	CTD
	3/27/2023 17:43	AL590_197-1	54.3885	12.2525	16	on deck	CTD
	3/27/2023 18:12	AL590_198-1	54.4413	12.3310	17	in the water	CTD
	3/27/2023 18:17	AL590_198-1	54.4413	12.3308	17	on deck	CTD
	3/27/2023 18:18	AL590_198-2	54.4410	12.3306	17	in the water	VGRAB
	3/27/2023 18:20	AL590_198-2	54.4411	12.3306	17	on deck	VGRAB
	3/27/2023 19:25	AL590_199-1	54.5533	12.5114	15	in the water	CTD
	3/27/2023 19:30	AL590_199-1	54.5532	12.5109	15	on deck	CTD
	3/27/2023 19:31	AL590_199-2	54.5532	12.5108	15	in the water	VGRAB
	3/27/2023 19:33	AL590_199-2	54.5532	12.5107	15	on deck	VGRAB
	3/27/2023 20:17	AL590_200-1	54.5332	12.6668	14	in the water	CTD
	3/27/2023 20:20	AL590_200-1	54.5332	12.6666	14	on deck	CTD
Zingst	3/27/2023 20:57	AL590_201-1	54.5749	12.7874	14	in the water	CTD
	3/27/2023 21:01	AL590_201-1	54.5747	12.7870	14	on deck	CTD
	3/27/2023 21:03	AL590_201-2	54.5748	12.7870	14	in the water	VGRAB
	3/27/2023 21:05	AL590_201-2	54.5748	12.7868	14	on deck	VGRAB
CTD Transit	3/27/2023 21:35	AL590_202-1	54.5452	12.8733	11	in the water	CTD
	3/27/2023 21:40	AL590_202-1	54.5451	12.8733	11	on deck	CTD
	3/27/2023 22:36	AL590_203-1	54.6267	13.0292	14	in the water	CTD
	3/27/2023 22:40	AL590_203-1	54.6267	13.0291	14	on deck	CTD
Dranske	3/27/2023 23:21	AL590_204-1	54.6942	13.1338	23	in the water	CTD
	3/27/2023 23:28	AL590_204-1	54.6941	13.1335	23	on deck	CTD
CTD Transit	3/28/2023 1:00	AL590_205-1	54.6685	13.5819	29	in the water	CTD
	3/28/2023 1:06	AL590_205-1	54.6684	13.5818	29	on deck	CTD
	3/28/2023 1:08	AL590_205-2	54.6684	13.5820	29	in the water	VGRAB
	3/28/2023 1:10	AL590_205-2	54.6684	13.5816	29	on deck	VGRAB
	3/28/2023 2:11	AL590_206-1	54.5412	13.7534	23	in the water	CTD
	3/28/2023 2:15	AL590_206-1	54.5408	13.7523	23	on deck	CTD
	3/28/2023 3:11	AL590_207-1	54.4059	13.7578	21	in the water	CTD
	3/28/2023 3:14	AL590_207-1	54.4057	13.7569	21	on deck	CTD

	3/28/2023 4:04	AL590_208-1	54.2965	13.8542	13	in the water	CTD
	3/28/2023 4:08	AL590_208-1	54.2960	13.8536	13	on deck	CTD
	3/28/2023 4:09	AL590_208-2	54.2958	13.8533	13	in the water	VGRAB
	3/28/2023 4:11	AL590_208-2	54.2956	13.8525	13	on deck	VGRAB
	3/28/2023 5:37	AL590_209-1	54.1321	13.9556	11	in the water	CTD
	3/28/2023 5:42	AL590_209-1	54.1319	13.9549	11	on deck	CTD
	3/28/2023 10:08	AL590_210-1	54.0426	14.1239	13	in the water	CTD
	3/28/2023 10:12	AL590_210-1	54.0429	14.1238	14	on deck	CTD
	3/28/2023 10:54	AL590_211-1	53.9790	14.1999	10	in the water	CTD
	3/28/2023 10:57	AL590_211-1	53.9789	14.1997	10	on deck	CTD
	3/28/2023 11:00	AL590_211-2	53.9789	14.1996	10	in the water	VGRAB
	3/28/2023 11:01	AL590_211-2	53.9790	14.1999	10	on deck	VGRAB
	3/28/2023 11:23	AL590_212-1	54.0103	14.2216	11	in the water	CTD
	3/28/2023 11:27	AL590_212-1	54.0105	14.2217	11	on deck	CTD
	3/28/2023 12:21	AL590_213-1	54.1155	14.1216	15	in the water	CTD
	3/28/2023 12:25	AL590_213-1	54.1157	14.1218	15	on deck	CTD
	3/28/2023 12:26	AL590_213-2	54.1157	14.1217	15	in the water	VGRAB
	3/28/2023 12:28	AL590_213-2	54.1156	14.1216	15	on deck	VGRAB
	3/28/2023 13:09	AL590_214-1	54.2056	14.0599	12	in the water	CTD
	3/28/2023 13:12	AL590_214-1	54.2055	14.0594	12	on deck	CTD
	3/28/2023 13:54	AL590_215-1	54.2987	14.0135	16	in the water	VGRAB
	3/28/2023 13:55	AL590_215-1	54.2986	14.0134	16	on deck	VGRAB
	3/28/2023 13:57	AL590_215-2	54.2986	14.0135	16	in the water	CTD
	3/28/2023 14:01	AL590_215-2	54.2986	14.0136	16	on deck	CTD
	3/28/2023 14:49	AL590_216-1	54.4151	13.9799	14	in the water	CTD
	3/28/2023 14:53	AL590_216-1	54.4153	13.9796	14	on deck	CTD
	3/28/2023 15:41	AL590_217-1	54.5332	13.9229	19	in the water	CTD
	3/28/2023 15:46	AL590_217-1	54.5336	13.9226	19	on deck	CTD
	3/28/2023 15:47	AL590_217-2	54.5337	13.9228	19	in the water	VGRAB
	3/28/2023 15:49	AL590_217-2	54.5337	13.9228	19	on deck	VGRAB

	3/28/2023 16:49	AL590_218-1	54.6580	13.7972	31	in the water		CTD
	3/28/2023 16:53	AL590_218-1	54.6578	13.7972	31	on deck		CTD
	3/28/2023 17:50	AL590_219-1	54.7741	13.6330	43	in the water		CTD
	3/28/2023 17:54	AL590_219-1	54.7738	13.6332	43	on deck		CTD
	3/28/2023 17:56	AL590_219-2	54.7737	13.6332	43	in the water		VGRAB
	3/28/2023 17:58	AL590_219-2	54.7736	13.6332	43	on deck		VGRAB
	3/28/2023 18:43	AL590_220-1	54.8203	13.4489	45	in the water		CTD
	3/28/2023 18:50	AL590_220-1	54.8205	13.4506	45	on deck		CTD
	3/28/2023 18:52	AL590_220-2	54.8205	13.4513	45	in the water		VGRAB
	3/28/2023 18:56	AL590_220-2	54.8207	13.4513	45	on deck		VGRAB
	3/28/2023 19:48	AL590_221-1	54.8192	13.2286	44	in the water		CTD
	3/28/2023 19:53	AL590_221-1	54.8198	13.2286	44	on deck		CTD
	3/28/2023 20:41	AL590_222-1	54.7672	13.0391	29	in the water		CTD
	3/28/2023 20:45	AL590_222-1	54.7667	13.0398	29	on deck		CTD
	3/28/2023 20:46	AL590_222-2	54.7666	13.0399	29	in the water		VGRAB
	3/28/2023 20:48	AL590_222-2	54.7664	13.0402	29	on deck		VGRAB
Dranske	3/28/2023 22:02	AL590_223-1	54.6882	13.1650	22	profile start		MB
	3/29/2023 10:14	AL590_223-1	54.6852	13.1559	22	profile end		MB
	3/29/2023 10:40	AL590_224-1	54.6923	13.1428	23	in the water	Kapt. Blaubaer	ROV
	3/29/2023 11:09	AL590_224-1	54.6922	13.1429	23	on deck	Kapt. Blaubaer	ROV
	3/29/2023 11:37	AL590_225-1	54.6933	13.1434	23	in the water	Kapt. Blaubaer	ROV
	3/29/2023 12:30	AL590_225-1	54.6928	13.1431	23	on deck	Kapt. Blaubaer	ROV
	3/29/2023 12:51	AL590_226-1	54.6944	13.1415	23	in the water	Kapt. Blaubaer	ROV
	3/29/2023 13:03	AL590_226-1	54.6943	13.1416	23	on deck	Kapt. Blaubaer	ROV
Zingst	3/29/2023 16:00	AL590_227-1	54.5811	12.8021	11	profile start		MB
	3/30/2023 5:42	AL590_227-1	54.5765	12.8084	11	profile end		MB
	3/30/2023 6:28	AL590_228-1	54.5799	12.7673	16	in the water	Kapt. Blaubaer	ROV
	3/30/2023 6:40	AL590_228-1	54.5797	12.7675	16	on deck	Kapt. Blaubaer	ROV
CTD Transit	3/30/2023 7:49	AL590_229-1	54.7042	12.8716	22	in the water		CTD
	3/30/2023 7:55	AL590_229-1	54.7040	12.8717	22	on deck		CTD

	3/30/2023 8:46	AL590_230-1	54.6440	12.6789	19	in the water	CTD
	3/30/2023 8:52	AL590_230-1	54.6443	12.6794	19	on deck	CTD
	3/30/2023 10:14	AL590_231-1	54.5063	12.3871	18	in the water	CTD
	3/30/2023 10:18	AL590_231-1	54.5063	12.3874	18	on deck	CTD
	3/30/2023 10:49	AL590_232-1	54.4415	12.3289	17	in the water	CTD
	3/30/2023 10:54	AL590_232-1	54.4413	12.3298	17	on deck	CTD
	3/30/2023 11:48	AL590_233-1	54.3742	12.1242	19	in the water	CTD
	3/30/2023 11:53	AL590_233-1	54.3737	12.1237	20	on deck	CTD
	3/30/2023 12:34	AL590_234-1	54.3351	11.9807	18	in the water	CTD
	3/30/2023 12:39	AL590_234-1	54.3349	11.9811	18	on deck	CTD
	3/30/2023 13:09	AL590_235-1	54.3313	11.8770	21	in the water	CTD
	3/30/2023 13:15	AL590_235-1	54.3309	11.8777	21	on deck	CTD
	3/30/2023 13:17	AL590_235-2	54.3308	11.8778	21	in the water	VGRAB
	3/30/2023 13:19	AL590_235-2	54.3308	11.8777	21	on deck	VGRAB
	3/30/2023 14:15	AL590_236-1	54.3280	11.6393	26	in the water	CTD
	3/30/2023 14:21	AL590_236-1	54.3272	11.6394	26	on deck	CTD
	3/30/2023 14:21	AL590_236-2	54.3271	11.6395	26	in the water	VGRAB
	3/30/2023 14:24	AL590_236-2	54.3272	11.6398	26	on deck	VGRAB
	3/30/2023 20:11	AL590_237-1	54.4811	10.3631	19	profile start	MB
Kolberger Heide	3/31/2023 4:18	AL590_237-1	54.4839	10.3225	19	profile end	MB

7 Data and Sample Storage and Availability

Seafloor mapping data (multibeam, photographs, magnetic and GIS projects) are stored on GEOMAR servers with access control and are only available to project internal staff. Munition findings will be reported to corresponding authorities (EOD squads and the Navy underwater data centre in Rostock). Data will be provided to project members if required. Data including navigation data from munition findings will not be made publicly available. Position data from munition locations will not be uploaded onto the GEOMAR data management server OSIS. Access to such sensitive data is restricted.

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