CRUISE REPORT ALKOR 438

Foraminiferal biomonitoring in the North Sea

Cruise No. 438

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Kiel (Germany) – Kiel (Germany)

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Table of Content

1 Summary

Abstract - The aim of R/V Alkor cruise AL438 was to investigate the assemblage composition, population density and distribution of Recent benthic foraminifera in the Elbe estuary and southern North Sea. We focused on an assessment of the present state of the ecosystems and a comparison with data from former decades. Our work resumed investigations of the Geologisch-Paläontologisches Institut of Kiel University and the Federal Hydrographic Office from 1960s till the 1980s, as well as topical studies to the west of Helgoland. We revisited the same stations and took sediment samples with historical and modern grab samplers, box corer, Minicorer and a gravity corer. These samples were accomplished with samples from new stations in order to describe the relationships of foraminiferal faunas living in the Helgoland mud area with those inhabiting the surrounding sands. The sampling was accompanied with hydrographical measurements and water sampling to document relevant environmental parameters. The foraminiferal sampling was carried out for the first time following of the FOraminiferal BIoMOnitoring group (FOBIMO) recommendations as much as possible, in order to test the practicability of the guidelines. In total, 109 deployments at 37 stations were successfully accomplished.

Zusammenfassung - Ziel der Reise AL438 mit F.S. Alkor war die Untersuchung der Faunenzusammensetzung, Populationsdichte und Verbreitung rezenter Benthosforaminiferen im Elbe-Ästuar und der südlichen Nordsee. Wir wollten den gegenwärtigen Zustand der Ökosysteme beschreiben und mit Daten aus früheren Dekaden vergleichen. Unsere Arbeiten nahmen Untersuchungen des Geologisch-Paläontologischen Institutes der Universität Kiel und des Bundesamtes für Seeschiffahrt und Hydrographie aus den 1960er bis 1980er Jahren, sowie aktuelle Studien westlich vor Helgoland wieder auf. Wir haben die gleichen Stationen erneut beprobt und dabei historische und moderne Backengreifer, Kastengreifer, Minicorer und ein Schwerelot eingesetzt. Dieser Probensatz wurde mit zusätzlichen Proben von neuen Stationen ergänzt. Mit ihnen sollen die Beziehungen der Foraminiferengemeinschaften auf der Schlicklinse in der Aussenelbe mit denen auf den umgebenden Sandgründen herausgearbeitet werden. Die Probennahme wurde mit hydrographischen Messungen und der Entnahme von Wasserproben begleitet, um relevante Umweltparameter zu dokumentieren. Die Foraminiferenbeprobung wurde zum ersten Mal weitestgehend nach den Empfehlungen der FOraminiferal BIoMOnitoring (FOBIMO) Gruppe durchgeführt, um die Praktikabilität der Richtlinien zu testen. Insgesamt wurden 109 Geräteeinsätze an 37 Stationen erfolgreich absolviert.

2 Participants

Name	Function	Institution
Dr. Joachim Schönfeld	Chief Scientist, documentation	GEOMAR
Lars Jurkat	sampling gear operation	GEOMAR
Maik Lange	sampling gear operation	GEOMAR
Reinhard Mey	sampling gear operation	GEOMAR
Prof. Dr. Gerhard Schmiedl	Co-Chief Scientist, sampling	Uni. Hamburg
Dr. Yvonne Milker	foraminiferal sampling	Uni. Hamburg
Katharina Müller-Navarra	foraminiferal sampling	Uni. Hamburg
Svenja Schmid	documentation, sampling	Uni. Bonn
Elena Golikova	documentation, sampling	St. Petersburg
Tanita Wein	foraminiferal sampling	ZMB Kiel
Julia Weissenbach	foraminiferal and water sampling	ZMB Kiel

GEOMAR: Helmholtz-Zentrum für Ozeanforschung Kiel, Germany

Uni. Hamburg: Institut für Geologie, Universität Hamburg, Germany

Uni. Bonn: Steinmann Institut, Bereich Paläontologie, Universität Bonn, Germany

St. Petersburg: Department of Invertebrate Zoology, Faculty of Biology, Saint-Petersburg State University, Russian Federation

ZMB Kiel: Institut für Allgemeine Mikrobiologie, Christian-Albrechts-Universität Kiel, Germany

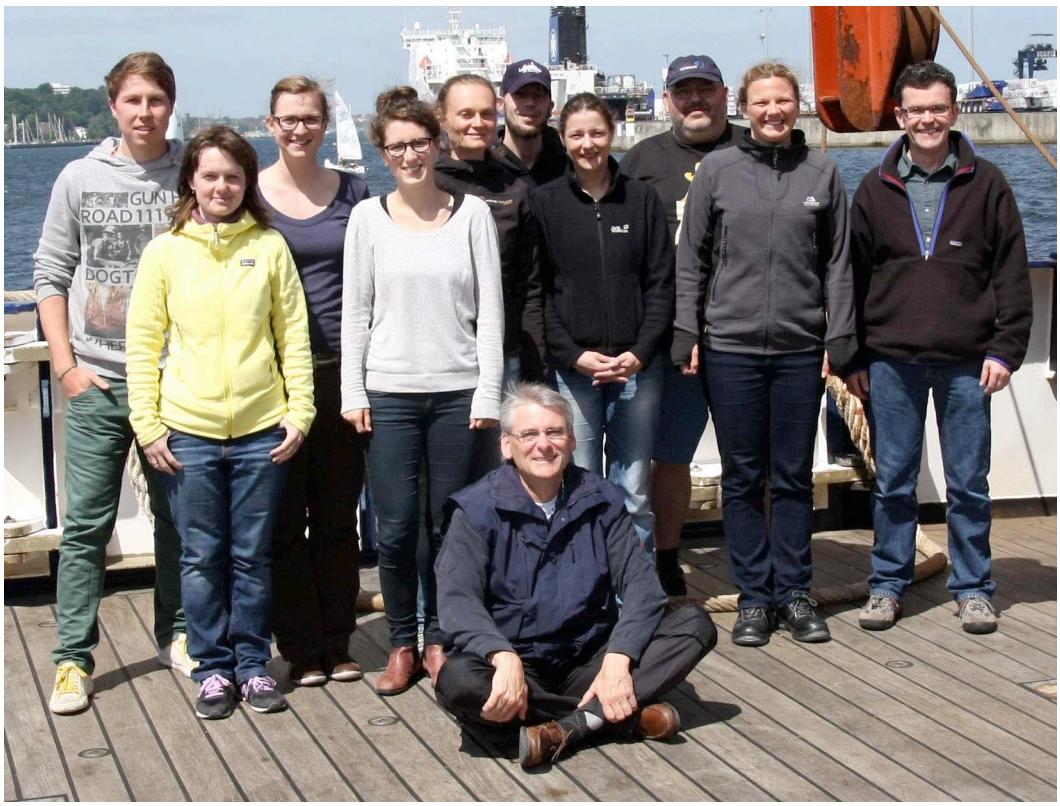

Fig. 2.1 Cruise participants on the afterdeck of R/V Alkor at Schwentine mouth, Port of Kiel.

3 Research Program

The aim of R/V Alkor cruise AL438 was to investigate the assemblage composition, standing stock and species distribution of benthic foraminifera in the Elbe estuary and southern North Sea. We focused on the present state of foraminiferal assemblages and a comparison with data from former decades. In particular, emphasis was given to foraminiferal faunas from the Helgoland mud area (Hertweck, 1983; von Haugwitz et al., 1988), their depth structure and species composition, and the relationship of mud-dwelling faunas with assemblages on the surrounding sands. Other objectives were faunal changes during late Holocene climatic variations and the impact of late mediaval storm events, the species inventory of living amoebas, and nanno-vesicles of marine bacteria.

We concentrated our operations on stations that were aligned to a transect following the Elbe estuary commencing off Brockdorf, Unterelbe, crossing Helgoland mud area, and terminating at the Helgoland Experiment Site to the southwest of the island. Most of these sites have been sampled already in the 1960s to 1980s and in 2011, and living benthic foraminifera were described (Wang, 1983; Küppers, 1987; Schönfeld et al., 2013). Comparing literature data with the actual situation will reveal whether foraminiferal associations have changed during the past decades. Additional surface sediment samples were taken for grainsize and geochemical analyses in order to assess the content of organic carbon, specific organic compounds, and trace metals. Short gravity cores were taken at stations, from where high-resolution sedimentary records have been described (Hebbeln et al., 2003). These new cores from sites with established age models will allow to track faunal changes back to medieval times and to assess the influence of the Little Ice Age climatic variation and severe storm events. The operations comprised:

- Surface sediment sampling with different Van Veen grabs, a Reineck box corer and a four-tube Mini Muc.
- Retrieval of gravity cores with a pilot corer.
- Water sampling through the ship's pump and filtering.
- Hydrographic measurements with a hand-held conductimeter.

The collection, documentation, staining and preservation of surface sediment samples was done in compliance of the FOBIMO protocol as much as possible (Schönfeld et al., 2012). In detail, this comprised that samples have to be taken with an interface corer from finegrained sediments and a box corer on sand grounds. Three replicates have to be taken from different deployments. The 0 to 1 cm surface layer should be sampled. Continuous samples of the same thickness from deeper levels may be considered as well. A target volume of 50 cm^3 is to be taken, and the actual sample volume has to be determined. Foraminiferal samples are to be stained and preserved immediatly after retrieval with a solution of 2 gram rose Bengal in 1 l ethanol (98%, technical quality). The ethanol volume should exceed the sample volume, and the sample should be shaken thoroughly after addition of the preservative.

However, foraminiferal samples were taken from grab samples as well, including those retrieved with a historical grab from the Institut für Geowissenschaften der Universität Kiel as it has been used in the 1960s. Parallel samples were taken with a timely box or interface corer in order to assess the difference in faunal composition that may be induced by the different sampling devices.

4 Narrative of the Cruise

The cruise was scheduled to commence on Wednesday 28th May 2014 at 7:00 am. Not less than 1.2 tons of sampling gear, other equipment and luggage of the cruise participants was brought on board R/V Alkor berthed at Schwentine quai, GEOMAR Eastshore buildings, on Tuesday, 27th May in the morning. The vessel returned to stay over night at its usual place at GEOMAR jetty, westshore. Strong easterly winds raised during Tuesday afternoon, and it was not possible any more to depart with the vessel from westshore jetty. Therefore, the captain and chief scientist decided to postpone the departure of the cruise by 24 hours. The winds calmed down during Wednesday, and we departed on Thursday, 29th May at 6:45 am. The ship headed to Kiel Canal, we passed Holtenau locks, and we spend the morning with a comprehensive safety instruction, unpacking and set-up of the equipment. The scientific party was ready for operations on early afternoon.

There were no significant delays during Kiel Canal passage, we passed Brunsbüttel locks and arrived at our first station 769 in the Elbe estuary at 5:10 pm (Fig. 4.1). The operational scheme of 8-hours shifts with 4 cruise participants on watch was put into action. We made two more stations upstream of Brunsbüttel up to the village of Brockdorf, and we deployed the historical grab sampler, modern grab sampler and box corer. The historical grab sampler was too light for the strong ebb current. It drifted off very much and bounced on the water surface several times upon retrieval. Thereby, the grab lost its content even though it had sucessfully sampled the Elbe river bed. We therefore decided to use the modern grab sampler instead and enforced it with two auxiliary 10-kg lead weights. The box corer also had problems with the strong tidal current. The base frame was pushed back and jammed the spade of the closing mechanism. Therefore, we had to dismount the front strut of the frame and hoped that the stability of the corer was not affected. The box corer worked still sufficiently well after this modification.

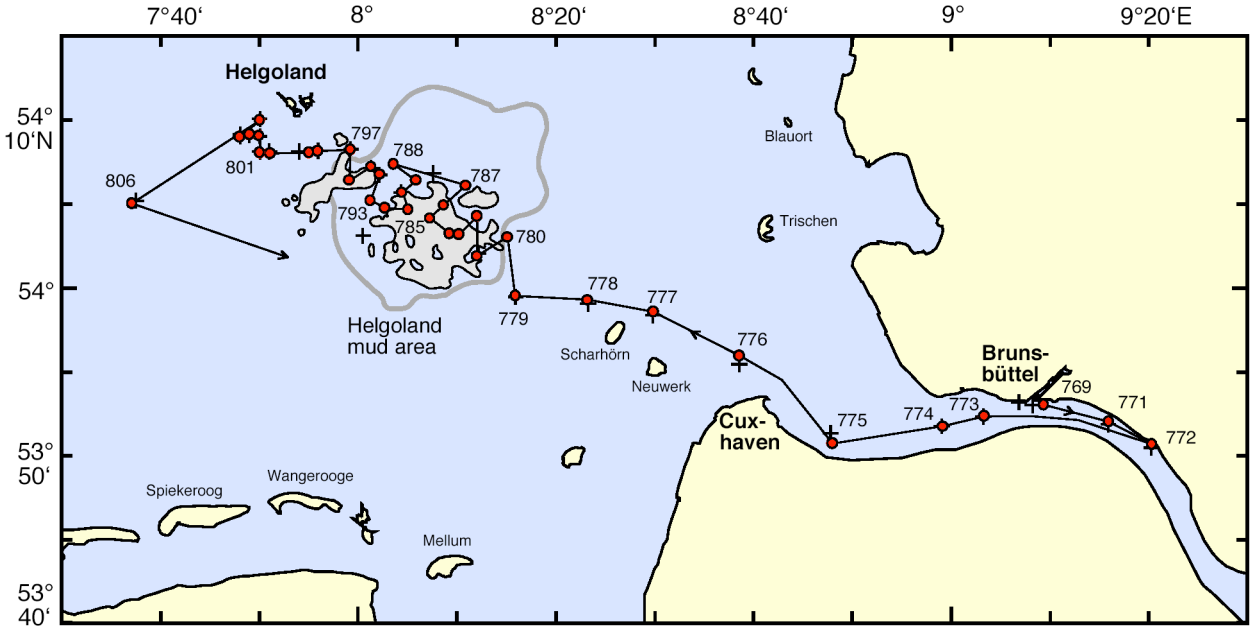

Fig. 4.1 Cruise track and stations of R/V Alkor cruise AL438. Red dots: stations, crosses: locations of earlier foraminiferal and paleoceanographic studies, grey area: bottom sediments with >80% silt and clay (Laurer et al., 2014), grey outline: Helgoland mud area mapped with hydro-acoustic subbottom profiles (von Haugwitz et al., 1988).

After station 772 off Brockdorf, we went back, resumed sampling off Neufeld village to the west of Brunsbüttel and continued further downstream successively revisiting the stations of Wang (1983). A slightly different location had to be taken at some stations, in particular off Otterndorf and Cuxhaven. The Elbe navigation channel had changed its position during the past decades and the original coordinates were not accessible. A pebble or shell often obstructed the closing of grab sampler and box corer in the Elbe estuary. The sample partly flushed out and washed off the sediment surface. Up to station 779 off the western spit of Scharhörn Riff, 20 of 48 deployments failed. Consequently, the deployments were repeated in case of failures until three foraminiferal samples could be taken from well preserved surface sediments obtained from different deployments at the station.

The Van Veen grab was routinely deployed first at each station in order to characterise the sediment and to decide whether a box corer or Mini Muc could be deployed thereafter. The Mini Muc was only used in finegrained sediments. Slacking and hoisting velocities were chosen by the ship's crew member operating the winch. Deployment times were 2 to 4 minutes at water depths between 6 and 50 m. Average operation times, i.e. from the beginning of the deployment to the beginning of the next deployment of the same or another device, were 4 minutes for the historical grab sampler, 7 minutes for the modern Van Veen grab, 8 minutes for the box corer, and 8 to 35, on average 24 minutes for the Mini Muc. Transit times between the stations varied from 10 to 69 minutes. If station distances and transit times are compared, the average positioning time approaching a station was 14 minutes, average cruise velocity between the stations was 10 knots. This average speed is rather high and it was certainly effected in combination with the strong ebb current, which prevailed at the beginning of the station work in the Elbe estuary.

The close succession of stations and short operation times made it necessary to re-organise the station work flow and responsibilities of crew members. Two persons were necessary for operating the sampling device including cleaning of grab, boxes and Mini Muc tubes, re-charging and maintenance. One of them was also responsible for sediment surface description and helped the third person when slicing a Mini Muc core. The third person was in charge of sampling, photography of the sediment surface, and occasionally hydrographic measurements. The fourth crew member was mainly keeping the station book, communicating with the bridge, and labelled all sample vessels. Help of another crew member off-duty with the preservation and stowing of foraminiferal samples, cleaning the laboratory or washing up sampling utensils, and delivery of sample vials was sometimes necessary. Therefore, an ideal shift size of five persons has been proven.

Winds were calm blowing with 2 to 4 Bft from East, later turning south to west during the night and intensified to 5 or 6 on Friday, 30th of May in the evening. Ship movements were low, and station work made good progress. The weather was fair offering us spectacular views on the Buntsandstein cliffs of Helgoland (Fig. 4.2). On Friday morning and Friday afternoon, we deployed the small gravity corer. Core recovery was 0.96 m and the tube was bent at station 787, and 1,71 m at station 794. The last station was 806 at the Helgoland Experiment Site where only one box corer was deployed because of time constraints. Station work was finished on Saturday, 31st of May at 00:40 am and the vessel returned to Brunsbüttel. Some afterwork had still to be done in the laboratory and on deck, in particular the sampling gear was thoroughly cleaned and moved into the hanger, and the shift operational scheme for the scientific crew was suspended on

1:30 am. In total, we successfully accomplished 109 deployments at 37 stations during 31.5 hours we spent on the Elbe estuary and North Sea. This is a maximum one could achive under the given time constraints and limited number of participants. The return journey went smoothly and fast, and we made use of the incoming tide. We passed Brunsbüttel locks at 7:00 am, had a quick passage through Kiel Canal, which we used for packing our equipment, and we berthed at GEOMAR eastshore facilities at 2 pm, where we unloaded the equipment and sampling gear. Most cruise participants disembarked and the cruise ended at 2:30 pm. R/V Alkor returned to its usual place at GEOMAR westshore jetty, where the remaining participants disembarked as well.

Fig. 4.2 Southwestern cliffs of Helgoland in the dusk.

5 Preliminary Results

5.1 Hydrographic Measurements

(Joachim Schönfeld, Julia Weissenbach and Tanita Wein)

Salinity measurements were performed with a WTW Cond 3210 hand-held conductimeter. The accuracy of the instrument is ±0.1 psu. Salinity values are reported on the PSS-78 scale, because the instrument was calibrated by the manufacturer with a 0.01 mol l^{-1} KCl solution and not with seawater standards. Seawater samples were taken on stations in the Elbe estuary from the ships seawater pump. On the North Sea, near-bottom water samples were siphoned off from the supernatant water of Mini Muc tubes, grabs and box cores. Measurements were made with a regular sample volume of ca. 100 ml. The sample was poured in a small polyethylene beacker provided with the conductimeter, and the electrode was centred in the beaker with the custom-made stand from the conductimeter set.

The salinity of surface waters in the Elbe estuary successively increased from 1.4 psu at Station 772 off Brockdorf to 30 psu at Station 778 off Scharhörn Riff (Fig. 5.1.1). The salinity of the near-bottom water on Station 782 close to Helgoland mud area was with 30.7 psu very similar. Near-bottom salinities slightly increased further with distance from Scharhörn Riff up to 33.3 psu at Station 796. There was no systematic difference recognised between supernatant

water of box corer, grab sampler and Mini Muc. However, it is conceivable that water from the tightly plugged Muc cores more accurately represents the near-bottom conditions.

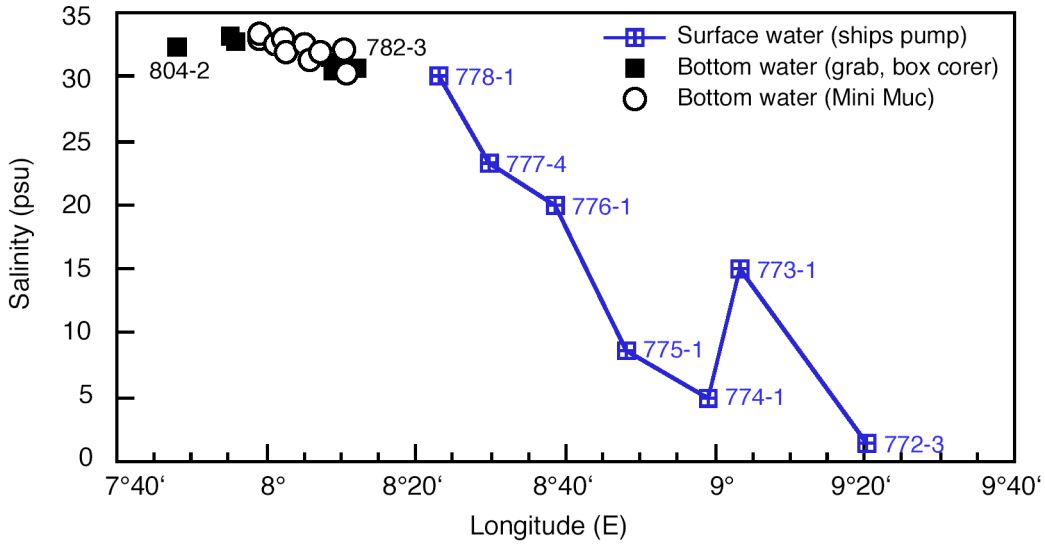

Fig. 5.1.1 Surface and near-bottom water salinities along the Elbe Estuary and inner German Bight from Brockdorf (Station 772-3) to the west of Helgoland (Station 804-2). Note the small difference between surface and near-bottom waters off Scharhörn (Stations 778-1 and 782-3) indicating that North Sea waters were well mixed.

5.2 Water sampling

(Julia Weissenbach)

Surface water samples of two liters were taken at five stations. The samples were designated for studies on outer membrane vesicles (OMV). The water was first filtered through a gossamer filter to remove suspended sediment particles from the water. Thereafter, several filter steps with nitrocellulose filters (20 µm, 8 µm, 5 µm, 3 µm, 0,8 µm and 0,2 µm) were performed to remove bacteria (> 0,2 µm), and to collect only particles with a size smaller than 0,2 µm. Filtering was done with an underpressure of 200 mbar maintained by a KNF Neuberger NO26.1.2 AN.18 low-vaccuum pump. The filters were frozen at –80°C for control experiments. Additional samples of 5 mL were collected from surface and near-bottom waters samples at 27 stations for metagenomics. They were blended with glutaraldehyde for a final concentration of 0,25 % and directly frozen at -80°C.

5.3 Surface Sediment Sampling

5.3.1 Devices and operations

(Joachim Schönfeld, Elena Golikova, Lars Jurkat, Maik Lange, Reinhard Mey, Yvonne Milker, Katharina Müller-Navarra, Svenja Schmid, Gerhard Schmiedl, Julia Weissenbach and Tanita Wein)

Surface sediment sampling was performed with an historical and a timely VAN VEEN grab (BG), REINECK box corer (KG), and a Mini Muc K/MT 410 (MIC). The modern VAN VEEN grab designed by Hydrobios, Kiel, was of 35 x 35 cm in dimension and had a weight of approximately 40 kg including two auxiliaury lead weights. The historical grab sampler was 20 x 20 cm in size.

The grab samplers were used to explore the bottom sediment properties in order to judge which device is appropriate to obtain a good surface sediment preservation on recovery. The box corer was preferred on sandy bottoms. The corer had a weight of 200 kg. It was equipped with boxes of 20 x 20 cm and 25 cm length. The Mini Muc was deployed in finegrained sediments only. The weight of the Mini Muc was 180 kg, and it was equipped with four tubes of 610 mm length, 100 mm inner diameter, and a midpoint distance of 21 cm (Kuhn and Dunker, 1994). We also had a genuine Barnett Multicorer of 400 kg weight on board. The Multicorer was equipped with eight tubes of 10 cm inner diameter. The Multicorer was designated to be used when the Mini Muc was too light to obtain a sufficient core recovery. Furthermore, we had a Shipek grab available, which was to be deployed in case pebble lags or hard grounds were encountered. Both, Multicorer and Shipek grab were not used during the cruise.

The supernatant water from grab samples and box cores was siphoned off with a silicone hose when hanging on the wire before the device was set on deck. The water was siphoned off from Mini Muc cores when the MIC was placed on its transport stand and securely lashed. A water sample for salinity measurements was taken at 5 BG and KG stations and at 9 MIC stations. Water samples of 100 ml for analyses of stable oxygen and carbon isotopes were taken at the MIC stations too. The isotope samples were poisoned with 20 mg $CuSO_4$ to terminate micobial activity.

The box of the box corer was dismounted when the corer was placed on deck after recovery. The box was gently moved not to disturb the sediment surface by swashing remnants of supernatant water. The box was cautiously put on a custom made rack for description and sampling. The grab sampler was placed on a washing table and stabilised with wooden wedges after recovery. The lids of the grab were opened. The surfaces of grab samples and box cores were photographed and described. Sediment composition, colour, and structures were noted and a sketch of the surface was made. Occurrences of macroorganisms were noted as well. A volume-defined surface sample for foraminiferal studies was taken from 0 to 1 cm sediment depth either with a frame of 87.6 cm^2 or with a polycarbonate tube of 72 mm inner diameter. The foraminiferal sample was preserved with a solution of 2 gram rose Bengal per litre ethanol (98%, technical quality). Two more surface sediment samples were taken with a spoon for grainsize and geochemical analyses. They were collected in 100-ml polypropylene beakers. The sample designated for geochemical analyses was immediately frozen at –20°C. Samples for amoebian studies were taken as well (see below).

The Mini Muc was deployed at those locations where the Van Veen grab retrieved soft sediments. The purpose of Mini Muc deployment was to recover both, a reliable sediment surface and an undisturbed sediment sequence in order to study the faunal composition and microhabitat depth of living benthic foraminifera. The supernatant water was siphoned off with a silicone hose. Surface preservation, core recovery, and sedimentary structures were noted, for instance depth of a conspicuous colour change indicating the redox boundary, shell lags, or bioturbation features. The cores were placed on an extruding stand. The coring tube was pushed down until the sediment surface comes close to the top of the coring tube. A graduated plastic ring was placed on the top of the tube, and tube was pushed down by one more centimetre. Surface or core samples were sliced off with a shuffle spatule that was pushed between the plastic ring and coring tube (Murray, 2006; Schönfeld et al., 2012).

If the sediment surfaces were well preserved in all cores, the 0-1 cm level of 3 cores was sampled for foraminiferal studies. One core was sliced in 1-cm intervals down to 10 cm for endobenthic foraminiferal investigations. The fourth core was sliced to the same depth for grainsize and geochemical analyses. Each foraminiferal sample was collected in a 200-ml, wide neck, polyethylene bottle and preserved with ethanol/Rose Bengal solution. The geochemical samples were immediately frozen at –20°C. Samples for grainsize analyses were kept at 4°C.

5.3.2 Amoebian Samples

(Elena Golikova)

Eight surface sediment samples were taken for amoebian studies during the cruise (Table 11.1). The samples were collected with a Mini Muc and box corer. They were inoculated in sterile culture flasks with filter-sterilized seawater. Seawater was sterilized by using a series of filters and a vacuum pump. The following filters were used: 8.0 μm, 5.0 μm, 3.0 μm, 0.8 μm, and 0.22 μm. Samples were placed on the cooling agents and then stored in the laboratory. Cooling agents were frozen in the refrigerator and replaced if heated. After the cruise, the samples were brought to the Department of Invertebrate Zoology, St-Petersburg State University.

The samples will be subsequently used for isolation of living naked lobose amoebae (Amoebozoa). Amoebae will be microscopically detected in the samples, cultured and identified using microscopic and molecular methods. The purpose of the study is to get the data on biodiversity of marine Amoebozoa from as broad geographic range of habitats as possible for comparison of deep-sea and shallow-water amoebozoan communities. This project is supported by the grant 12-04-33229 from the Russian Foundation of Basic Research ("Biodiversity of naked lobose amoebae (Amoebozoa) in deep-sea habitats") supervised by Dr. A. Kudryavtsev (St-Petersburg State University).

5.3.3 Sedimentary Facies Distribution

(Joachim Schönfeld, Yvonne Milker, Reinhard Mey and Gerd Schmiedl)

Medium to fine sands with clay pebbles and patchy mud drapes on sand with ripples were encountered in the Elbe estuary. They pass into fine sand with shell debris off Neuwerk and Scharhörn, and further westwards into a muddy fine sand. Muddy fine sands were also retrieved to the southeast of Helgoland and at the Helgoland Experiment site. Medium and coarse sands with shell debris were found to the south and southwest of Helgoland. Sandy mud was retrieved in the Helgoland mud area as expected. The southeastern limit of this facies followed the boundary of an area with bottom sediments constituing of >80% silt and clay reasonably well. In the northwestern part, however, the sandy mud facies fringed a central area where mud with mollusk shell debris prevailed (Fig. 5.3.3). This pattern is not depicted by actual distribution charts of surface sediments (Laurer et al., 2014). A possible explantion for this discrepancy is that accessorial components were given too much consideration in our sediment description, whereas their granulometric proportion was certainly lower. None-the-less it is obvious, that a visual facies description at 37 stations during R/V Alkor cruise AL438 may not substantially supplement or even revise sediment distribution charts that were compiled over decades and are based on grainsize data from thousands of samples (Figge, 1981; Laurer et al., 2014).

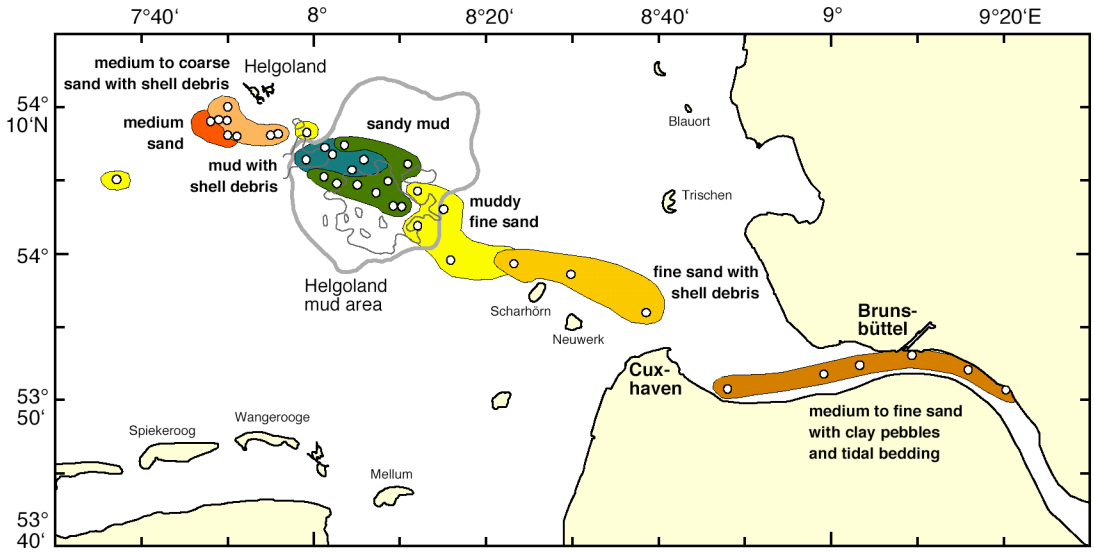

Fig. 5.3.3 Facies distribution and stations of R/V Alkor cruise AL438 (circles). Thin grey outline: bottom sediments with >80% silt and clay (Laurer et al., 2014), thick grey outline: Helgoland mud area (von Haugwitz et al., 1988).

5.4 Sediment Coring

5.4.1 Coring Device, Core Description and Sampling

(Svenja Schmid, Joachim Schönfeld, Lars Jurkat, Maik Lange and Reinhard Mey)

Sediment cores wer taken with a pilot gravity corer (SL), which is otherwise used as trigger weight for a Marinetechnik Kawohl piston corer. The pilot corer weight was 100 kg. The corer was mounted with a 2-m long PVC tube of 90 mm outer diameter and 2.7 mm wall thickness. A nose cone with a core catcher made of stainless steel was attached to the lower end of the coring tube and fixed with PVC tape. After deployment, the tube was dismounted from the weight, cleaned, and the nose cone with core catcher was removed. The sediment cores were cut in 1 meter sections, capped and labelled according to a standard scheme. The core sections were left in the hanger at outside temperature. They were immediately transferred to a cold store at GEOMAR after the cruise and kept at 4°C.

On Monday, 2nd June, the cores were cut lengthwise in halves at GEOMAR core description laboratory. The working halves were used for sediment sampling, the archive halves were used for visual core description. The core description was documented and a sketch was made depicting the lithology, sedimentary structures, colour, and macrofossil occurrences. Sampling for determining the physical properties was performed with cut-off 10 ml syringes of 1.5 cm diameter in 5-cm intervals. Usually 5 to 8 cm^3 were taken and transferred to a 20 ml polystyrene beaker, weighed, freeze-dried, and weighed again. Bulk sediment samples of 1.5 cm thickness were taken from the same horizons as the physical properties samples. They were transferred into 150-ml polypropylene beakers, weighed, and freeze-dried as well. These samples are designated for benthic foraminiferal studies. The dried physical properties samples will be used for organic carbon and carbonate analyses.

6 Concluding Remarks on the FOBIMO Protocol

(Joachim Schönfeld)

Implementation of the FOBIMO recommendations was generally feasible on board a medium sized research vessel operating in estuarine and inner shelf environments. Lightweight and easy-to-handle sampling devices are to be preferred because of shorter operation time and involvement of only two members of the ships crew. However it turned out that the weight of the devices should be higher than 40 kg for grabs and higher than approximately 150 kg for box and gravity corer. Lighter devices will not achieve a sufficient penetration. Their deployment in strong tidal currents, recovery and handling on deck at rough seas is difficult.

Replicate sampling at a station will not cause considerable delays in the cruise schedule as the operation and deployment times were very short. Rather it turned out to be a challenging task to keep up with sampling and documentation. Even an experienced crew with lots of practice will soon be at their limits when a new box or Mini Muc core needs to be worked up every ten minutes. Sufficient staffing with at least five persons per shift is essential. Clear responsibilities and a balanced work load for the shift members have to be ensured for a successful sampling campaign. Permanent control of documentation and labelling of sampling vessels, and a review of the procedures together with both, shift members doing the sampling and technicians operating the devices, during breaks or transit times is necessary to ensure a constant high quality of the samples.

Practical solutions, for instance handy sampling utensils, any-surface marker, effective cleaning items, and sample vials of sufficient dimensions, turned out to be essential for a full compliance to the FOBIMO scheme, even under stress or tireness. The solutions have to be worked out before the cruise, and they are to be provided in time. For instance, a sample vessel volume of 200 cm^3 is too small once a sample of 88 cm^3 has to be topped up with 135 cm^3 ethanol/rose Bengal solution for preservation. Push cores with graduated rings of different dimensions, shuffle spatules, flexible scrapers and plastic spoons were appreciated.

7 Station List AL438

AL438-	Location	Device	Date [UTC]	Time [UTC]	Latitude	Longitude	Depth [m]
769-1	Wang 376	hist. BG	29.05.2014	15:12	53° 53.05'N	9° 9.42' E	16
769-2		KG	29.05.2014	15:22	53° 53.04'N	9° 9.43' E	16
769-3		KG	29.05.2014	15:32	53° 53.05'N	9° 9.43' E	16
769-4		KG	29.05.2014	15:40	53° 53.05'N	9° 9.42' E	16
771-1	Wang 369	hist. BG	29.05.2014	16:17	53° 52.03'N	9° 15.88' E	14
771-2		hist. BG	29.05.2014	16:20	53° 52.03'N	9° 15.88' E	14
771-3		BG	29.05.2014	16:24	53° 52.04' N	9° 15.87' E	14
771-4		KG	29.05.2014	16:29	53° 52.04' N	9° 15.86' E	14
771-5		KG	29.05.2014	16:37	53° 52.06' N	9° 15.84' E	14
771-6		KG	29.05.2014	16:44	53° 52.06' N	9° 15.82' E	14
771-7		KG	29.05.2014	16:48	53° 52.06' N	9° 15.82' E	14
772-1	Wang 374	BG	29.05.2014	17:19	53° 50.62' N	9° 20.35' E	16
772-2		KG	29.05.2014	17:24	53° 50.62' N	9° 20.37' E	16
772-3		KG	29.05.2014	17:32	53° 50.62' N	9° 20.37' E	16
772-4		KG	29.05.2014	17:40	53° 50.62' N	9° 20.38' E	16
773-1	Wang 15269	hist. BG	29.05.2014	18:50	53° 52.35' N	9° 3.37' E	12
773-2		KG	29.05.2014	18:54	53° 52.37' N	9° 3.36' E	12
773-2a		KG	29.05.2014	18:57	53° 52.37' N	9° 3.36' E	12
773-3		BG	29.05.2014	19:02	53° 52.38' N	9° 3.36' E	11
773-4		BG	29.05.2014	19:09	53° 52.39' N	9° 3.36' E	11
774-1	Wang 15268	hist. BG	29.05.2014	19:33	53° 51.70' N	8° 59.18' E	8
774-2		KG	29.05.2014	19:40	53° 51.70' N	8° 59.19' E	8
774-3		KG	29.05.2014	19:46	53° 51.71' N	8° 59.18' E	8
774-4		KG	29.05.2014	19:52	53° 51.72' N	8° 59.19' E	8
775-1	Wang 15266	hist. BG	29.05.2014	20:37	53° 50.71' N	8° 47.99' E	8
775-2		KG	29.05.2014	20:40	53° 50.71' N	8° 48.04' E	8
775-3		KG	29.05.2014	20:45	53° 50.69' N	8° 48.12' E	8
775-4		KG	29.05.2014	20:51	53° 50.72' N	8° 48.24' E	6
775-5		KG	29.05.2014	20:57	53° 50.75' N	8° 48.25' E	6
775-6		BG	29.05.2014	21:02	53° 50.77' N	8° 48.23' E	6
776-1	Wang 15265	hist. BG	29.05.2014	22:13	53° 55.98' N	8° 38.62' E	13
776-2		KG	29.05.2014	22:16	53° 55.95' N	8° 38.64' E	13
776-3		KG	29.05.2014	22:24	53° 55.96' N	8° 38.64' E	13
776-4		KG	29.05.2014	22:28	53° 55.95' N	8° 38.63' E	13
776-5		KG	29.05.2014	22:35	53° 55.93' N	8° 38.63' E	13
777-1	Wang 15264	hist. BG	29.05.2014	23:33	53° 58.57' N	8° 29.87' E	17
777-2		KG	29.05.2014	23:39	53° 58.56' N	8° 29.88' E	16
777-3		KG	29.05.2014	23:49	53° 58.55' N	8° 29.86' E	17
777-4		KG	29.05.2014	23:56	53° 58.55' N	8° 29.86' E	17
778-1	Wang 15263	hist. BG	30.05.2014	00:36	53° 59.30' N	8° 23.20' E	21
778-2		KG	30.05.2014	00:39	53° 59.31' N	8° 23.21' E	21
778-3		KG	30.05.2014	00:47	53° 59.32' N	8° 23.19' E	21
778-4		KG	30.05.2014	00:54	53° 59.33' N	8° 23.18' E	20
779-1	Wang 15262	hist. BG	30.05.2014	01:39	53° 59.53' N	8° 15.93' E	26
779-1		BG	30.05.2014	01:42	53° 59.53' N	8° 15.93' E	26
779-2		BG	30.05.2014	01:44	53° 59.53' N	8° 15.92' E	26
779-3		KG	30.05.2014	01:46	53° 59.53' N	8° 15.93' E	26
779-4		KG	30.05.2014	01:54	53° 59.51' N	8° 15.96' E	25
779-5		KG	30.05.2014	02:01	53° 59.51' N	8° 15.96' E	25

AL438-	Location	Device	Date [UTC]	Time [UTC]	Latitude	Longitude	Depth [m]
780-1	Neu-8	BG	30.05.2014	02:42	54° 3.06' N	8° 15.10' E	15
780-2		KG	30.05.2014	02:46	54° 3.06' N	8° 15.12' E	14
780-3		KG	30.05.2014	02:55	54° 3.05' N	8° 15.09' E	15
780-4		KG	30.05.2014	03:03	54° 3.05' N	8° 15.01' E	14
781-1	Wang 15261	BG	30.05.2014	03:28	54° 1.92' N	8° 12.13' E	16
781-2		KG	30.05.2014	03:31	54° 1.94' N	8° 12.15' E	16
781-3		KG	30.05.2014	03:39	54° 1.96' N	8° 12.10' E	15
781-4		KG	30.05.2014	03:46	54° 1.98' N	8° 12.04' E	15
782-1	Neu-7	BG	30.05.2014	04:08	54° 4.24' N	8° 12.12' E	17
782-2		KG	30.05.2014	04:13	54° 4.23' N	8° 12.14' E	16
782-3		KG	30.05.2014	04:23	54° 4.23' N	8° 12.17' E	16
782-4		KG	30.05.2014	04:31	54° 4.23' N	8° 12.21' E	16
783-1	Wang 15259	BG	30.05.2014	04:52	54° 3.16' N	8° 10.26' E	17
783-2		MIC	30.05.2014	05:05	54° 3.18' N	8° 10.23' E	16
784-1	Neu-9	BG	30.05.2014	05:46	54° 3.20' N	8° 9.32' E	17
784-2		MIC	30.05.2014	05:51	54° 3.20' N	8° 9.32' E	17
785-1	Neu-5	BG	30.05.2014	06:16	54° 4.16' N	8° 7.27' E	19
785-2		MIC	30.05.2014	06:45	54° 4.15' N	8° 7.31' E	19
786-1	Neu-6	BG	30.05.2014	07:12	54° 4.93' N	8° 8.68' E	18
786-2		MIC	30.05.2014	07:21	54° 4.95' N	8° 8.75' E	18
786-3		KG	30.05.2014	07:29	54° 4.97' N	8° 8.82' E	19
786-4		KG	30.05.2014	07:38	54° 5.00' N	8° 8.92' E	19
786-5		KG	30.05.2014	07:48	54° 4.98' N	8° 9.00' E	19
787-1	GeoB 4805-1	BG	30.05.2014	08:19	54° 6.11' N	8° 10.90' E	19
787-2		MIC	30.05.2014	08:35	54° 6.08' N	8° 10.88' E	19
787-3		SL	30.05.2014	09:11	54° 6.03' N	8° 10.96' E	20
788-1	Neu-2	BG	30.05.2014	09:56	54° 7.36' N	8° 3.61' E	25
788-2		MIC	30.05.2014	10:06	54° 7.35' N	8° 3.61' E	25
789-1	Neu-3	BG	30.05.2014	10:26	54° 6.39' N	8° 5.87' E	23
789-2		MIC	30.05.2014	10:34	54° 6.38' N	8° 5.86' E	24
790-1	GeoB 4802-1	BG	30.05.2014	10:55	54° 5.71' N	8° 4.48' E	25
790-2		MIC	30.05.2014	11:08	54° 5.69' N	8° 4.47' E	25
791-1	Wang 15257	BG	30.05.2014	11:33	54° 4.65' N	8° 5.08' E	24
791-2		MIC	30.05.2014	12:15	54° 4.66' N	8° 5.04' E	24
792-1	Neu-4	BG	30.05.2014	12:34	54° 4.79' N	8° 2.73' E	24
792-2		MIC	30.05.2014	12:43	54° 4.79' N	8° 2.72' E	26
793-1	Neu-10	BG	30.05.2014	13:00	54° 5.20' N	8° 1.28' E	28
793-2		MIC	30.05.2014	13:19	54° 5.20' N	8° 1.25' E	28
794-1	GeoB 4801-1	BG	30.05.2014	13:41	54° 6.77' N	8° 2.23' E	27
794-2		MIC	30.05.2014	13:53	54° 6.71' N	8° 2.24' E	26
794-3		SL	30.05.2014	14:08	54° 6.72' N	8° 2.13' E	29
795-1	Wang 15255	BG	30.05.2014	14:26	54° 7.19' N	8° 1.30' E	28
795-2		BG	30.05.2014	14:30	54° 7.22' N	8° 1.23' E	28
795-3		MIC	30.05.2014	14:45	54° 7.25' N	8° 1.23' E	27
796-1	Neu-11	BG	30.05.2014	15:22	54° 6.44' N	7° 59.14' E	30
796-2		MIC	30.05.2014	15:25	54° 6.44' N	7° 59.13' E	31
797-1	Wang 15254	BG	30.05.2014	16:02	54° 8.23' N	7° 59.21' E	36
797-2		MIC	30.05.2014	16:07	54° 8.23' N	7° 59.15' E	36
798-1	Küppers 26	BG	30.05.2014	16:30	54° 8.14' N	7° 55.84' E	43
798-2		KG	30.05.2014	16:43	54° 8.14' N	7° 55.99' E	43
798-3		KG	30.05.2014	16:52	54° 8.07' N	7° 55.92' E	43
798-4		KG	30.05.2014	17:01	54° 8.07' N	7° 55.86' E	43
798-5		KG	30.05.2014	17:10	54° 8.08' N	7° 55.86' E	43

AL438-	Location	Device	Date [UTC]	Time [UTC]	Latitude	Longitude	Depth [m]
799-1	Küppers 20	BG	30.05.2014	17:24	54° 8.05' N	7° 55.07' E	47
799-2		KG	30.05.2014	17:35	54° 8.07' N	7° 55.10' E	47
799-3		KG	30.05.2014	17:43	54° 8.06' N	7° 55.10' E	47
799-4		KG	30.05.2014	17:50	54° 8.06' N	7° 55.14' E	47
800-1	Küppers 19	BG	30.05.2014	18:19	54° 8.01' N	7° 51.14' E	46
800-2		KG	30.05.2014	18:23	54° 8.03' N	7° 51.14' E	47
800-3		KG	30.05.2014	18:30	54° 8.05' N	7° 51.12' E	47
801-1	Küppers 12	BG	30.05.2014	18:50	54° 8.04' N	7° 50.00' E	43
801-2		KG	30.05.2014	18:54	54° 8.03' N	7° 49.79' E	43
801-3		KG	30.05.2014	19:00	54° 8.01' N	7° 49.97' E	43
802-1	Küppers 13	KG	30.05.2014	19:21	54° 9.06' N	7° 49.99' E	49
802-2		KG	30.05.2014	19:25	54° 9.06' N	7° 49.99' E	49
802-3		KG	30.05.2014	19:31	54° 9.06' N	7° 50.00' E	50
803-1	Küppers 2	BG	30.05.2014	19:51	54° 9.11' N	7° 49.10' E	46
803-2		KG	30.05.2014	19:56	54° 9.10' N	7° 49.09' E	46
803-3		KG	30.05.2014	20:02	54° 9.09' N	7° 49.09' E	46
803-4		KG	30.05.2014	20:09	54° 9.09' N	7° 49.07' E	46
804-1	Küppers 11, 10	BG	30.05.2014	20:30	54° 9.00' N	7° 48.08' E	42
804-2		KG	30.05.2014	20:35	54° 9.00' N	7° 48.07' E	43
804-3		KG	30.05.2014	20:41	54° 8.99' N	7° 48.08' E	42
805-1	Küppers 15	BG	30.05.2014	21:09	54° 9.98' N	7° 50.06' E	45
805-2		KG	30.05.2014	21:16	54° 9.96' N	7° 50.05' E	45
805-3		KG	30.05.2014	21:23	54° 9.95' N	7° 50.04' E	45
806-1	Helgoland-Experiment	KG	30.05.2014	22:34	54° 5.03' N	7° 37.19' E	40

Devices: BC: REINECK box corer, BG: grab sampler, MIC: Mini Muc, SL: gravity corer. Locations: author name and station numbers are given for locations of Küppers (1987) and Wang (1983), GeoB numbers are given for locations of Hebbeln et al. (2003), the location of Schönfeld et al. (2013) is named “Helgoland Experiment“, and new locations are numbered with the prefix “Neu-“. Note: water depths are given as sounding depth at the moment of bottom contact. They were rounded up to metres.

8 Data and Sample Storage and Availability

Station list data obtained during R/V Alkor cruise AL438 are archived at German Oceanographic Data Centre, Bundesamt für Seeschiffahrt und Hydrographie (BSH), Hamburg (http://www.sea-data.bsh.de). They are available to the public. The hydrographic measurements are archived at PANGAEA database (http://www.pangaea.de). The descriptions of sediment cores are archived at PANGAEA too.

The samples taken on R/V Alkor cruise AL4381 were distributed to the following principle investigators for initial analyses. Seawater samples are analysed by Julia Weissenbach at Institut für Allgemeine Mikrobiologie, Universität Kiel. Surface sediment samples are analysed by Joachim Schönfeld, GEOMAR, Gerhard Schmiedl, Universität Hamburg, and Alexander Kudryavtsev, St-Petersburg State University to study the sediment composition, microfaunal inventory, organic carbon, biomarker, and trace metals. Sediment cores are analysed by Svenja Schmid, Universität Bonn to study benthic foraminiferal assemblages and organic carbon.

Sediment cores are archived at Lithothek Core Repository, GEOMAR, Kiel. Bulk sediment samples from box cores, multicorer and grab samples are curated at Institut für Geologie, Universität Hamburg. Subsampleas are available to the public upon request by January 2010.

9 Acknowledgements

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10 References

Figge, K., 1981. Sedimentverteilung in der Deutschen Bucht (Blatt: 2900, Maßstab: 1:250.000). Deutsches Hydrographisches Institut, Hamburg.

Hebbeln, D., Scheurle, C., Lamy, F., 2003. Depositional history of the Helgoland mud area, German Bight, North Sea. Geo-Marine Letters, 23: 81-90.

Hertweck, G., 1983. Das Schlickgebiet in der inneren Deutschen Bucht. Aufnahme mit dem Sedimentechographen. Senckenbergiana maritima, 15: 219-249.

Kuhn, G., Dunker, E., 1994. Der Minicorer, ein Gerät zur Beprobung der Sediment/Bodenwasser-Grenze. Greifswalder Geowissenschaftliche Beiträge, 2: 99-100.

Küppers, R., 1987. Systematische und Ökologische Studien zur Bestandsaufnahme der Foraminiferenfauna um Helgoland in Abhängigkeit vom Jahresgang. 369 pp., Dissertation Universität Bonn.

Laurer, W.U., Naumann, M., Zeiler, M., 2014. Erstellung der Karte zur Sedimentverteilung auf dem Meeresboden in der deutschen Nordsee nach der Klassifikation von FIGGE (1981). Geopotenzial Deutsche Nordsee, Modul B, Dokumentation 1: 1-19, Kartenversion 2.1 vom 30.10.2014, Bundesanstalt für Geowissenschaften und Rohstoffe, Hannover.

Murray, J.W. 2006. Ecology and Applications of Benthic Foraminifera. Cambridge University Press, Cambridge, 426 pp.

Schönfeld, J., Alve, E., Geslin, E. and members of the FOBOMO Group, 2012. The FOBIMO (FOraminiferal BIo-MOnitoring) initiative – Towards a standardised protocol for soft-bottom benthic foraminiferal monitoring studies. Marine Micropaleontology, 94-95: 1-13.

Schönfeld, J., Golikova, E., Korsun, S., Spezzaferri, S., 2013. The Helgoland Experiment – assessing the influence of methodologies on Recent benthic foraminiferal assemblage composition. Journal of Micropalaeontology, 32: 161-182.

von Haugwitz, W., Wong, H.K., Salge, U., 1988. The mud area southeast of Helgoland: A reflection seismic study. Mitteilungen des Geologisch – Paläontologischen Instituts der Universität Hamburg, 65: 409-422.

Wang, P., 1983. Verbreitung der Benthos-Foraminiferen in Elbe-Ästuar. Meyniana, 35: 67-83.

11 Appendix

Table 11.1: Recovery, sediment composition, samples and hydrographic measurements.

AL438-	Remarks, samples, measurements
769-1	Muddy sand, 1 foraminiferal sample.
769-2	1 foraminiferal sample, 1 geochemistry sample, 1 surface water sample, 1 metagenomics water sample.
769-3	1 foraminiferal sample, 1 geochemistry sample.
769-4	1 foraminiferal sample, 1 geochemistry sample.
771-1	Grab sampler empty, 1 metagenomics water sample, 1 OMV water sample.
771-2	Grab sampler empty.
771-3	Medium sand, well sorted, 1 foraminiferal sample.
771-4	1 foraminiferal sample, 1 geochemistry sample.
771-5	1 foraminiferal sample.
771-6	Box corer failed.
771-7	2nd try; Box corer failed again.
772-1	Sand with clay pebbles, 1 foraminiferal sample, 1 metagenomics water sample.
772-2	1 foraminiferal sample, 1 geochemistry sample.
772-3	1 foraminiferal sample; surface water salinity 1.4 psu.
772-4	1 foraminiferal sample.
773-1	Fine sand with clay pebbles and plant debris. Surface water salinity 15.0 psu.1 foraminiferal sample, 1 metagenomics water sample.
773-2	Box corer failed.
773-2a	2nd try; Box corer failed.
773-3	Sand with clay pebbles, 1 foraminiferal sample.
773-4	1 foraminiferal sample.
774-1	Muddy sand, well sorted, with few clay pebbles. Surface water salinity 5.0 psu. 1 foraminiferal sample, 1 metagenomics water sample.
774-2	1 foraminiferal sample.
774-3	1 foraminiferal sample.
774-4	1 foraminiferal sample.
775-1	Fine sand with mica; sample almost flushed out. Surface water salinity 8.7 psu, 1 metagenomics water sample.
775-2	Box corer failed.
775-3	Sample partly flushed, the middle of the surface is considerably well preserved, 1 foraminiferal sample.
775-4	Sample partly flushed, the middle of the surface is considerably well preserved, 1 foraminiferal sample.
775-5	Box core flushed completely, surface destroyed, no description and sampling possible.
775-6	Fine sand with mica, water saturated, 1 foraminiferal sample.
776-1	Grab sample flushed completely, no sediment surface description. Surface water salinity 19.9 psu, 1 OMV water sample.
776-2	Fine sand, well sorted, with shell debris, 1 foraminiferal sample.
776-3	Box core flushed, surface destroyed, no description and sampling possible.
776-4	1 foraminiferal sample.
776-5	1 foraminiferal sample.
777-1	Grab sample flushed completely.
777-2	Box core surface partly flushed. Fine sand, well sorted, with shell debris, 1 foraminiferal sample.
777-3	Box core flushed completely, no samples, no surface description.
777-4	Surface water salinity 23.2 psu, 1 foraminiferal sample, 1 metagenomics water sample.

AL438-	Remarks, samples, measurements
778-1	Slightly muddy fine sand with shell fragments. Surface water salinity 30 psu, 1 foraminiferal sample, 1 metagenomics water sample.
778-2	Box core partly flushed, 1 foraminiferal sample.
778-3	1 foraminiferal sample.
778-4	1 foraminiferal sample.
779-1	Grab sampler failed.
779-1	Grab sampler empty.
779-2	Grab sampler empty.
779-3	Muddy fine sand. 1 foraminiferal sample, 1 geochemistry sample.
779-4	1 foraminiferal sample, 1 amoebian sample.
779-5	1 foraminiferal sample.
780-1	Muddy fine sand. 1 foraminiferal sample.
780-2	1 foraminiferal sample, 1 amoebian sample, 1 geochemistry sample, 1 water sample, , 1 metagenomics water sample, 1 OMV water sample
780-3	1 foraminiferal sample.
780-4	1 foraminiferal sample.
781-1	Muddy fine sand. 1 foraminiferal sample.
781-2	1 foraminiferal sample, 1 water sample, 1 metagenomics water sample, 1 OMV water sample.
781-3	1 foraminiferal sample.
781-4	1 foraminiferal sample, 1 amoebian sample.
782-1	Muddy sand with shell debris. 1 foraminiferal sample.
782-2	1 foraminiferal sample, 1 geochemistry sample, 1 water sample, 1 metagenomics water sample, 1 OMV water sample.
782-3	1 foraminiferal sample, bottom water salinity 30.7 psu.
782-4	1 foraminiferal sample.
783-1	Mud. 1 foraminiferal sample.
783-2	3 foraminiferal samples, 1 amoebian sample, 1 geochemistry sample, 1 bottom water sample, 1 metagenomics water sample, salinity 32.2 psu.
784-1	Sandy, silty clay. 1 foraminiferal sample, 1 metagenomics water sample.
784-2	3 foraminiferal samples, 1 amoebian sample.
785-1	Slightly sandy mud, 1 foraminiferal surface sample.
785-2	3 foraminiferal samples, 1 metagenomics water sample, salinity of supernatant water 32 psu.
786-1	Sandy mud, 1 foraminiferal sample, 1 metagenomics water sample, salinity of supernatant water 31.6 psu.
786-2	Penetration depth 10 cm only, 3 tubes flushed.
786-3	1 foraminiferal sample, bottom water salinity 30.5 psu.
786-4	1 foraminiferal sample.
786-5	1 foraminiferal sample.
787-1	Slightly sandy mud, 1 foraminiferal sample,
787-2	Slightly sandy, solid clay, 1 foraminiferal sample, 1 metagenomics water sample, salinity of supernatant water 30.2 psu.
787-3	Core tube bent at 1.10 m, recovery 0.96 cm.
788-1	Sandy mud, 1 foraminiferal sample, 1 metagenomics water sample.
788-2	2 foraminiferal samples.
789-1	1 foraminiferal sample.
789-2	Mud with shell debris at surface, 3 foraminiferal samples, 1 metagenomics water sample, bottom water salinity 31.4 psu.
790-1	1 foraminiferal sample.
790-2	Mud with shell debris, 2 foraminiferal samples, 1 amoebian sample, 1 metagenomics water sample.

AL438-	Remarks, samples, measurements
791-1	Sandy mud with shell lag, 1 foraminiferal sample.
791-2	3 foraminiferal samples, 1 metagenomics water sample, bottom water salinity 32.6 psu.
792-1	1 foraminiferal sample.
792-2	Sandy mud, 3 foraminiferal samples, 1 metagenomics water sample, bottom water salinity 32.0 psu.
793-1	1 foraminiferal sample.
793-2	Sandy mud, 3 foraminiferal samples, 1 amoebian sample.
794-1	1 foraminiferal sample.
794-2	Mud with shell debris, 2 foraminiferal samples, 1 metagenomics water sample, bottom water salinity 32.9 psu.
794-3	Core recovery 1.71 m.
795-1	Grab sample completely flushed.
795-2	1 foraminiferal sample.
795-3	3 foraminiferal samples, 1 geochemistry sample, 1 metagenomics water sample, bottom water salinity 32.5 psu.
796-1	Mud with bivalve shells, 1 foraminiferal sample.
796-2	3 foraminiferal samples, 1 amoebian sample, bottom water salinity 33.3 psu.
797-1	Silty fine sand, 1 foraminiferal sample.
797-2	3 foraminiferal samples, 1 geochemistry sample, 1 metagenomics water sample, bottom water salinity 32.9 psu.
798-1	Coarse-grained shell debris, 1 foraminiferal sample.
798-2	Box corer failed.
798-3	1 foraminiferal sample, 1 geochemistry sample, 1 metagenomics water sample, bottom water salinity 32.7 psu.
798-4	1 foraminiferal sample.
798-5	1 foraminiferal sample.
799-1	Coarse grained sediment with many shells, 1 foraminiferal sample.
799-2	1 foraminiferal sample, 1 geochemistry sample.
799-3	1 foraminiferal sample, 1 metagenomics water sample, bottom water salinity 33.2 psu.
799-4	1 foraminiferal sample.
800-1	Coarse to medium sand with shells, 1 foraminiferal sample.
800-2	1 foraminiferal sample.
800-3	1 foraminiferal sample.
801-1	Slightly silty medium sand, 1 foraminiferal sample.
801-2	1 foraminiferal sample.
801-3	1 foraminiferal sample.
802-1	Medium to coarse sand with abundant shell debris, 1 foraminiferal sample.
802-2	1 foraminiferal sample.
802-3	1 foraminiferal sample.
803-1	Silty medium sand with shell debris, 1 foraminiferal sample.
803-2	Box core flushed out completely
803-3	1 foraminiferal sample.
803-4	1 foraminiferal sample.
804-1	Medium sand, well sorted, 1 foraminiferal sample.
804-2	1 foraminiferal sample, 1 metagenomics water sample, bottom water salinity 32.3 psu.
804-3	1 foraminiferal sample.
805-1	Silty medium to coarse sand with pebbles and shell debris, 1 foraminiferal sample.
805-2	1 foraminiferal sample.
805-3	1 foraminiferal sample.
806-1	Silty fine sand, 1 foraminiferal sample.

Table 11.2: Sounding depth and altitude of the sea floor. The altitude of the sea floor with reference to German Reference Surface (NN) was calculated from the sounding depth and tide gauge records closest to the respective stations (Bake C - Scharhörn, Bake Z, Brokdorf, Brunsbüttel Mole 1, Cuxhaven Steubenhöft, Helgoland Südhafen, and Zehnerloch).

AL438-	Depth (m)	Altitude (m NN)
769-1	16.0	-15.3
769-2	15.7	-15.1
769-3	15.7	-15.2
769-4	15.8	-15.3
771-1	13.9	-13.5
771-2	14.2	-13.8
771-3	13.7	-13.4
771-4	13.9	-13.6
771-5	13.7	-13.5
771-6	13.7	-13.5
771-7	13.8	-13.6
772-1	16.3	-16.5
772-2	16.0	-16.2
772-3	16.1	-16.3
772-4	15.6	-15.9
773-1	11.6	-12.8
773-2	12.0	-13.2
773-2a	12.0	-13.3
773-3	11.0	-12.3
773-4	10.9	-12.2
774-1	8.0	-9.8
774-2	8.0	-9.7
774-3	8.0	-9.7
774-4	8.0	-9.7
775-1	7.7	-8.8
775-2	7.8	-8.9
775-3	7.6	-8.6
775-4	6.1	-6.9
775-5	5.7	-6.4
775-6	5.6	-6.3
776-1	13.3	-12.6
776-2	13.1	-12.3
776-3	13.0	-12.1
776-4	13.1	-12.2
776-5	12.7	-11.7
777-1	16.8	-15.3
777-2	16.5	-15.0
777-3	16.9	-15.4
777-4	17.2	-15.8
778-1	20.8	-19.4
778-2	20.5	-19.1
778-3	21.0	-19.6
778-4	20.0	-18.6
779-1	25.7	-24.9
779-1	25.7	-25.0
779-2	25.6	-24.9
779-3	25.7	-25.0
779-4	25.4	-24.8
779-5	25.3	-24.8
780-1	14.6	-14.6
780-2	14.5	-14.5
780-3	14.5	-14.7
780-4	14.4	-14.7
781-1	15.7	-16.3
781-2	15.5	-16.1
781-3	15.4	-16.1
781-4	15.4	-16.1
782-1	16.6	-17.5
782-2	16.4	-17.4
782-3	16.4	-17.5
782-4	16.5	-17.6
783-1	16.6	-18.0
783-2	16.5	-17.9
784-1	17.2	-18.9
784-2	17.2	-18.9
785-1	19.3	-21.0
785-2	19.1	-20.7
786-1	18.4	-19.9
786-2	18.5	-19.9
786-3	18.6	-19.9
786-4	18.8	-20.0
786-5	18.9	-20.0
787-1	18.7	-19.1
787-2	18.9	-19.1
787-3	19.5	-19.3
788-1	25.0	-24.3
788-2	24.9	-24.1
789-1	23.4	-22.5
789-2	23.6	-22.6
790-1	24.7	-23.6
790-2	25.0	-23.8
791-1	24.0	-22.8
791-2	24.0	-22.8
792-1	24.0	-22.8
792-2	26.0	-24.9
793-1	28.0	-27.0
793-2	28.2	-27.3
794-1	26.7	-26.0
794-2	26.0	-25.4
794-3	29.0	-28.5
795-1	27.6	-27.2
795-2	28.0	-27.7
795-3	27.3	-27.2
796-1	30.4	-30.5
796-2	30.5	-30.8
797-1	35.7	-36.3
797-2	35.6	-36.2
798-1	43.0	-43.9
798-2	42.7	-43.6
798-3	43.2	-44.2
798-4	43.0	-44.1
798-5	43.0	-44.2
799-1	47.5	-48.7
799-2	47.3	-48.6
799-3	47.3	-48.6
799-4	46.9	-48.3
800-1	46.0	-47.5
800-2	46.6	-48.2
800-3	46.9	-48.5
801-1	42.8	-44.4
801-2	42.8	-44.3
801-3	42.8	-44.3
802-1	49.2	-50.6
802-2	49.4	-50.7
802-3	49.7	-51.0
803-1	46.3	-47.4
803-2	46.1	-47.2
803-3	46.2	-47.2
803-4	45.9	-46.8
804-1	42.4	-43.0
804-2	42.6	-43.2
804-3	42.0	-42.5
805-1	44.7	-44.8
805-2	44.7	-44.8
805-3	45.0	-45.0
806-1	40.0	-39.3

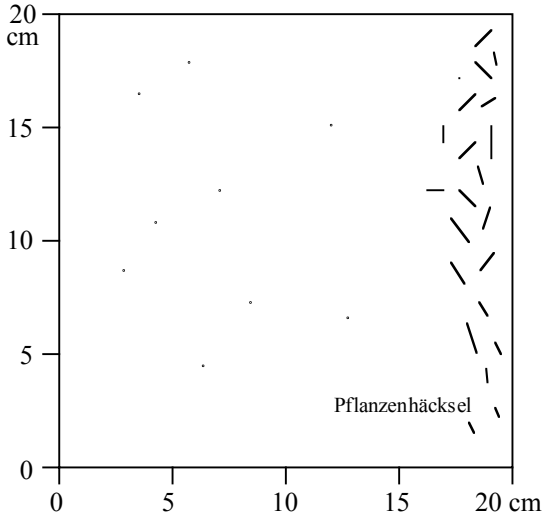
Table 11.3: Physical properties of sediment cores AL438-787-3 and AL438-794-3.

AL438-794-3 depth (cm)	Wet bulk density (g cm^{-3})	Dry bulk density (g cm^{-3})
6.0	1.68	1.16
10.5	1.49	0.83
15	1.41	0.69
20.5	1.40	0.77
24.5	1.58	0.83
30.5	1.55	0.67
35.5	1.51	0.86
40.5	1.60	0.89
45.5	1.68	1.14
50.5	1.67	0.98
55.5	1.67	1.00
60.5	1.57	0.90
65.5	1.70	1.10
70.5	1.48	0.79
75.5	1.54	0.86
81.5	1.57	0.90
85.5	1.71	1.09
90.5	1.82	1.01
95.5	1.64	1.02
100.5	1.77	1.14
105.5	1.52	0.85
110.5	1.55	0.90
115.5	1.48	0.78
120.5	1.42	0.71
125.5	1.46	0.80
130.5	1.70	1.14
135.5	1.59	0.98
140.5	1.60	0.94
145.5	1.49	0.89
150.5	1.63	1.00
155.5	1.47	0.81
160.5	1.44	0.72
164.5	1.51	0.83

AL438-787-3 depth (cm)	Wet bulk density (g cm^{-3})	Dry bulk density (g cm^{-3})
5.5	1.46	0.77
10.0	1.77	1.21
15.0	1.50	0.84
20.0	1.52	0.84
25.0	1.74	1.11
30.0	1.44	0.69
35.0	1.53	0.80
40.0	1.58	0.90
45.0	1.40	0.65
50.0	1.46	0.74
54.5	1.41	0.75
61.0	1.99	1.44
65.0	1.71	1.13
70.0	1.40	0.65
76.0	1.65	1.04
81.0	1.71	0.88
85.0	1.64	0.99
90.0	1.47	0.80

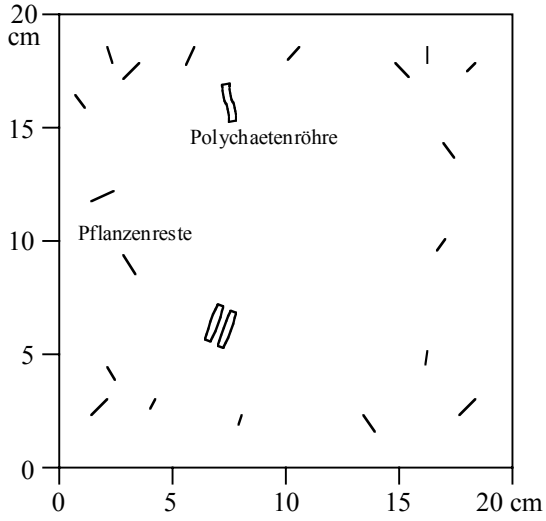
Figure 11.4: Description of box core surfaces.

AL438-769-1



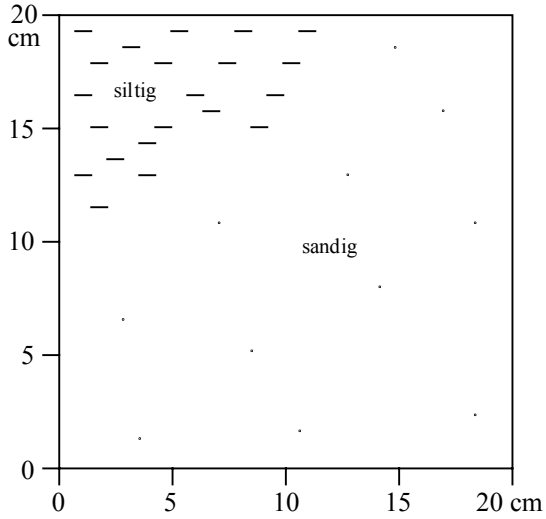
Sediment: Siltiger Sand mit kleinen Schillfragmenten.
Farbe: Olivgrün
Morphologie: Oberfläche teilweise gestört.
Organismen: Pflanzenhäcksel, auf einer Seite zusammengespült.

AL438-769-2



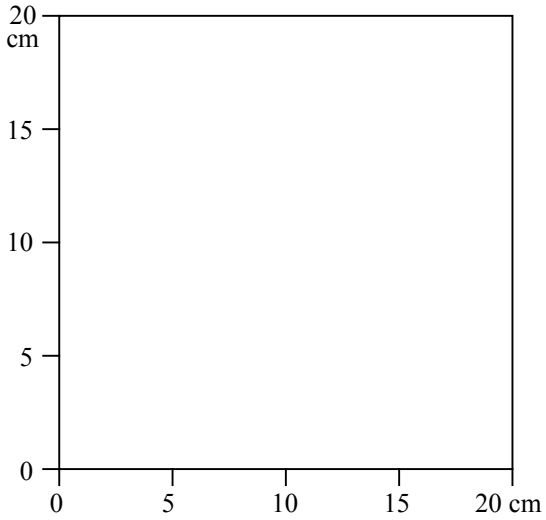
Sediment: Schwach siltiger Sand.
Farbe: Grau-olivgrün
Struktur: Gezeiten-Wechselschichtung
Morphologie: Uneben, Oberfläche geneigt mit einem Gefälle von ca. 5 cm.
Organismen: Polychaeten, Pflanzenreste

AL438-769-3



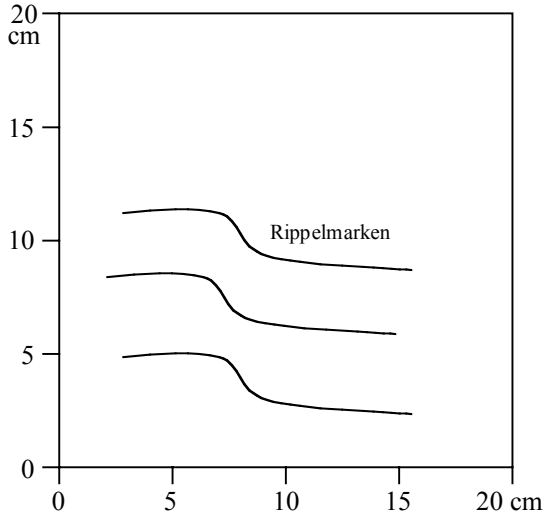
Sediment: Leicht siltiger Sand.
Farbe: Graugrün
Struktur: Gezeiten-Wechselschichtung
Morphologie: Oberfläche eben
Organismen: Organische Reste

AL438-769-4



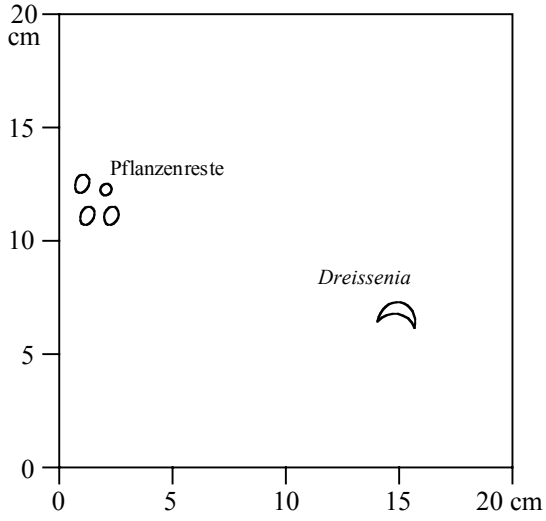
Sediment: Sand, siltig auf der Oberfläche.
Farbe: Graugrün
Struktur: Gezeiten-Wechselschichtung
Morphologie: -
Organismen: Holzstück

AL438-771-3



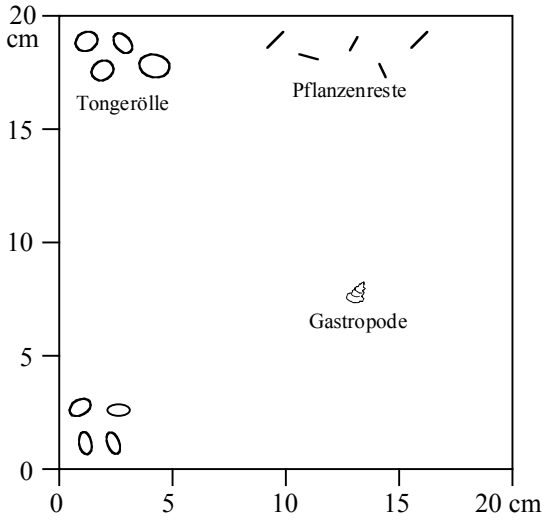
Sediment: Mittelsand, gut sortiert
Farbe: Beigebraun
Struktur: Rippelmarken
Morphologie: -
Organismen: -

AL438-771-4



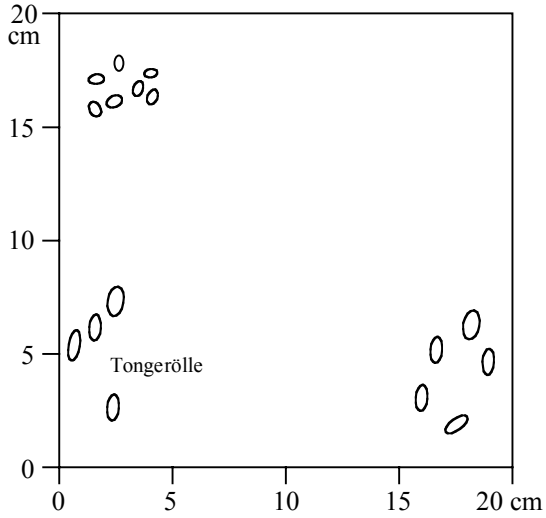
Sediment: Mittelsand, gut sortiert.
Farbe: Beige-Graubraun
Struktur: -
Morphologie: Leicht unebene Oberfläche.
Organismen: Muschel (*Dreissenia*), Pflanzenreste.

AL438-771-5



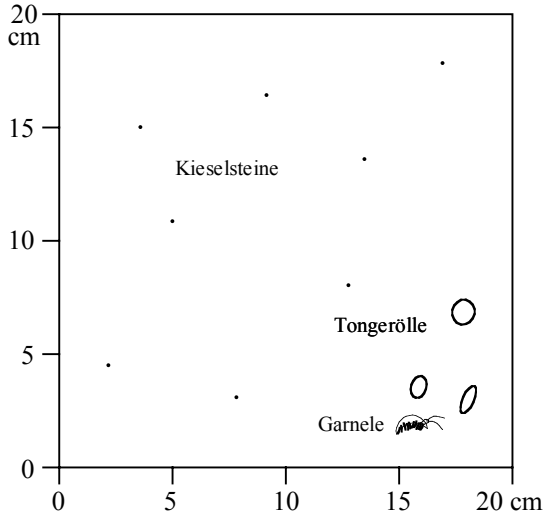
Sediment: Gut sortierter Mittelsand mit Ton-Intraklasten.
Farbe: Beige-braungrau
Struktur: -
Morphologie: leicht unebene Oberfläche.
Organismen: kleine Gastropode, Pflanzenreste.

AL438-772-1



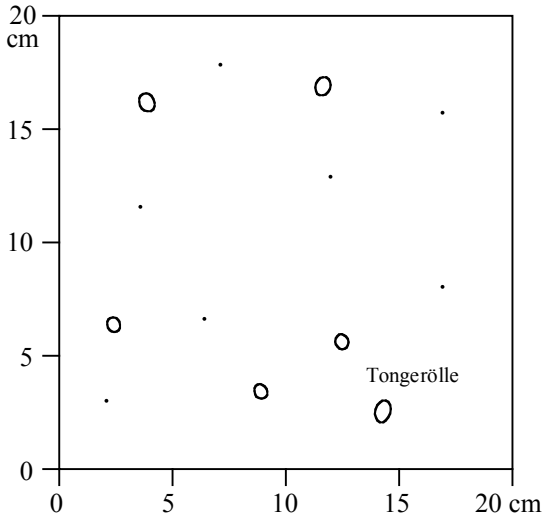
Sediment: Sand, mit tonigen Intraklasten.
Farbe: Graubraun
Struktur: Intraklasten
Morphologie: -
Organismen: -

AL438-772-2



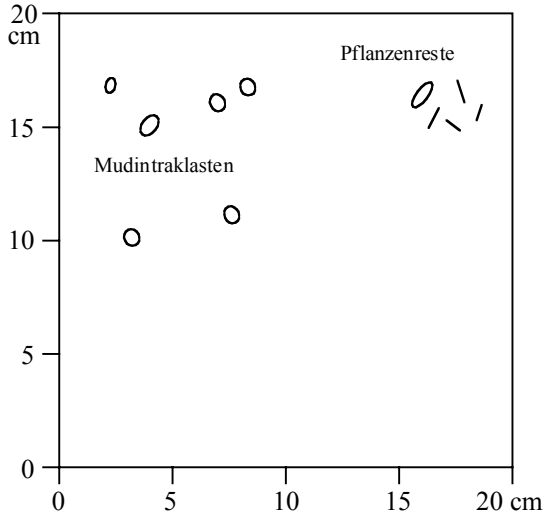
Sediment: Mittel- bis Grobsand, Ton-Intraklasten, einige Kieselsteine.
Farbe: Grau-beigebraun
Struktur: Dunkle Schicht mit Pflanzenresten.
Morphologie: Oberfläche uneben.
Organismen: Gamele

AL438-772-3



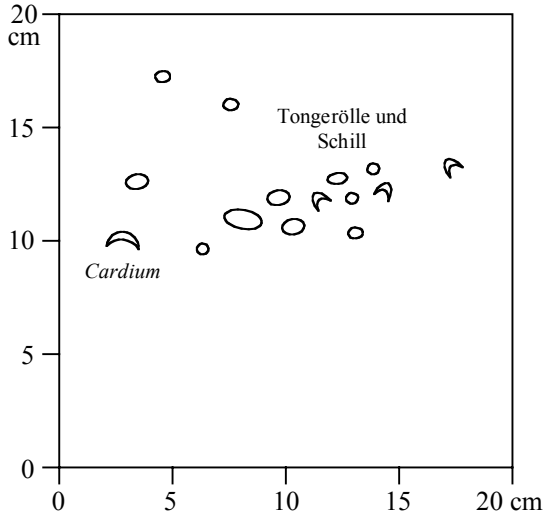
Sediment: Mittel- bis Grobsand, Ton-Intraklasten, Kieselsteine.
Farbe: Grau-beigebraun
Struktur: Gezeiten-Wechselschichtung mit Konzentration von Pflanzenresten.
Morphologie: -
Organismen: -

AL438-772-4



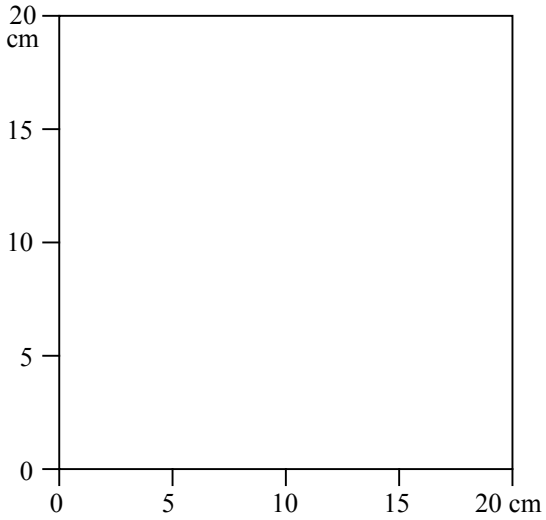
Sediment: Mittel- bis Grobsand, Ton-Intraklasten.
Farbe: Grau-beigebraun
Struktur: Gezeiten-Wechselschichtung mit Konzentration von Pflanzenresten.
Morphologie: -
Organismen: einige Molluskenfragmente.

AL438-773-1



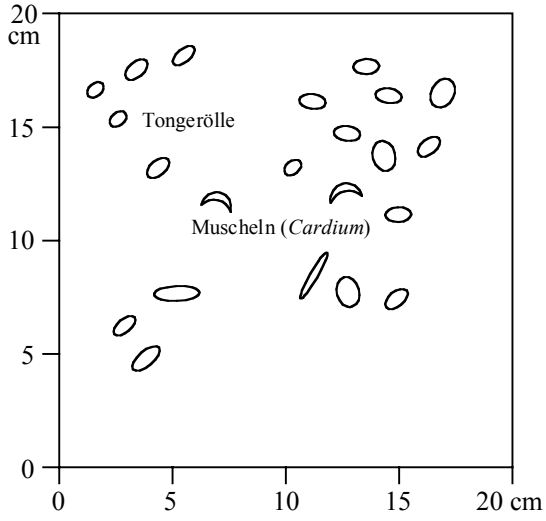
Sediment: Feinsand, Ton-Intraklasten, Pflanzenreste.
Farbe: Braungrau
Struktur: -
Morphologie: Oberfläche geneigt und teilweise ausgespült.
Organismen: kleine Schillfragmente (*Cardium*).

AL438-773-3



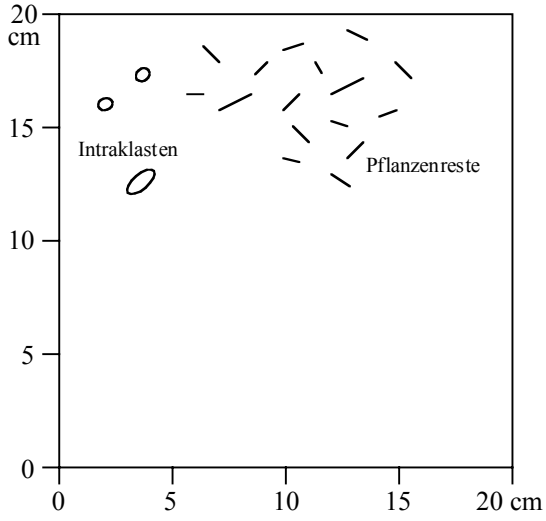
Sediment: Feinsand, einige Intraklasten, Pflanzenreste.
Farbe: Graubraun
Struktur: -
Morphologie: Oberfläche leicht uneben.
Organismen: Muschel (*Cardium*)

AL438-773-4



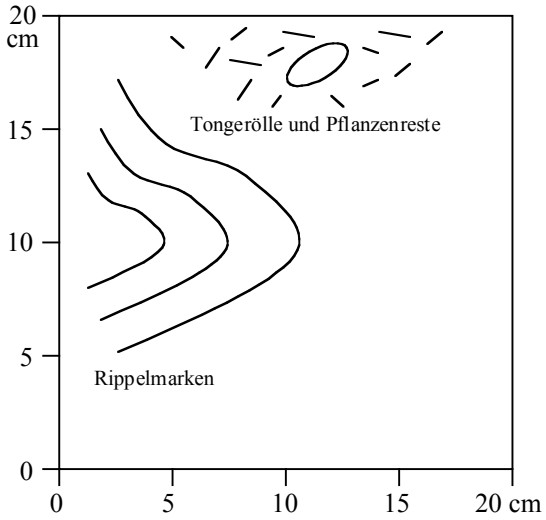
Sediment: Feinsand, viele Ton-Intraklasten,
Pflanzenreste.
Farbe: Graubraun
Struktur: -
Morphologie: Oberfläche leicht uneben.
Organismen: einige Muscheln (*Cardium*).

AL438-774-2



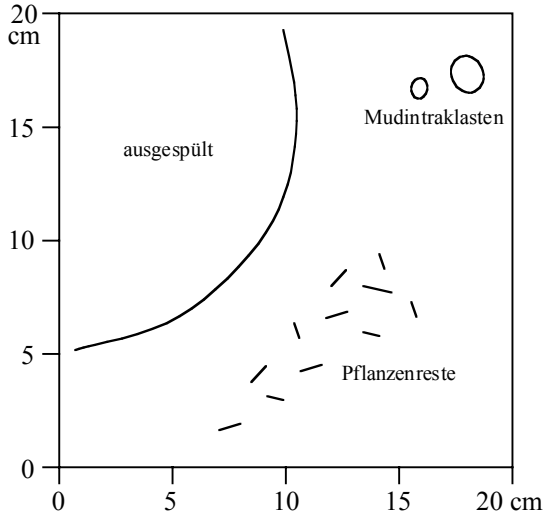
Sediment: Siltiger Sand, gut sortiert, einige Intraklasten,
Pflanzenreste.
Farbe: Braun-olivgrün
Struktur: -
Morphologie: -
Organismen: -

AL438-774-3



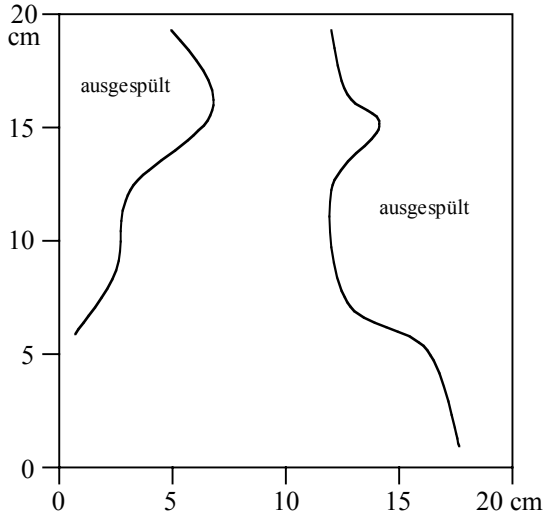
Sediment: Siltiger Sand, gut sortiert, Ton-Intraklasten, Pflanzenreste.
Farbe: Braun-olivgrau.
Struktur: Rippelmarken
Morphologie: -
Organismen: -

AL438-774-4



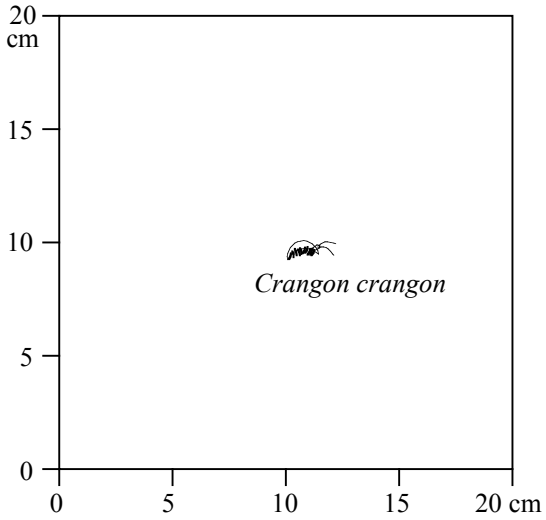
Sediment: Siltiger Sand, gut sortiert, einige Ton-Intraklasten, Pflanzenreste.
Farbe: Braun-olivgrau
Struktur: -
Morphologie: -
Organismen: -

AL438-775-1



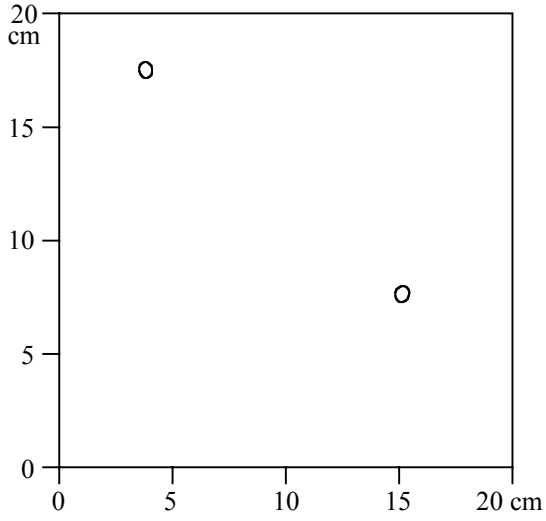
Sediment: Feinsand mit Glimmer.
Farbe: Grau-braungrün
Struktur: -
Morphologie: Sediment teilweise ausgespült.
Organismen: -

AL438-775-2



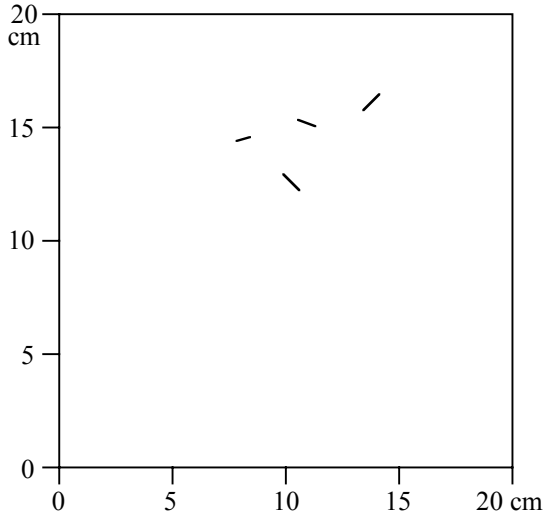
Sediment: Feinsand, gut sortiert, Pflanzenreste.
Farbe: Grün-graubraun
Struktur: -
Morphologie: -
Organismen: Garnele (*Crangon crangon*)

AL438-775-3



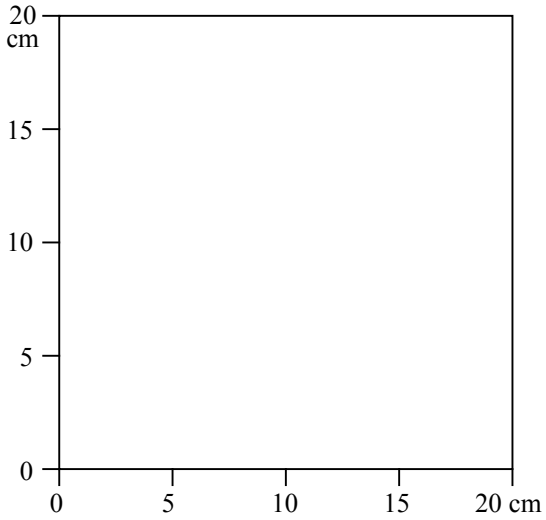
Sediment: Feinsand, gut sortiert, wenige Ton-Intraklasten.
Farbe: Grünbraun
Struktur: -
Morphologie: -
Organismen: -

AL438-775-4



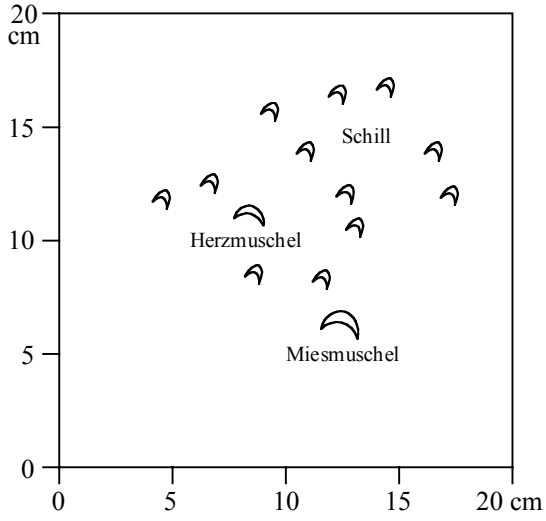
Sediment: Siltiger Feinsand, gut sortiert, mit Pflanzenresten.
Farbe: Grünbraun
Struktur: -
Morphologie: -
Organismen: -

AL438-775-6



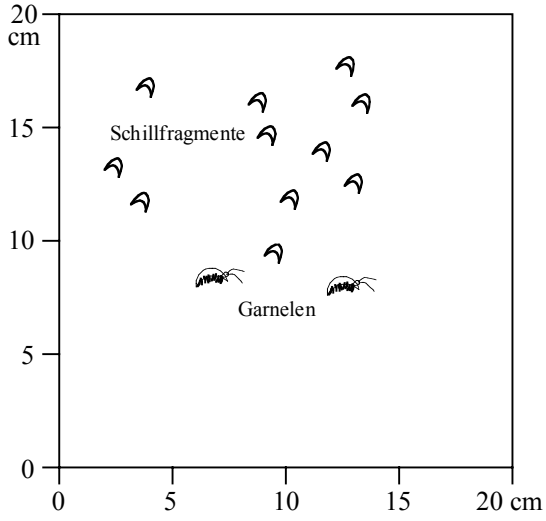
Sediment: Siltiger Feinsand, gut sortiert, wasserreich.
Farbe: Oliv-graubraun
Struktur: Sediment teilweise ausgespült.
Morphologie: -
Organismen: -

AL438-776-4



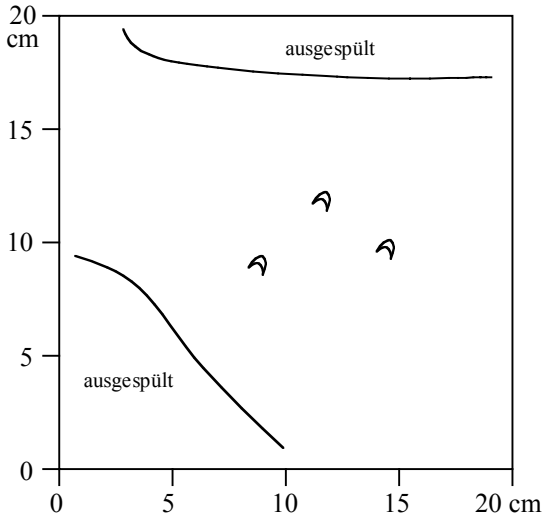
Sediment: Feinsand, gut sortiert, schillreich.
Farbe: Graugrün
Struktur: -
Morphologie: -
Organismen: Miesmuschel (*Mytilus edulis*), Herzmuschel (*Cardium*), teils komplett, teils als Schill.

AL438-776-2



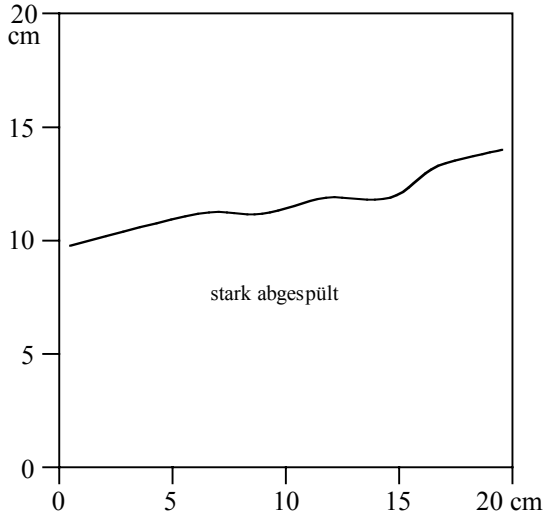
Sediment: Feinsand, sehr gut sortiert, mit Schillfragmenten.
Farbe: Grüngrau
Struktur: -
Morphologie: -
Organismen: wenige Garnelen

AL438-776-5



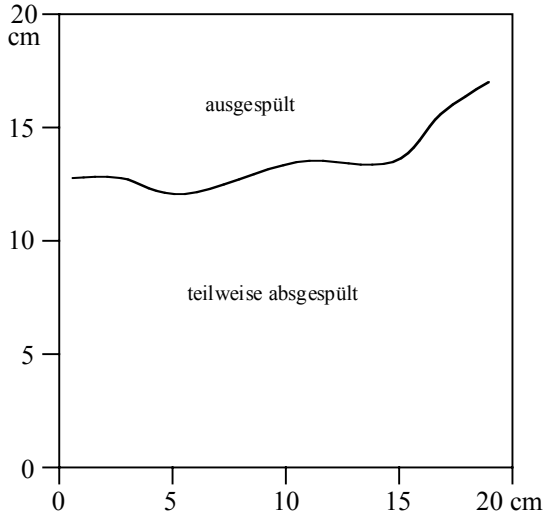
Sediment: Feinsand, gut sortiert, sehr kleine Schillfragmente.
Farbe: Grüngrau
Struktur: Eventuell ein Rippelkamm, Sediment teilweise ausgespült.
Morphologie: -
Organismen: wenige Schillfragmente.

AL438-777-2



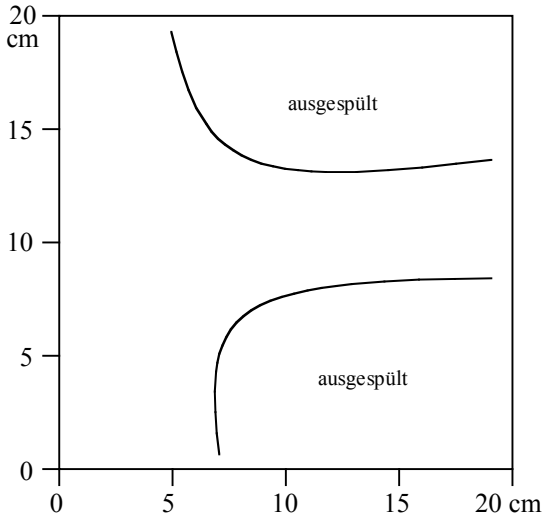
Sediment: Feinsand, gut sortiert, mit Pflanzenresten.
Farbe: Graugrün
Struktur: Oberfläche teilweise stark abgespült.
Morphologie: -
Organismen: -

AL438-777-4



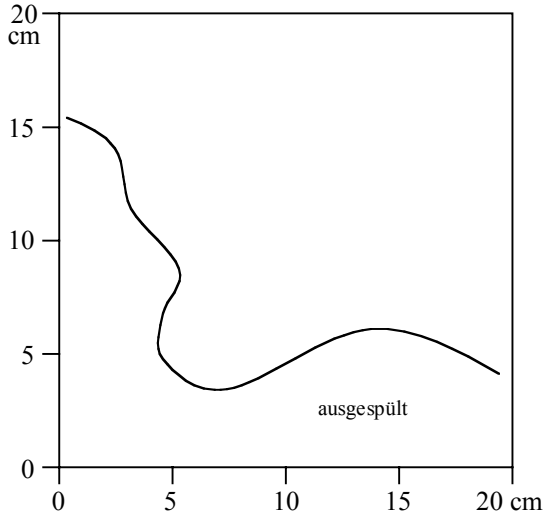
Sediment: Feinsand, gut sortiert.
Farbe: Graugrün
Struktur: Oberfläche teilweise abgespült.
Morphologie: -
Organismen: -

AL438-778-1



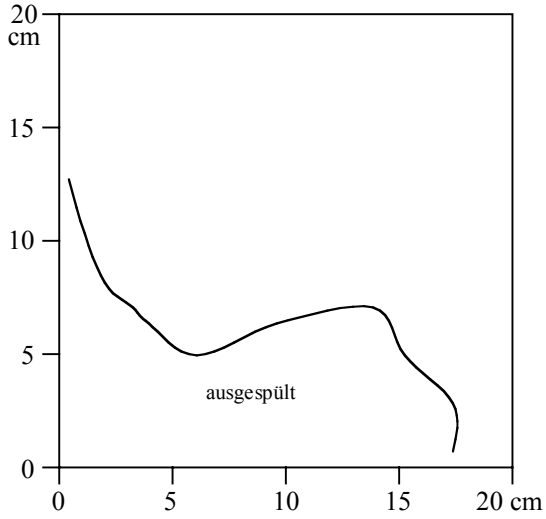
Sediment: leicht siltiger Feinsand, einige Muschelfragmente.
Farbe: Graugrün
Struktur: Sediment teilweise ausgespült.
Morphologie: -
Organismen: -

AL438-778-2



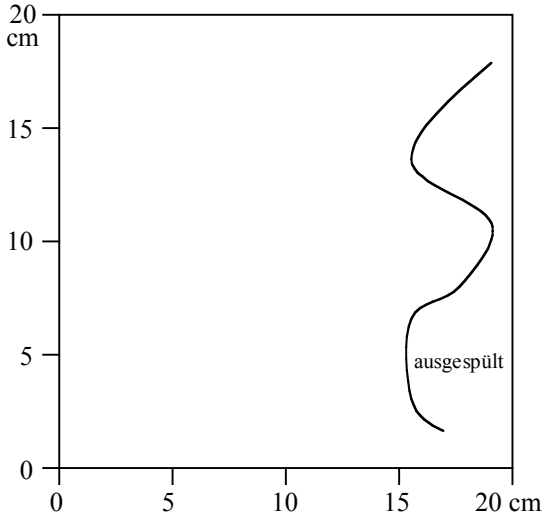
Sediment: Feinsand, gut sortiert, einige Muschelfragmente.
Farbe: Graugrün
Struktur: Sediment teilweise ausgespült.
Morphologie: -
Organismen: Schwertmuschel (*Ensis*), Polychaeten.

AL438-778-3



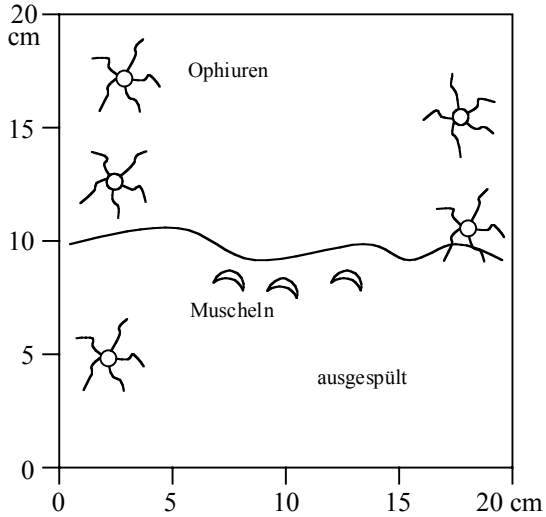
Sediment: Feinsand, gut sortiert, mit einigen Muschelfragmenten.
Farbe: Grauoliv
Struktur: Sediment teilweise ausgespült.
Morphologie: Oberfläche leicht geneigt
Organismen: -

AL438-778-4



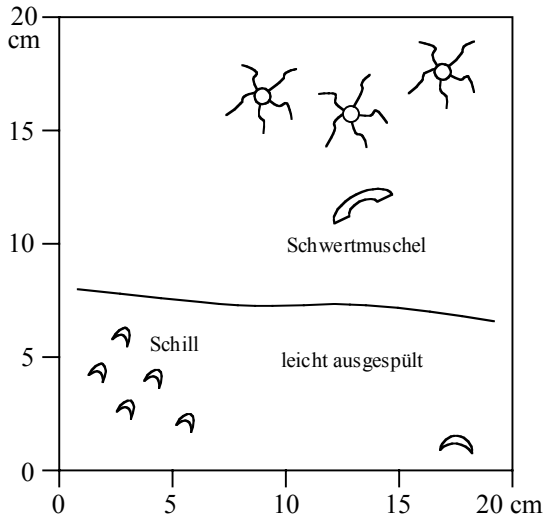
Sediment: Leicht siltiger Feinsand, einige Muscheln.
Farbe: Graugrün
Struktur: Sediment teilweise ausgespült.
Morphologie: Oberfläche leicht uneben.
Organismen: Schwertmuschel (*Ensis*)

AL438-779-3



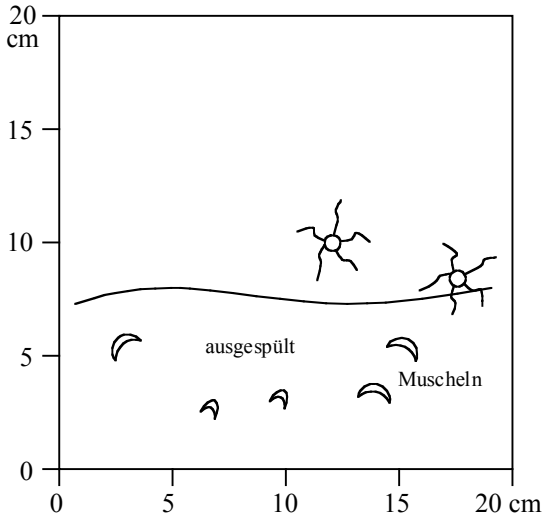
Sediment: siltiger Feinsand
Farbe: Braun-olivgrün
Struktur: Sediment teilweise ausgespült.
Morphologie: -
Organismen: Ophiuren, Muscheln.

AL438-779-4



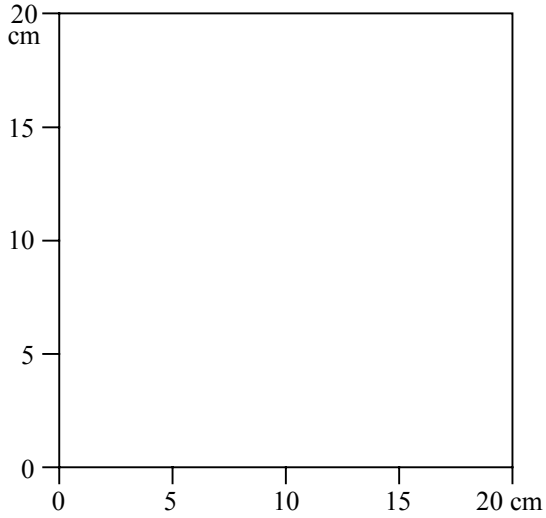
Sediment: Siltiger Feinsand
Farbe: Braun-olivgrün
Struktur: Oberflächensedimen teilweise leicht ausgespült, unterhalb von 1 cm schwarz.
Morphologie: Oberfläche leicht geneigt.
Organismen: Ophiuren, Schwertmuschel (*Ensis*), Muschelfragmente.

AL438-779-5



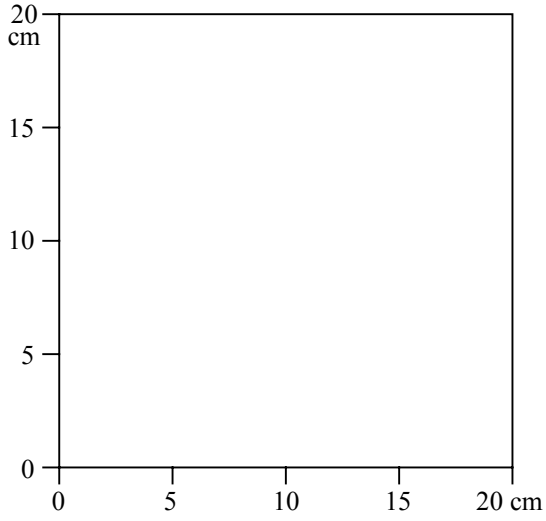
Sediment: Siltiger Feinsand
Farbe: Braun-olivgrün
Struktur: Oberfläche teilweise ausgespült, unterhalb von 1 cm schwarz bis dunkelgrün.
Morphologie: -
Organismen: Muscheln, Ophiuren, Muschelfragmente.

AL438-780-1



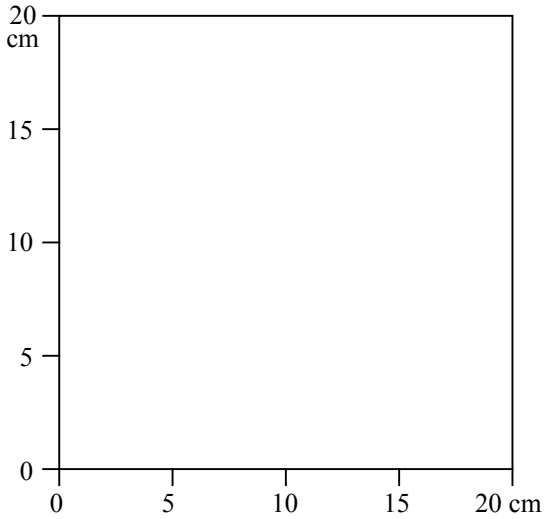
Sediment: Siltiges Sediment
Farbe: Grüngrau
Struktur: -
Morphologie: Unregelmäßig
Organismen: -

AL438-780-2



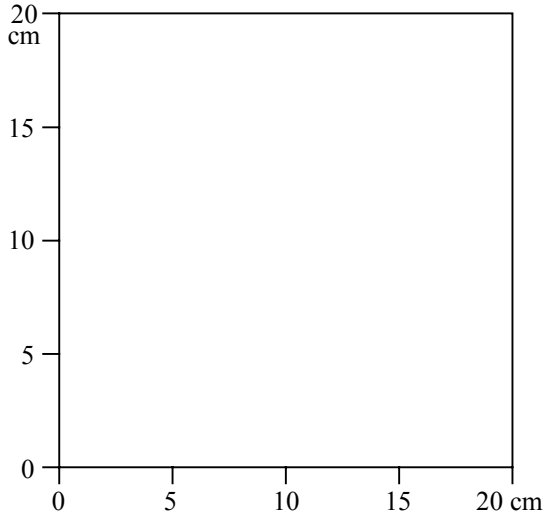
Sediment: Siltiges Sediment
Farbe: Grünbraun mit Schwarz.
Struktur: Oberfläche zerstört
Morphologie:
Organismen: Ophiuren

AL438-780-3



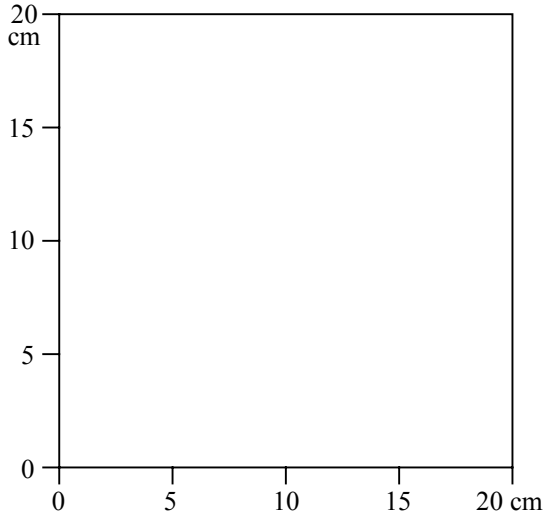
Sediment: Siltiger Feinsand
Farbe: Braungrau
Struktur: -
Morphologie: eben
Organismen: -

AL438-780-4



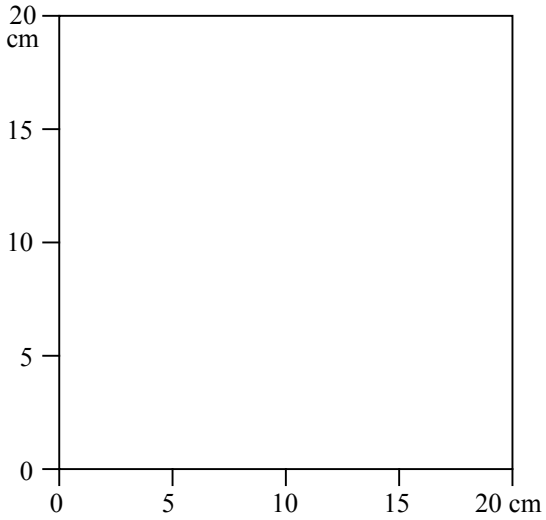
Sediment: Siltiges Sediment
Farbe: Graugrün
Struktur: -
Morphologie: -
Organismen: -

AL438-781-1



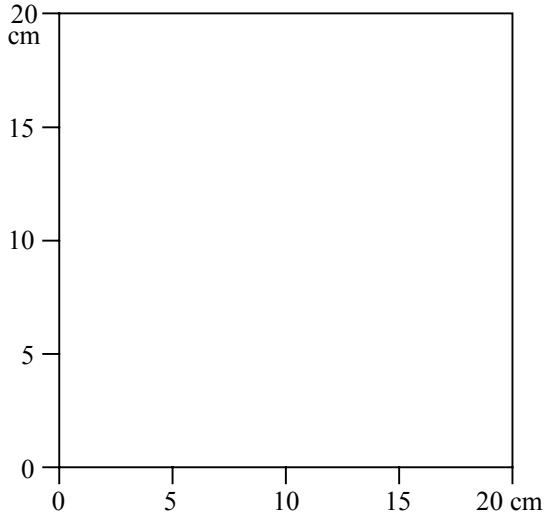
Sediment: Siltiger Sand
Farbe: Grüngraubraun
Struktur: -
Morphologie: -
Organismen: -

AL438-781-2



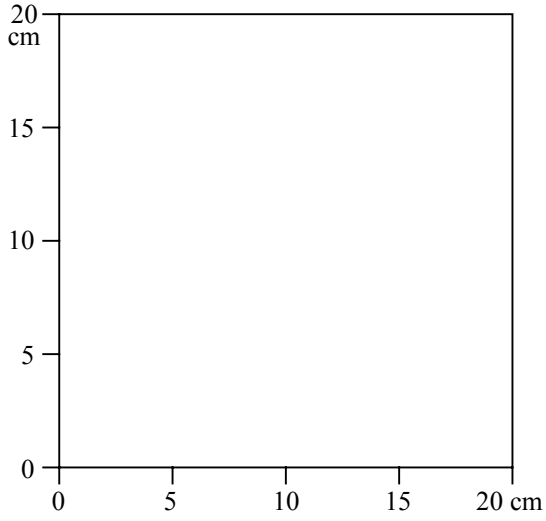
Sediment: Siltiges Sediment
Farbe: Grünbraun
Struktur: -
Morphologie: -
Organismen: -

AL438-781-3



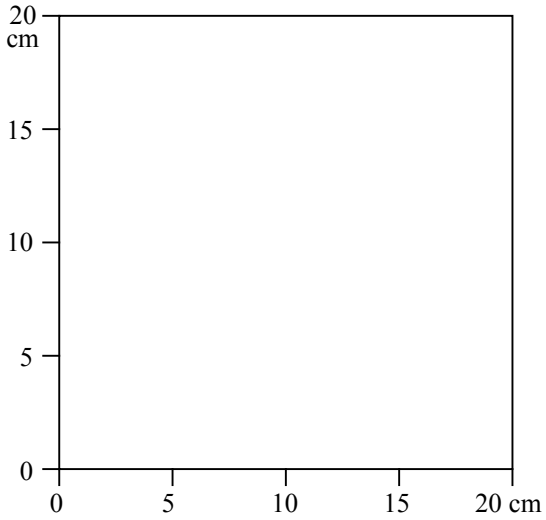
Sediment: Siltiger Feinsand
Farbe: Graugrün
Struktur: -
Morphologie: -
Organismen: -

AL438-781-4



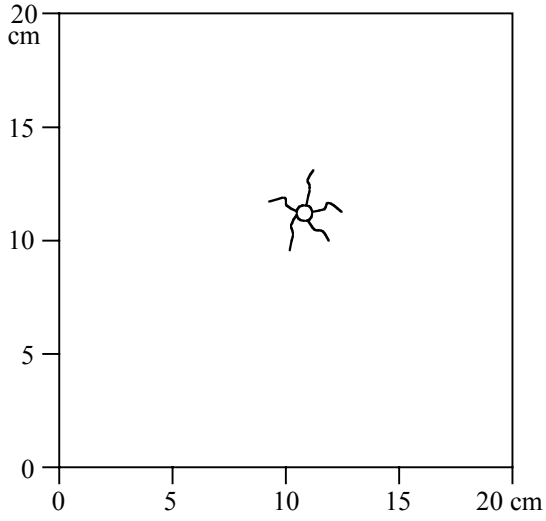
Sediment: Siltiges Sediment
Farbe: Grünbraun
Struktur: -
Morphologie: -
Organismen: -

AL438-782-1



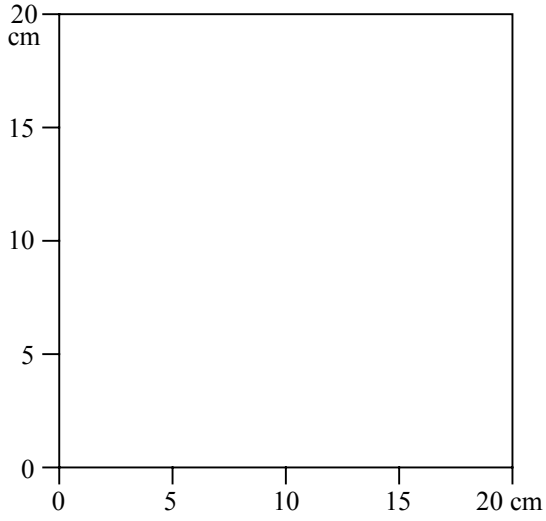
Sediment: Siltiges Sediment mit Schilllage, unterhalb 1 cm Ton (Schwarz).
Farbe: -
Struktur: zerstörte Oberfläche
Morphologie: -
Organismen: Muschelfragmente

AL438-782-2



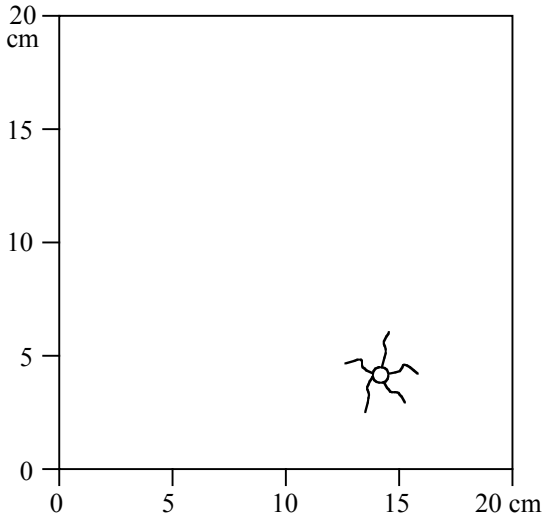
Sediment: Siltiges Sediment, nach wenigen mm anoxisch und schwarz.
Farbe: Grünbraun
Struktur: Gut erhaltene Oberfläche
Morphologie: -
Organismen: Ophiure

AL438-782-3



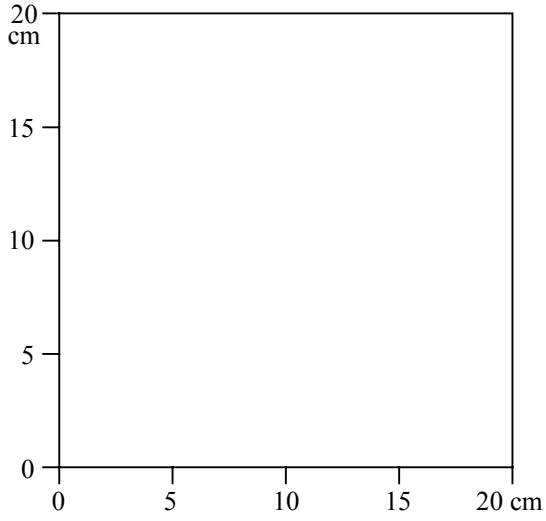
Sediment: Siltiger Sand
Farbe: Graugrün
Struktur: -
Morphologie: -
Organismen: Ophiure

AL438-782-4



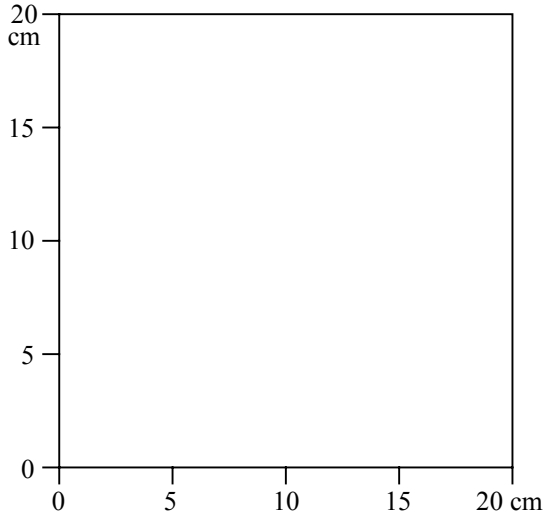
Sediment: Siltiges Sediment
Farbe: Grünbraun
Struktur: -
Morphologie: -
Organismen: Ophiure, Muschelfragmente.

AL438-783-1



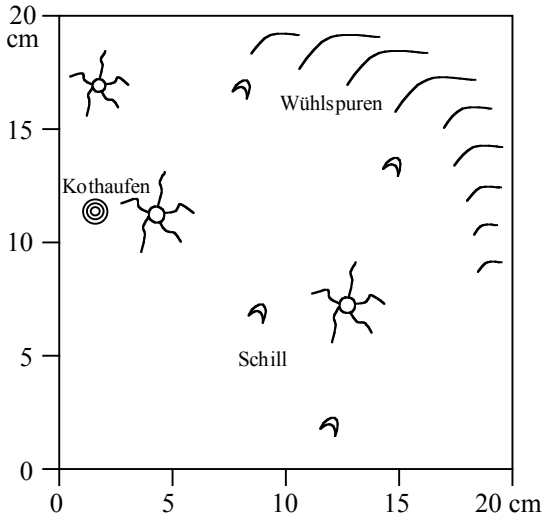
Sediment: Siltig, toniges Sediment
Farbe: Schwarz
Struktur: -
Morphologie: -
Organismen: -

AL438-784-1



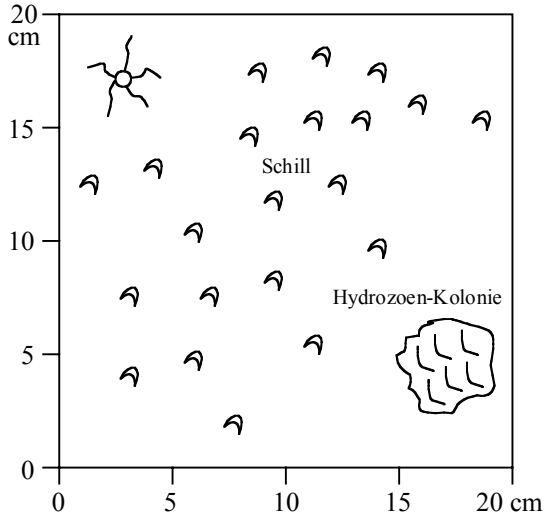
Sediment: Siltig, toniges Sediment.
Farbe: Grau/Schwarz
Struktur:
Morphologie:
Organismen:

AL438-786-3



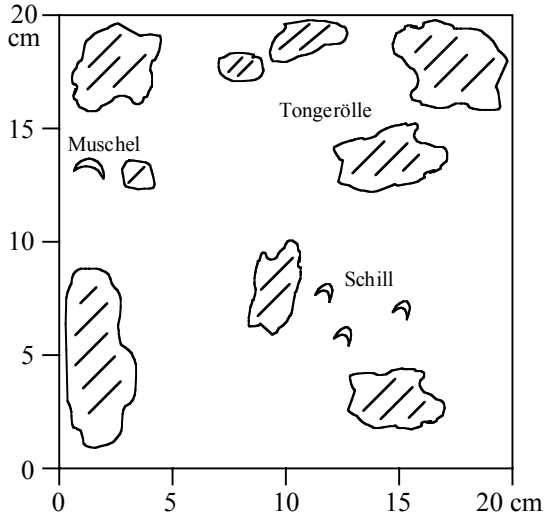
Sediment: Sandiger Schlick mit Schill, sehr weich.
Farbe: Grünlich-braun
Struktur: Wühlspuren, Kothaufen
Morphologie: Eben
Organismen: Ophiuren

AL438-786-4



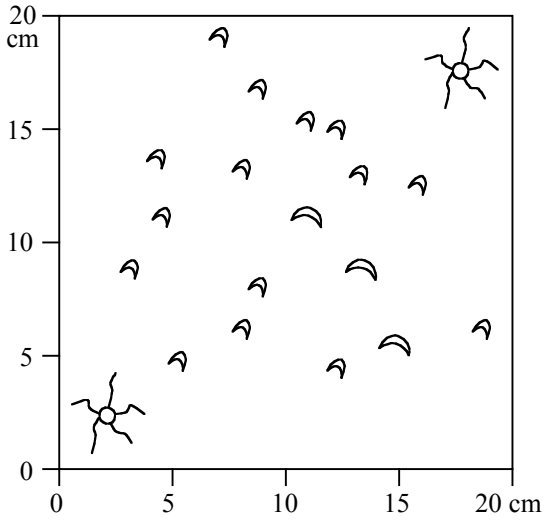
Sediment: Weicher, leicht sandiger Schlick mit viel Schill.
Farbe: Grünlich-hellbraun
Struktur: Muschelpflaster, Ophiuren-Spuren.
Morphologie: Eben, Hydrozoen-Kolonie erhöht.
Organismen: Hydrozoen, ein großer Ophiure.

AL438-786-5



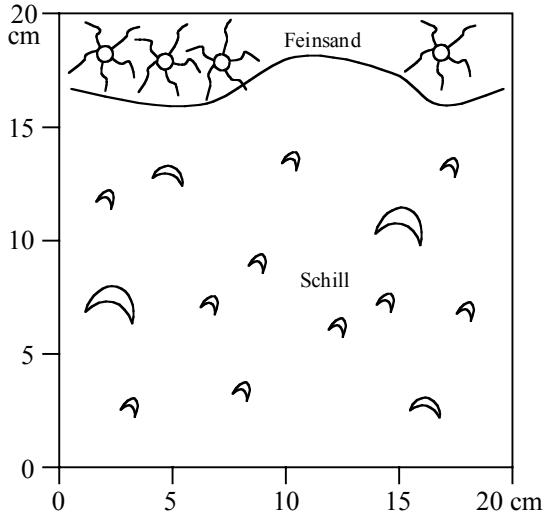
Sediment: Sehr weicher, leicht sandiger Schlick mit Tongeröllen.
Farbe: Grünlich-hellbraun
Struktur: Tongerölle, unregelmäßig mit braunen Eisenoxidresten überzogen.
Morphologie: Leicht undulös
Organismen: Muschelschill

AL438-798-3



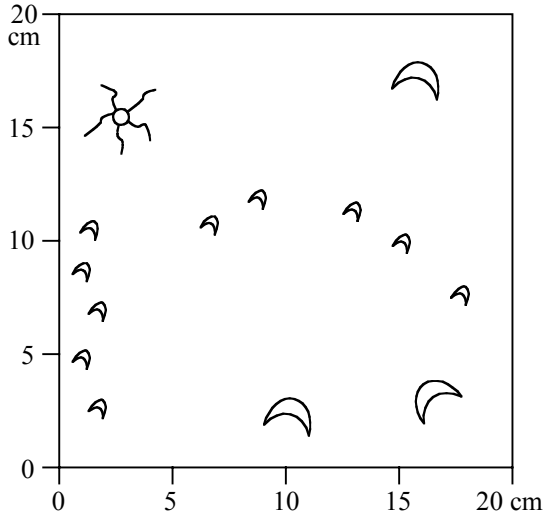
Sediment: Sand mit viel Schill.
Farbe: Braun
Struktur: -
Morphologie: -
Organismen: Ophiuren.

AL438-789-4



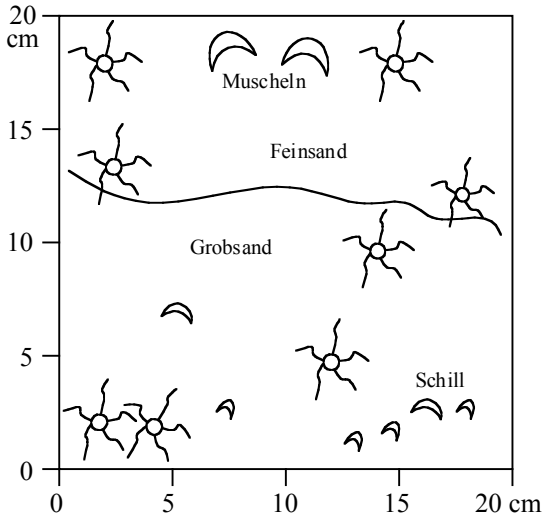
Sediment: Grobsand mit viel Schill, teilweise Feinsand.
Farbe: Graubraun
Struktur: -
Morphologie: -
Organismen: Ophiuren

AL438-798-5



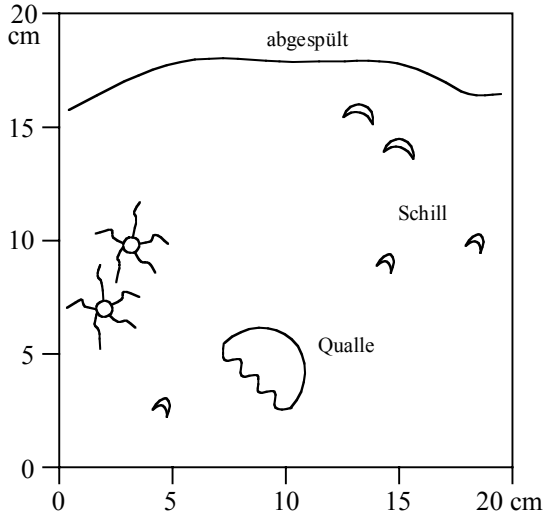
Sediment: Grob- und Feinsand mit Schill.
Farbe: Graubraun
Struktur: -
Morphologie: -
Organismen: Ophiuren, Polychaeten.

AL438-799-3



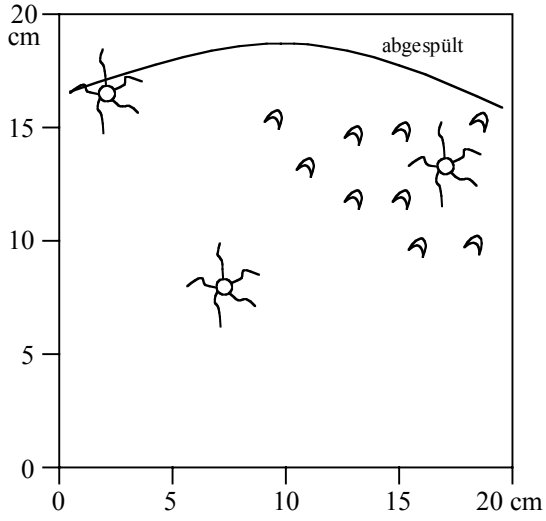
Sediment: Grob- und Feinsand mit Schill.
Farbe: Graubraun
Struktur: -
Morphologie: -
Organismen: Ophiuren

AL438-799-2



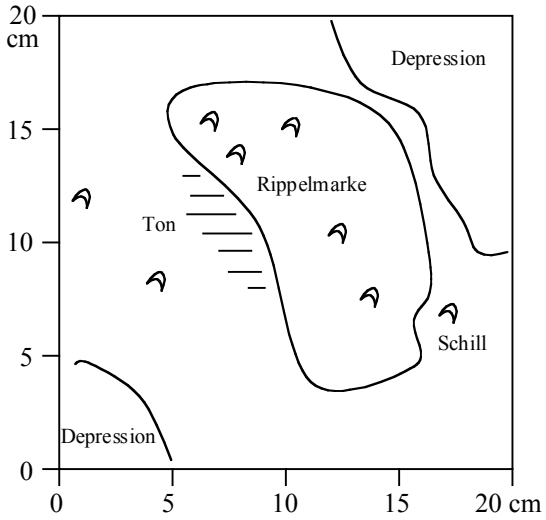
Sediment: Grobsand mit Schill.
Farbe: Graubraun
Struktur: -
Morphologie: -
Organismen: Ophiuren, Qualle.

AL438-799-4



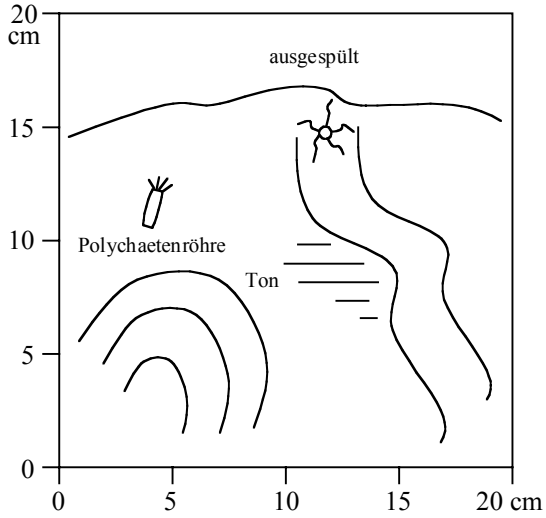
Sediment: Fein- und Grobsand, Schill.
Farbe: Braungrau
Struktur: -
Morphologie: -
Organismen: Ophiuren, Polychaeten, Crustaceen.

AL438-800-2



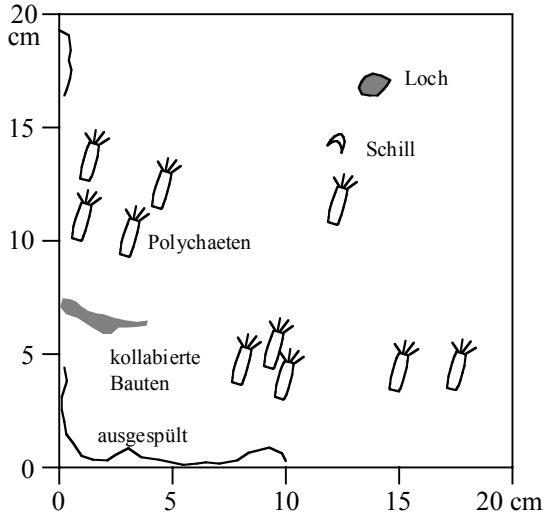
Sediment: Gut sortierter Mittel- bis Grobsand, Schill.
Farbe: Hellbraun
Struktur: Rippelmarke
Morphologie: Oberfläche geneigt und gewellt.
Organismen: -

AL438-800-3



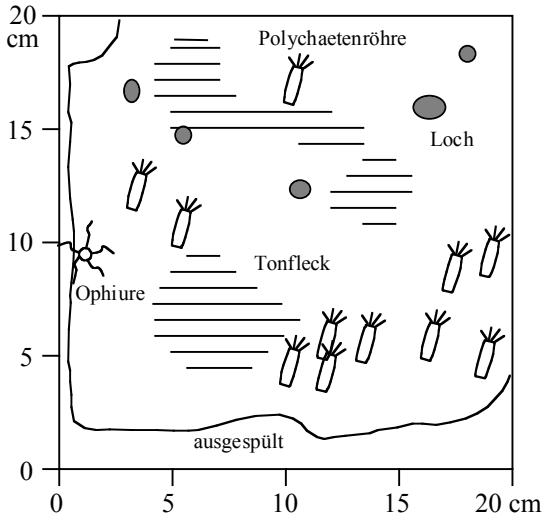
Sediment: Gut sortierter Mittel- bis Grobsand mit Schill.
Farbe: Hellbraun
Struktur: 2 Rippel im Abstand von ca. 15 cm, Tonfleck im Rippeltal.
Morphologie: -
Organismen: Ophiure, Polychaete.

AL438-801-2



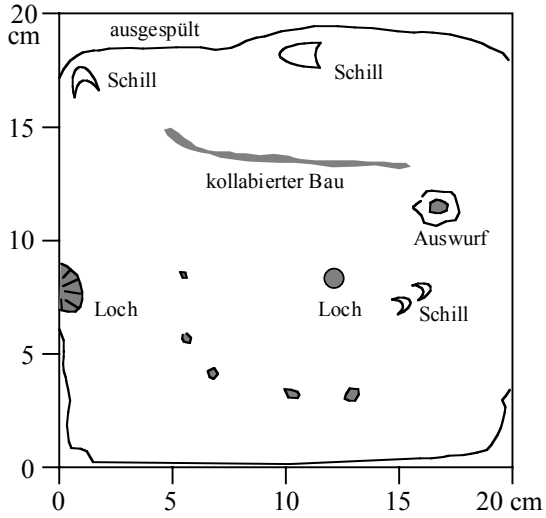
Sediment: Siltiger Mittelsand, weich
Farbe: Grünlich-hellbraun
Struktur: Kollabierte Bauten
Morphologie: Eben, Oberfläche geneigt.
Organismen: Polychaeten in Gruppen.

AL438-801-3



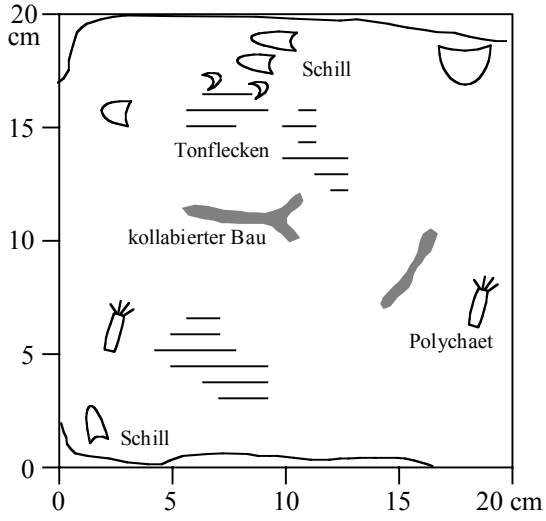
Sediment: Siltiger Mittelsand mit Tonflecken auf der Oberfläche.
Farbe: Grünlich-hellbraun
Struktur: Offene Bauten
Morphologie: Undulös im cm-Bereich durch kollabierte Bauten. Oberfläche geneigt.
Organismen: Polychaeten in Gruppen, Ophiure, Scaphopode

AL438-802-2



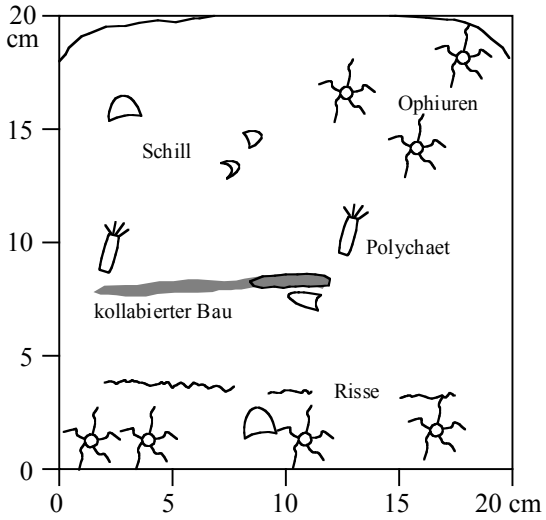
Sediment: Siltiger Mittelsand mit viel Schill
Farbe: Grünlich-hellbraun
Struktur: Kollabierte Bauten, offene Löcher, teilweise mit Auswurf.
Morphologie: Oberfläche geneigt
Organismen: Mollusken und Balaniden-Schill

AL438-802-3



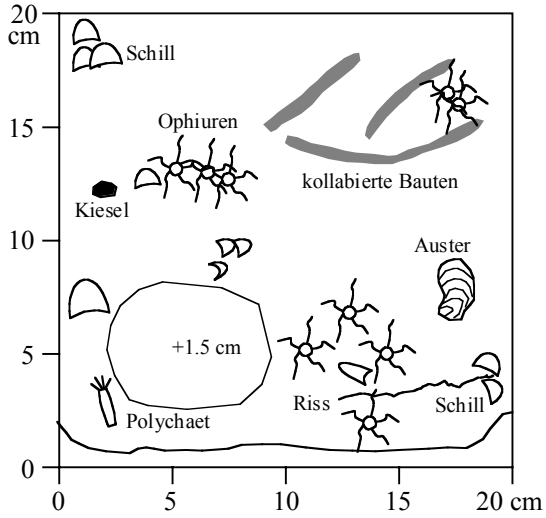
Sediment: Siltiger Mittelsand mit viel Schill
Farbe: Grünlich-hellbraun
Struktur: Viele kollabiert Bauten, Tonflecken
Morphologie: Undulös im 1 bis 2 cm Bereich, Oberfläche geneigt.
Organismen: Würmer, einige Polychaeten, Mollusken- und Balanidenschill.

AL438-803-3



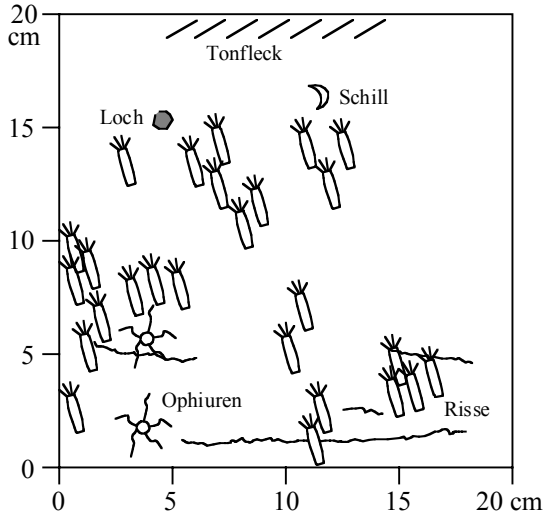
Sediment: Scharfer, schwach siltiger Mittelsand
Farbe: Grünlich-braungrau
Struktur: Kollabierte Bauten, Risse
Morphologie: Undulös im 1 - 2 cm Bereich, Oberfläche geneigt.
Organismen: Viele Ophiuren, einige Polychaeten, Mullusken- und Balanidenschill.

AL438-803-4



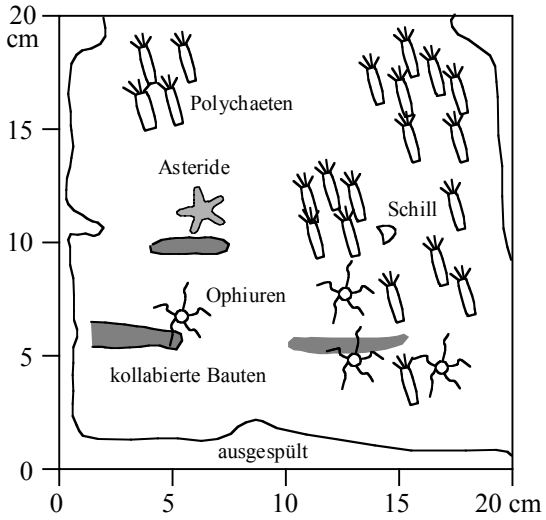
Sediment: Scharfer, gut sortierter Grobsand mit sehr viel Schill und Kieseln.
Farbe: Grünlich-beigegrau
Struktur: Kollabierte Bauten, Risse
Morphologie: Undulös im 10-cm Bereich, Erhebungen 1,5 cm hoch.
Organismen: Sehr viele Ophiuren, Polychaeten, Mollusken-, Austern- und Balanidenschill.

AL438-804-2



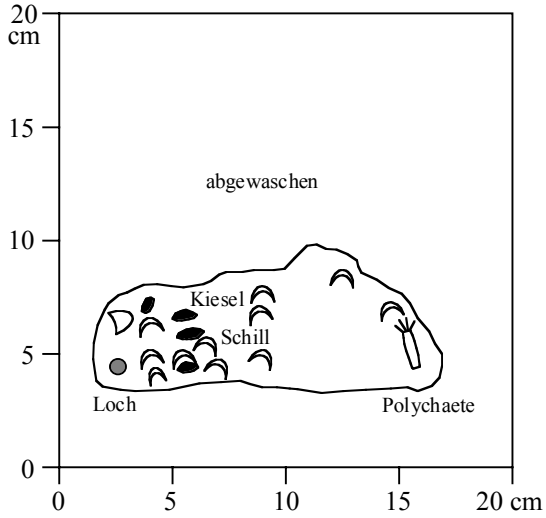
Sediment: Schwach siltiger Mittelsand mit Schill
Farbe: k.A.
Struktur: Risse
Morphologie: Eben, Oberfläche stark geneigt
Organismen: Viele Polychaeten, Ophiuren

AL438-804-3



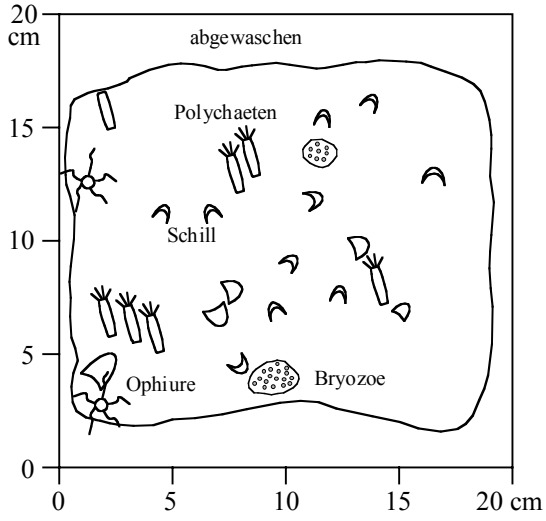
Sediment: Siltiger Mittel- bis Grobsand mit viel feinem Schill.
Farbe: Gräulich-hellbraun
Struktur: Kollabierte Bauten
Morphologie: Undulös im 1 - 2 cm Bereich, Oberfläche stark geneigt.
Organismen: Sehr viele Polychaeten, Ophiuren, ein Asteride.

AL438-805-2



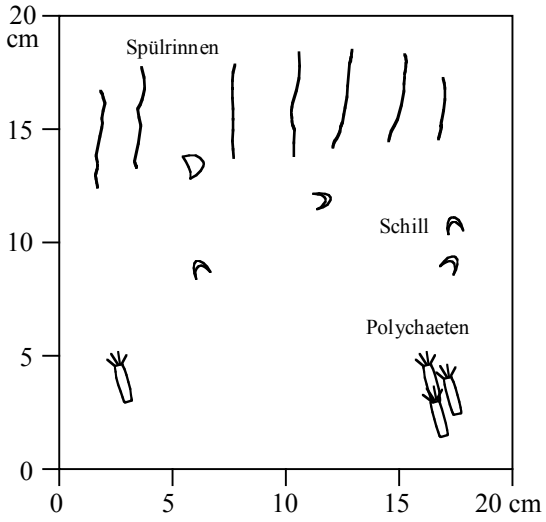
Sediment: Siltiger Grobsand, scharf, mit sehr viel Schill und Kieseln.
Farbe: Braungrün
Struktur: Offener Bau
Morphologie: Ein großer Teil des Sedimentes ist abgewaschen.
Organismen: Polychaetenröhren und Schill.

AL438-805-3



Sediment: Siltiger Mittel- bis Grobsand mit Schill und kleinen Kieseln.
Farbe: Grünlichgrau
Struktur: Schwach undulös im 1 - 2 cm Bereich, Schill in den Depressionen angereichert.
Morphologie: Oberfläche leicht geneigt
Organismen: Ophiuren, Polychaeten, kleine Bryozoen-Kolonien.

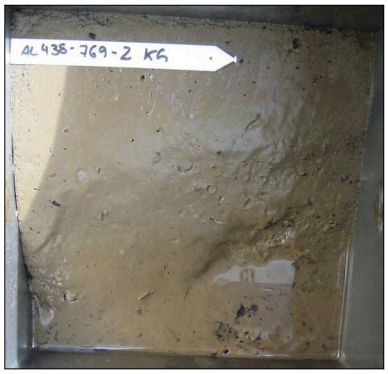
AL438-806-1



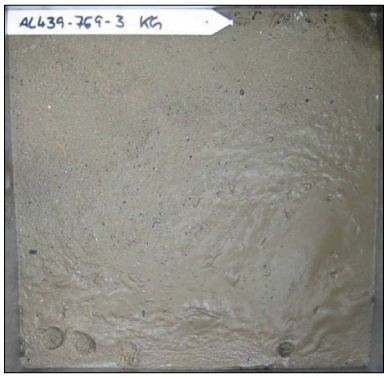
Sediment: Siltiger Feinsand
Farbe: Olivgrün
Struktur: Spülrinnen
Morphologie: Oberhalb der Spülrinnen undulös im 1 cm Bereich, Oberfläche geneigt.
Organismen: wenige Polychaeten

Figure 11.5: Photographs of box core and grab sample surfaces. Lenght of white label: 11.8 cm.

AL438-769-2

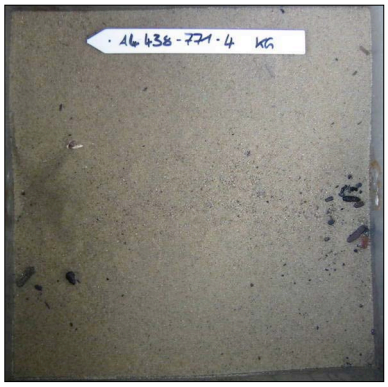


AL438-769-3



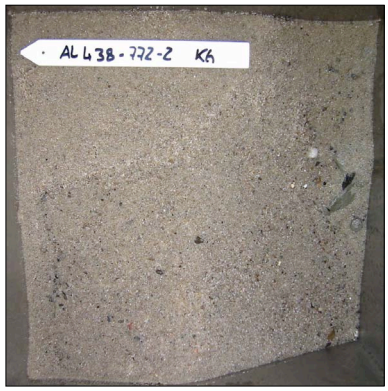
AL438-769-4

AL438-771-4

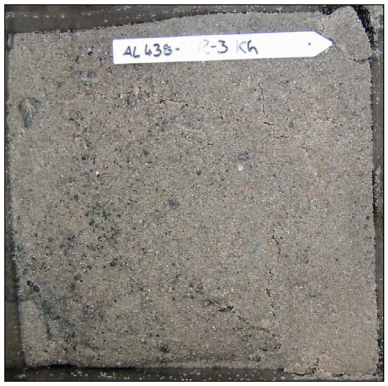


AL438-771-5

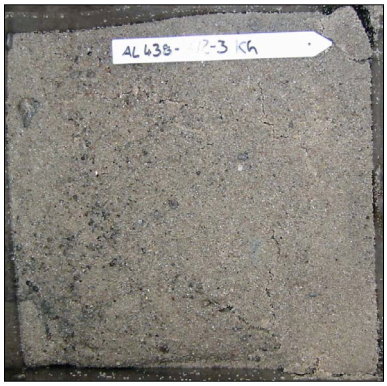
AL438-772-2



AL438-772-3

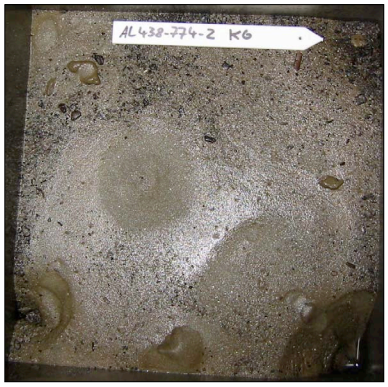


AL438-773-3



AL438-773-4

AL438-774-2



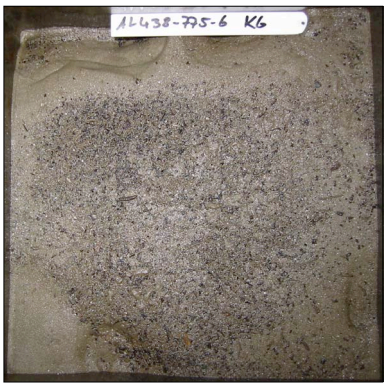
AL438-774-3

AL438-774-4

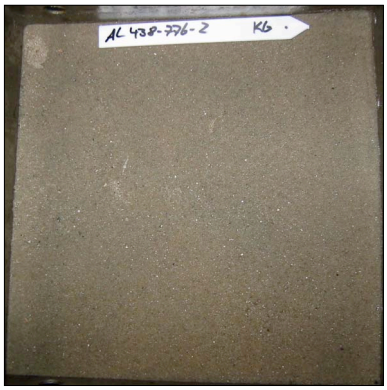
AL438-775-3

AL438-775-4

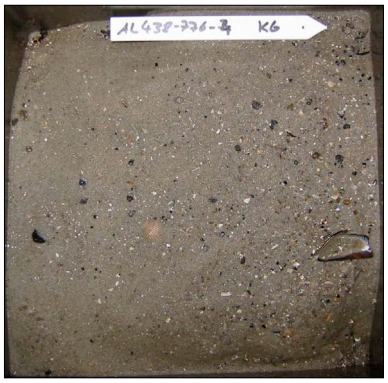
AL438-775-6



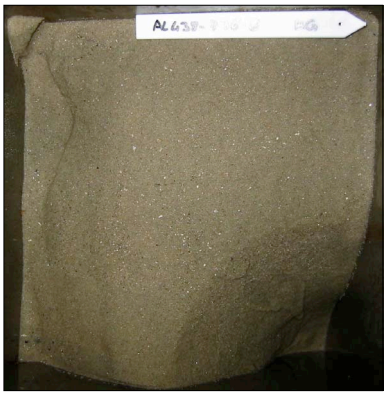
AL438-776-2



AL438-776-4



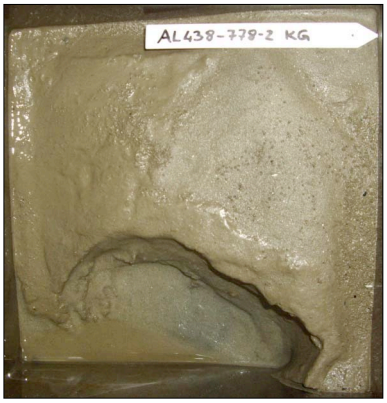
AL438-776-5



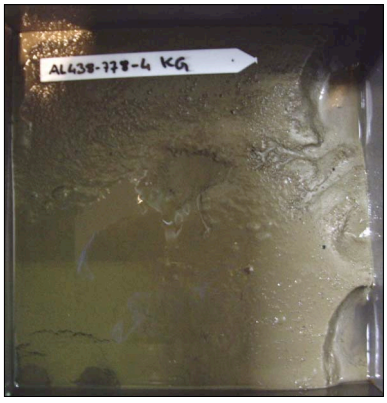
AL438-777-2

AL438-777-4

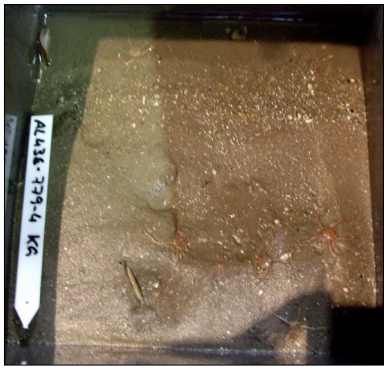
AL438-778-2



AL438-778-4

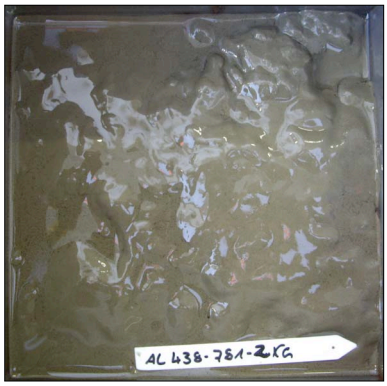


AL438-779-4



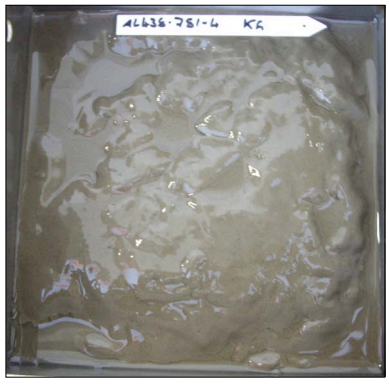
AL438-779-5

AL438-781-2

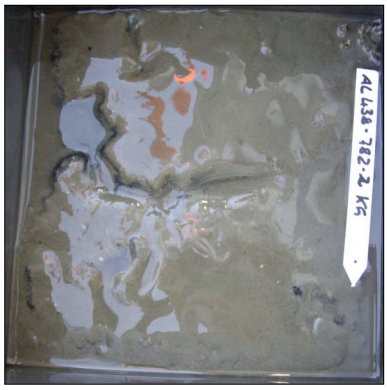


AL438-781-3

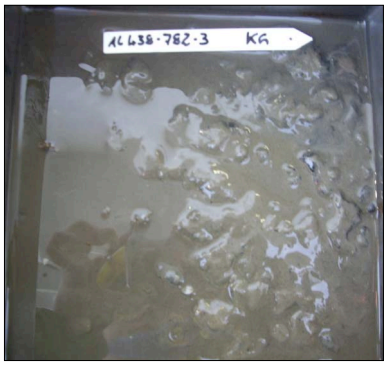
AL438-781-4



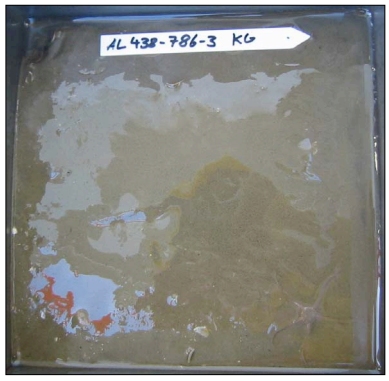
AL438-782-2



AL438-782-3



AL438-786-3



AL438-786-4

AL438-786-5

AL438-791-1

AL438-792-1

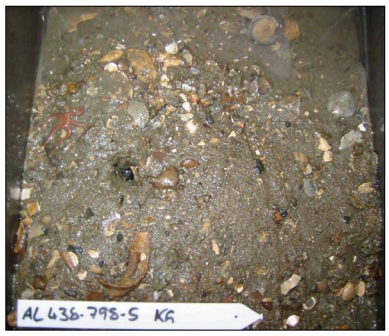
AL438-793-1

AL438-798-1

AL438-798-3

AL438-798-4

AL438-798-5

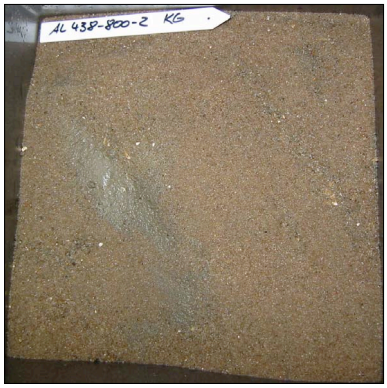


AL438-799-2

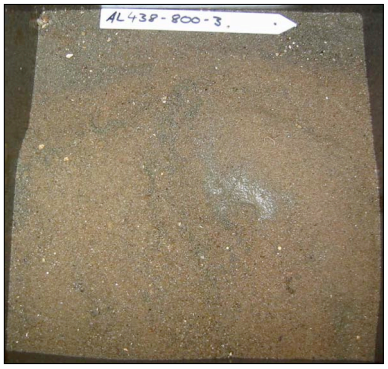
AL438-799-4

AL438-800-1

AL438-800-2



AL438-800-3



AL438-801-1

AL438-801-2

AL438-801-3

AL438-802-1

AL438-802-2

AL438-802-3

AL438-803-1

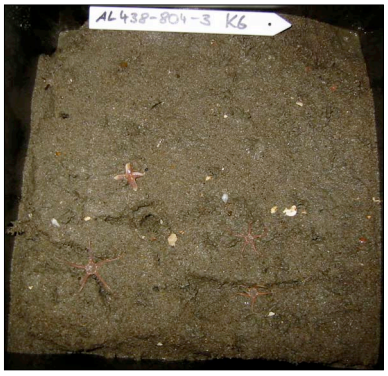
AL438-803-3

AL438-803-4

AL438-804-1

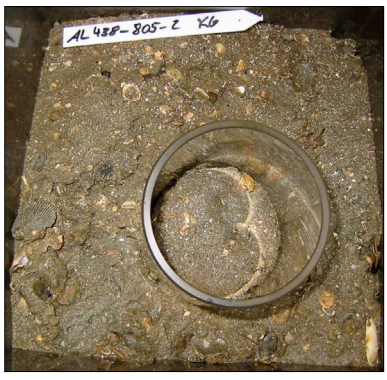
AL438-804-2

AL438-804-3



AL438-805-1

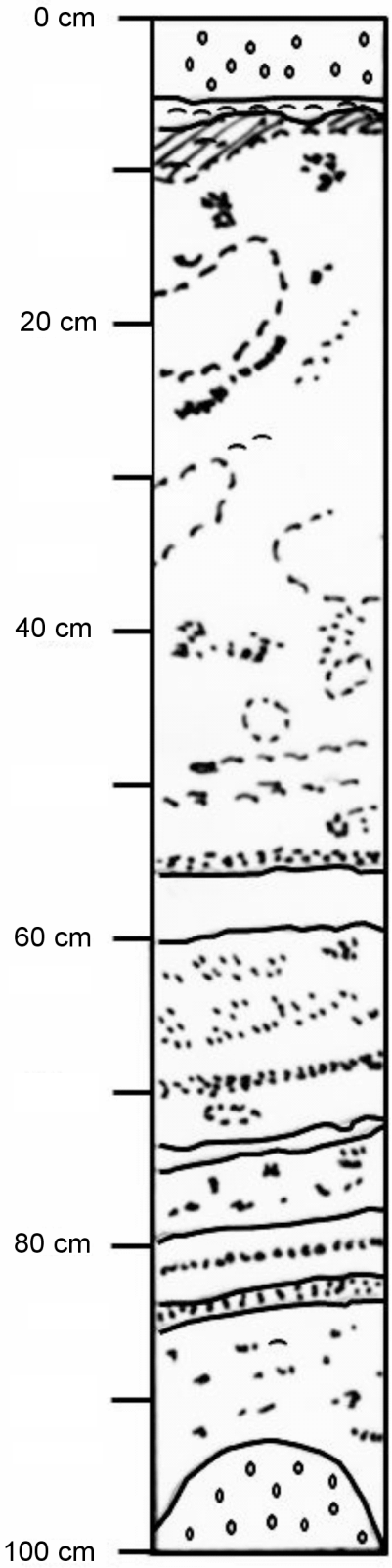
AL438-805-2



AL438-805-3

AL438-806-1

Figure 11.6: Description of core AL438-787-2.



0-5cm: Schaumstoff
5-7cm: feinsandiger Mittelsand mit Schill, dunkelgrau, 5Y 4/1
7-56cm: schwach sandiger Ton mit sandreichen Flecken und Linsen, wenig Schill, in den obersten 40cm gestörtes Gefüge, ab 48cm undeutliche Flaserschichtung an der Basis 5mm, zu einer Seite auskeilende sandreiche Linse, blaugrau, 2 GLEY 5/5B
56-60cm: Ton, homogen, blauschwarz, 2 GLEY 2,5/5PB
60-73cm: sandiger Ton mit sandreichen Flecken und Schmitzen, sandreiche Lagen bei 70-71cm, blauschwarz, 2 GLEY 5/10B
73-75cm: Ton, homogen, blauschwarz, 2 GLEY 5/10B
75-78cm: sandiger Ton, fleckig bioturbat, blauschwarz, 2 GLEY 5/10B
78-83cm: Ton, homogen, mit flaserig-sandreicher Einschaltung, blauschwarz, 2 GLEY 5/10B
83-85cm: sandiger Ton, mittelsandig, unregelmäßig bioturbat, blauschwarz, 2 GLEY 5/10B
85-93cm: mittelsandiger Ton mit sandreichen Schmitzen, blauschwarz, 2 GLEY 5/10B
93-100cm: Schaumstoff

Legende:

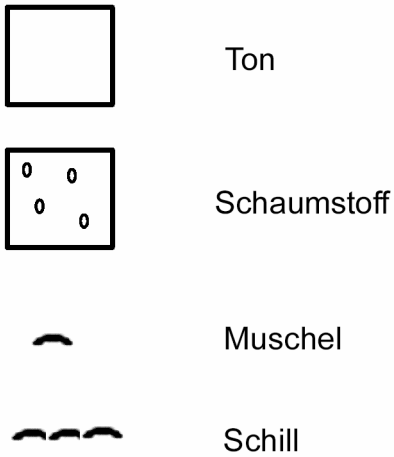


Figure 11.7: Description of core AL438-794-3.

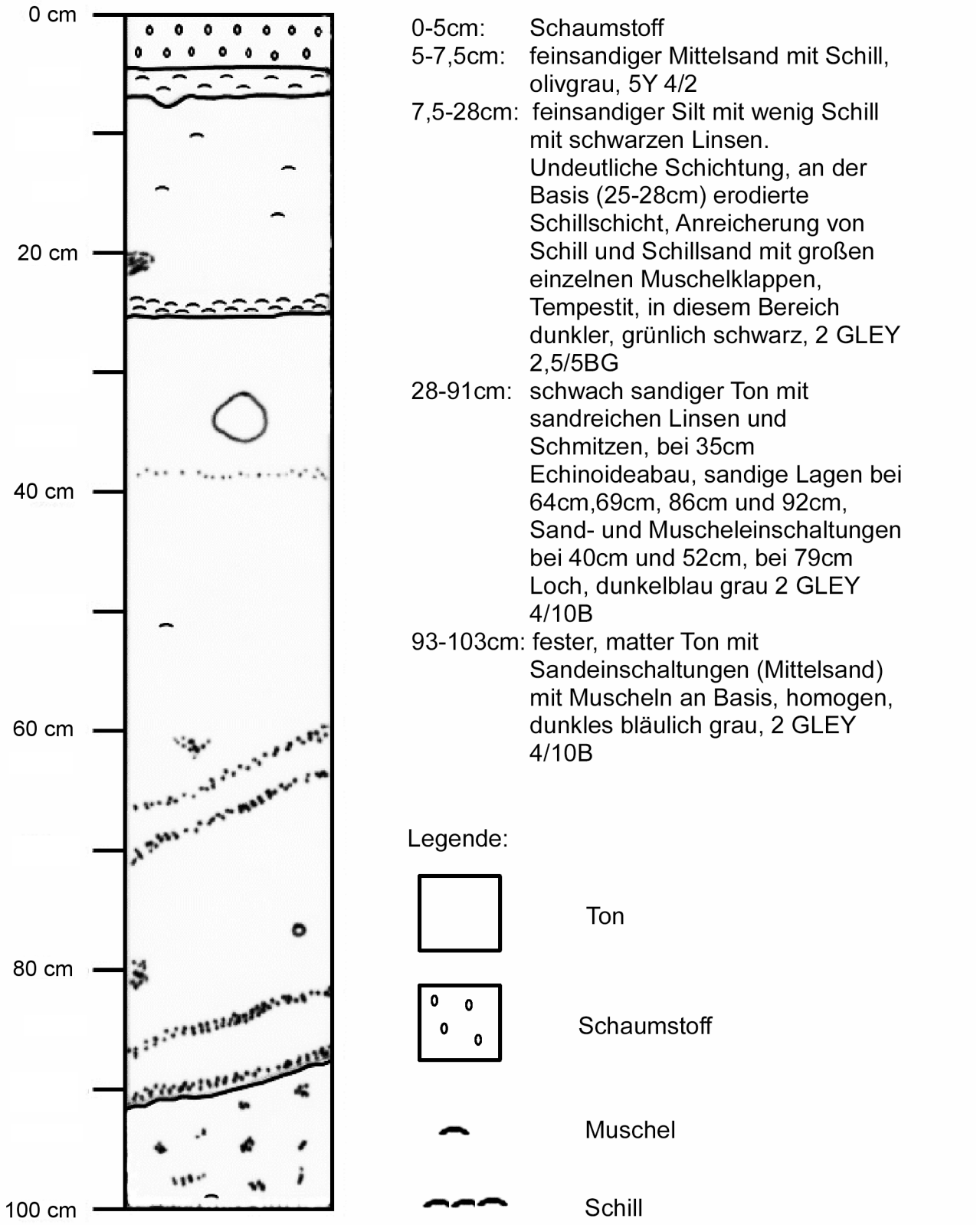


Figure 11.7: Description of core AL438-794-3 (continuation).