RV Alkor AL 396

Cruise Report

AufMod-F North Sea (west of the island of Sylt)

05th July – 19th July 2012

Institute of Geosciences
Sedimentology, Coastal- and Continental Shelf Research
Christian-Albrechts-University, Kiel

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Kiel, 19th November 2012

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1. List of participants

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IFG: Institute of Geosciences
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BSH: Federal Maritime and Hydrographic Agency (Bundesamt für Seeschiffahrt und Hydrografie), Hamburg

2. Introduction

The Cruise AL396 on the RV Alkor was accomplished as part of the KFKI (German Coastal Engineering Research Council) –project AufMod, funded by the BMBF. Main goal of AufMod is a model-based analysis of long-term morphodynamic processes in the German Bight (http://www.kfki.de/de/projekte/aktuell/aufmod). The Institute of Geosciences (IFG) is involved in AufMod-F covering the nearshore/shelf area (s. Fig. 1, where bedforms, their stability and sediment distribution patterns are the research focus. The goal is to develop and improve morphodynamic models on large-scale and long-term changes of the North Sea seafloor. Those numerical models need bathymetric and sedimentological data as basis to calculate sediment movements in the German Bight. Included in the required basis data are seafloor morphology, morphodynamics, sediment distribution patterns, dynamics and stypes, grain size compositions as well as size and characteristics of bedforms. With hydroacoustics it is possible to do large-scale and precise mapping. It also gives information about recent morphodynamics and sediment distribution and –transitions. Bedforms can only be detected and mapped by those methods.

Thus, for significant data input, hydroacoustics were used for the acquisition. Sidescan Sonar, Multibeam Echo Sounder and seismic surveys were planned complemented by grab- / box corer- and vibro corer samples for ground truthing.

Next to extensive hydroacoustic mapping, another focus of this cruise lay on the availability of potentially mobile sediments in the work area. This is a key information to be able to make statements regarding sediment dynamics in the work area. Extensive drilling was planned to get further insight into the stratigraphy.

Another focus of this cruise was laid on distinctive sorted bedforms and observations of sediment covering and penetrating by tube building worms (*Lanice conchilega*). Both features might allow new interpretations of morphodynamic developments of the seafloor and sedimentological processes. Finally, old core stations, taken from Köster in the 70'ies, should be crossed with SES tracks. Comparing the near surface reflectors with the core logs, should make it possible to correlate the cores with the seismics and gain further information and exact positions.

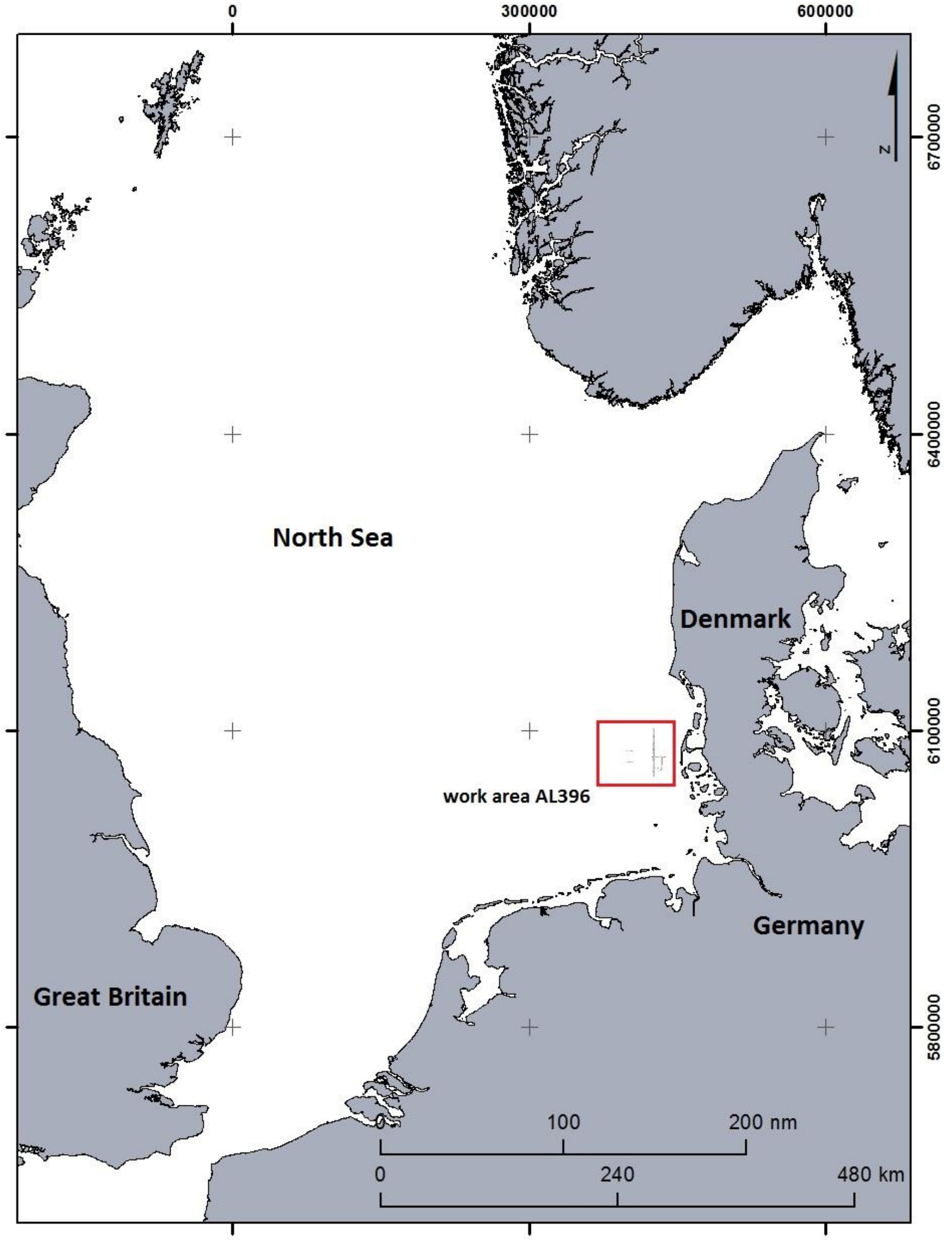

Figure 1: Work area (red frame) of cruise AL396 from 05.07.-19.07.2012 in the framework of the BMBF-funded AufMod-project (AufMod-F/ nearshore/shelf, Univ. of Kiel, K. Schwarzer). -(A. Krätschell)

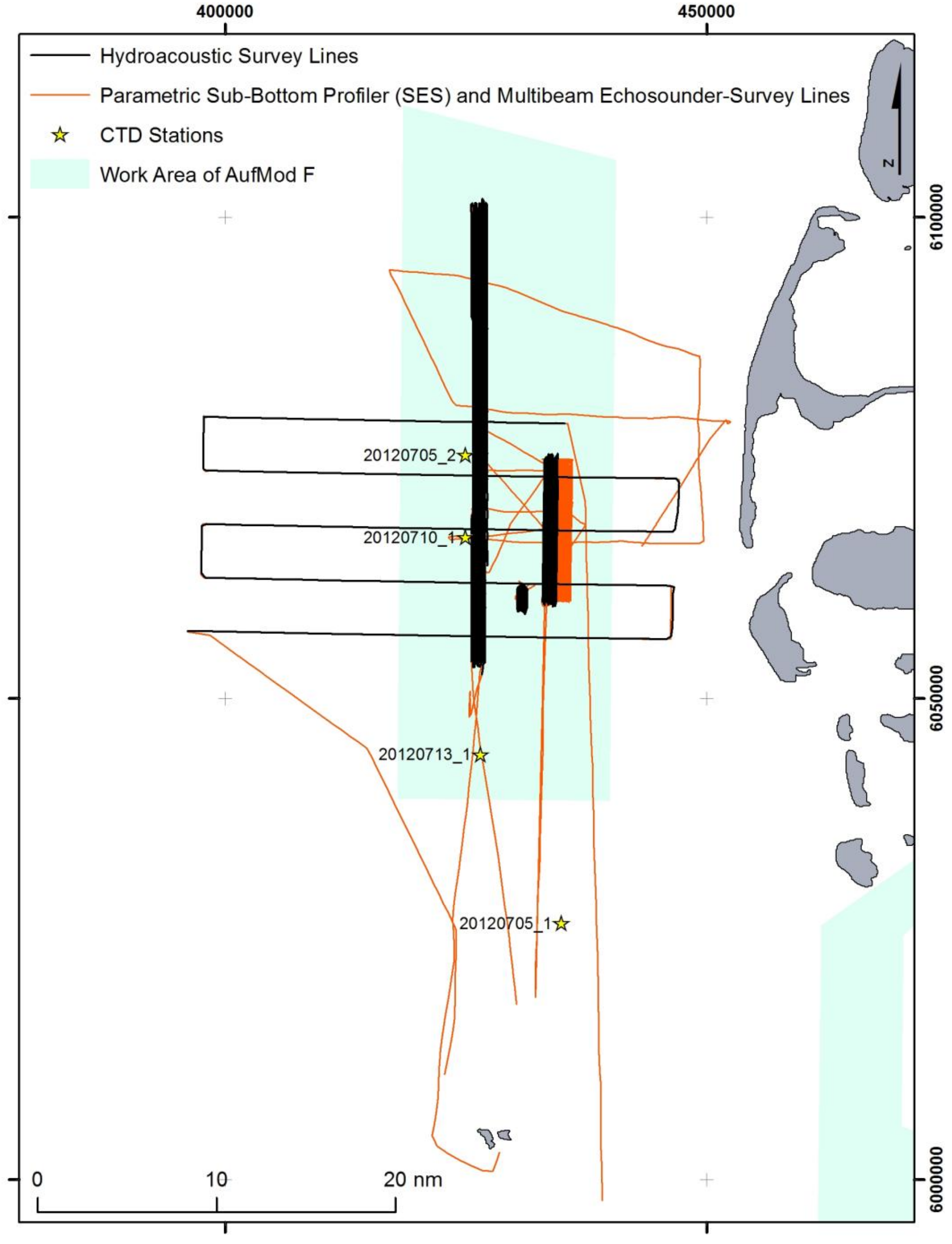

Figure 2: **Survey lines of the hydroacoustic surveys (Side Scan Sonar and Chirp Sub-Bottom Sonar, Boomer Seismics) and the Parametric Sub-Bottom Profiler (SES) together with the Multibeam Echosounder (MBES). The hull mounted SES and the MBES have been deployed longer than the other hydroacoustic instruments during relatively unfavourable weather conditions. CTD Stations are displayed with labels. - (A. Krätschell)**

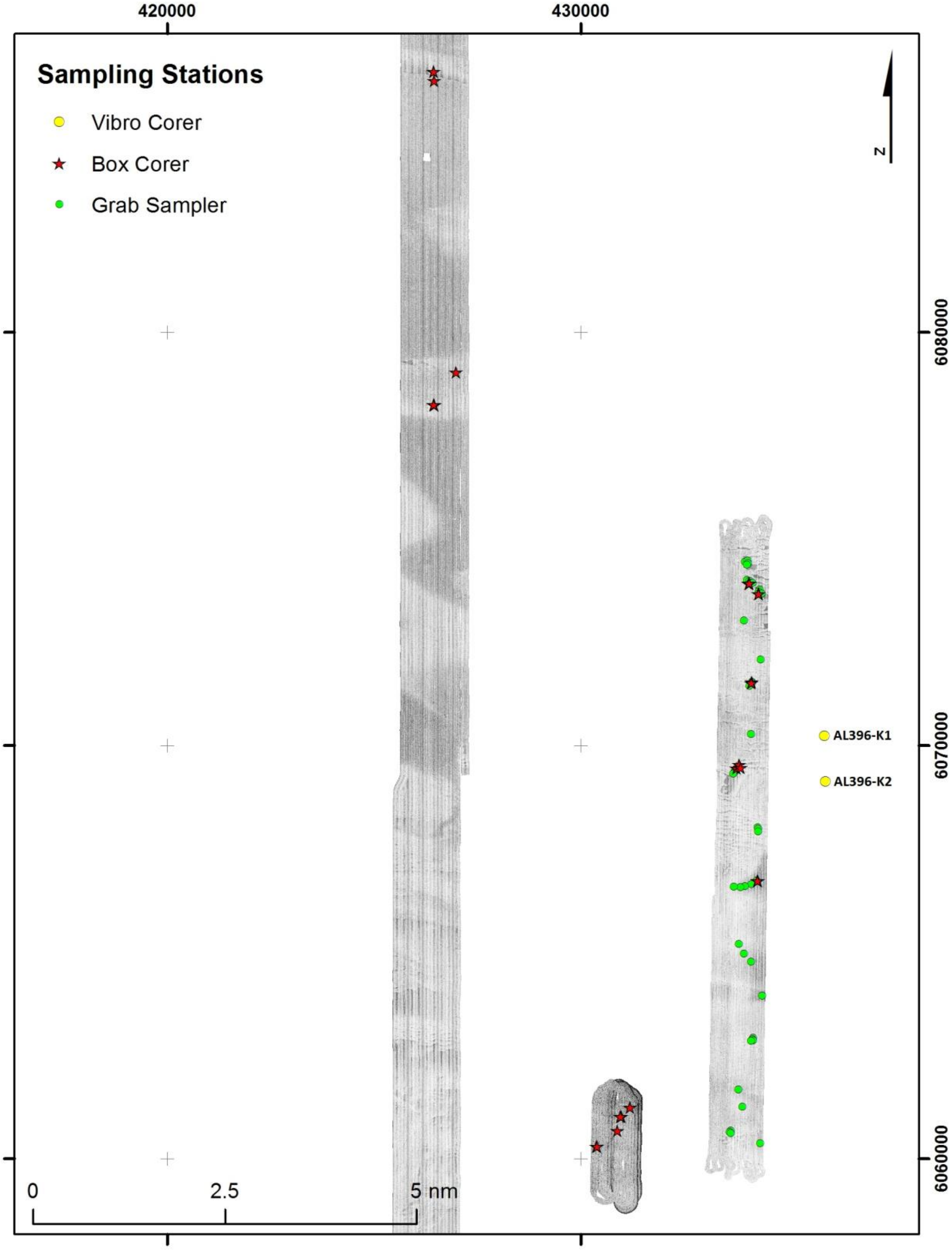

Figure 3: **Sampling stations of AL 396. Due to a breakdown of the vibro corer only 2 cores could be recovered. The box corer was applied at 25 stations. Sampling was conducted at 16 stations. The grab sampler was successfully applied and sampled at 45 stations. – (A. Krätschell)**

3. Cruise narrative (Time in UTC)

5th July 2012:

Weather	Cloudy, partly sunny, Wind: E, 2 - 3 Bft
06:00	Departure from Kiel and transit to research area.
19:00	Arrival at research area.
20:26	Calibration of MBES.
21:27	CTD profile.

6th July 2012:

Weather	Cloudy, partly sunny, short rain, Wind: NW, 2 Bft
00:08	Start of MBES and SES profiling.
06:30	MBES issues, device out of water and fixing.
07:45	MBES deployed.
10:53	CTD profile.
12:45	End of MBES profiling and heading to first VC station.
13:30	First VC station (VK6).
14:40	MBES/SES profiling continued.

During the night hydroacoustic profiling with SES, MBES.

7th July 2012:

Weather	Sunny, Wind: SE, 1-2 Bft
07:15	Stop of MBES and transit to 2nd VC station.
08:00	Start deploying of VC, problems with vessels` navigation.
09:15	VC on deck (core partly existent), device broken and unusable.
11:05	Resume profiling (MBES/SES).
16:30	Deployment of SSS and start of profiling.

During the night hydroacoustic profiling with SES, MBES. SSS

8th July 2012:

Weather	Overcast, thunderstorm, Wind: E, later SW, 5 Bft
8:00	Setup of “VK300”, other VC device.
13:45	Stop MBES and SSS profiling (towfish on deck) and transit to next VC station.
14:45	Arrival at VC station, due to bad weather conditions no coring and transit to new profile.
16:45	Start of new profiling with SES and MBES over old core stations.

During the night hydroacoustic profiling with SES, MBES.

9th July 2012:

Weather	Overcast, heavy rain, rough sea, Wind: E, later SW, 8 Bft**.**
06:00	Finished new profiling over old core stations. Transit to other MBES, SSS and SES-profiles.
10:40	SSS-, MBES-, SES-profiling stopped due to rough sea conditions, no overnight measuring.

10th July 2012:

Weather	Partly cloudy, Wind: W, 3-4 Bft**.**
	Course change to Helgoland, due to sick participant
10:00	Departure from Helgoland back to working area
14:15	CTD profile
14:30	Deployment of devices and resuming of profiles (MBES, SSS, SES)

During the night hydroacoustic profiling with SES, MBES and SSS.

11th July 2012:

Weather	Overcast, rain partly sunny, Wind: SW, 3-4 Bft., 5 Bft. in the evening.
06:00	Stopped profiling and SSS-device on deck and transit to first grabsample station
06:30	Start grab sampling (G1 – 44).
	Fixing of MBES issues. MBES is running correctly.
17:30	Stopped grab sampling and transit to long SSS-profiles in the western part of the working area
19:00	Start profiling on new track with SSS, MBES and SES

During the night hydroacoustic profiling with SES, MBES and SSS.

12th July 2012:

Weather	Overcast, rain partly sunny, Wind: SW, 3-4 Bft., 5 Bft. in the evening.
05:15	Start transit to Helgoland
11:00	Arrival at Helgoland, change of cruise-participants. Due to bad weather conditions, the departure was delayed until the next morning.

13th July 2012:

Weather	Overcast, partly sunny, Wind: S, 3Bft. in the evening 4-5 Bft. (E)
05:00	Departure back to working area
08:00	CTD profile
08:45	2 calibration profiles for MBES and SES recording
11:00	Start N-S profiles with MBES, SES, SSS, C3D-SBP and Boomer
18:30	Boomer on deck. Resume profiling with other devices (s.a.)

During the night hydroacoustic profiling with SES, MBES, SSS and C3D-SBP.

14th July 2012:

Weather	Overcast, Wind: SW, 3-4 Bft..
09:00	Transit to Box Corer-Station 1.
10:00	First Box Corer deployment.
12:30	Transit to N-S profiles
15:00	Resume profiling with MBES, SSS, SES and C3D-SBP

During the night hydroacoustic profiling with SES, MBES, SSS and C3D-SBP.

15th July 2012:

Weather	Sunny, Wind: W, 4-5 Bft..
08:00	Transit and SSS on deck.
09:00	Box Corer stations (KG01-06).
13:45	Transit to profiles.
14:25	Resume profiling with MBES, SES, SSS and C3D-SBP

No profiling during the night due to bad weather conditions.

16th July 2012:

Weather	Sunny, Wind: W, 4-5 Bft..
03:00	Arrival in Helgoland.
18:00	Start with transit to W-E profiles, SES recording.
21:30	Resume profiling with MBES, SES, SSS and C3D-SBP

During the night hydroacoustic profiling with SES, MBES, SSS and C3D-SBP.

17th July 2012:

Weather	overcast, Wind: W, 4-5 Bft..
05:00	devices on deck, CTD
06:00	Start profiling with MBES, SES, SSS and C3D-SBP
12:15	Box Corer stations (1-4)
13:30	Transit, SSS recording
14:00	Resume profiling with MBES, SES, SSS and C3D-SBP

During the night hydroacoustic profiling with SES, MBES, SSS and C3D-SBP.

18th July 2012:

Weather	Overcast, Wind: W, 2-3 Bft..
12:00	Transit to Kiel

19th July 2012:

Weather	Sunny, Wind: W, 4-5 Bft..
00:00	Transit to Kiel.
07:00	Arrival at Kiel Eastshore pier and unloading of equipment

4. Equipment

4.1 Side scan sonar and chirp subbottom sonar

The side scan sonar (Teldyne Benthos C3D) is a hybrid system, combining side scan sonar and a chirp sub bottom sonar system (Teledyne Benthos, Inc.). The ‘tow fish’ (TTV-298 Tow Vehicle (s. Fig. 4)) is towed behind the vessel by a vessel speed of about 5 knots. With its transducers, it emits acoustics waves, reaching the seafloor in a fan, where they are reflected and backscattered. Swath width for this survey was 200 m, with a frequency of 200 kHz; whereas each swath has an overlapping of 20 m with the neighbouring swath.

The ‘TTV-298’ contains port and starboard side scan sonar transducer arrays, sub bottom sonar transducers, a sub bottom hydrophone array and an attitude and heading reference system, which provides outputs on the vehicle’s pitch, roll and heading.

The data acquisition is quite reliable. Disturbances can occur due to tensions on the wire or wave induced air bubbles underneath the transducers.

The amount of backscatter coming back to the detectors, gives information about the roughness of the seafloor. The rougher the coverage, the higher is the backscatter. Based on this principle sediment properties can be interpreted. Low backscatter (bright shades) correlates to fine grained material and high backscatter (dark shades) to coarse-grained sediments. However, additional sediment samples are needed for proving ground truthing.

Figure 4: Teledyne Benthos ‘TTV-298 Tow Vehicle’ device with combined side scan sonar and chirp sub bottom sonar system.

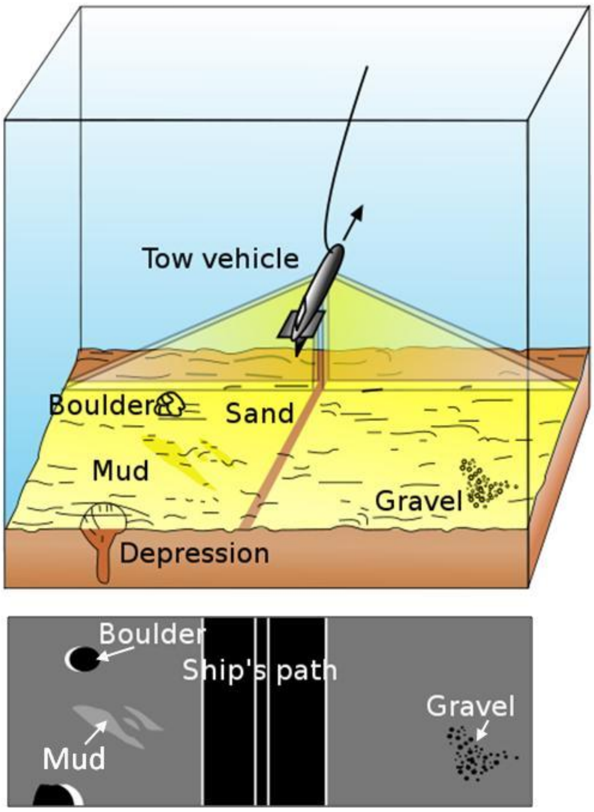

Figure 5: Diagram of a side scan sonar (USGS & Mysid 2007, modified)

The subbottom sonar system on the 'TTV-298 Tow Vehicle' was used to obtain data about the geological built up of the seafloor, using a *Chirp* signal. Therefore, the frequency is changing linear with time. The advantage is a short pulse, which is required for exact measuring. Less energy is needed; therefore, the signal is long and has a large bandwidth.

This gives an improved signal-to-noise-ratio (SNR) gain and time resolution, as well as it becomes independent of the transmitted signal duration. For sediment profiler it is necessary to compensate the strong attenuation of the signal inside the seafloor.

Output power levels can also be controlled to minimize environmental impact.

Because of their size, they are easy to handle and can even be used in combination with a side scan sonar. The slide is towed behind the vessel and is connected to the vessel by a cable and winches to regulate the height above the seafloor.

Via cable, the data was transmitted from the 'TTV-298' to the C3D processor, where they were displayed and processed using the software 'Triton Isis (Version 7.1.500.104) and 'Triton SB Logger TM 1.7.0.0'.

4.2 Multibeam echosounder

For mapping the seafloor, bathymetric data was collected with the multibeam echosounder (MBES) 'SEABEAM 1000' (L3-Communications, ELAC Nautic GmbH). Operating with a sonar frequency of 180 kHz, the system collects bathymetric data with a swath width of 153°. To calibrate the MBES with several CTD measurements were conducted and several pairs of opposite directed profiles over flat ground were run.

The multibeam data was aquired and recorded using the Software Hydrostar (L3-Communications, ELAC Nautic GmbH). For post processing the tidal range of about 2 m has to be taken into account and corrected.

4.3 Boomer

Boomer seismic is widely used for studying shallow geologic structures and sediment layers.

It consists of two units: The source, which is placed on a catamaran (Fig.6) and the streamer.

To form the signal an aluminium plate separates suddenly from a copper coil embedded in an epoxy resin. The rapid discharge of a capacitor causes eddy currents, induced in the aluminium plate, which produce a rapid repulsion and a cavitation volume in the water. There are two pulses. The first one is due to the rapid outward acceleration of the aluminium plate. The second pressure pulse is formed by the implosion of the cavitation volume.

Figure 6: Boomer catamaran (Photo: J. Thielsen)

A broad band of pulses is produced. Pulse lengths of 0.1-0.2 ms are capable for shallow water environments. Within this range they are able to resolve reflectors in a distance of less than 0.3 m (Jones, 2004).

4.4 HELCOM-standard grab sampler

Sampling for ground truthing of side scan sonar data and sedimentological analyses was carried out with a HELCOM-standard grab sampler. Each grab sample was described, photographed and sampled (Tab. 1).

4.5 Box corer

To gain in situ samples with an undisturbed sediment surface, the box corer was used. It can be deployed at the sampling station by the vessel’s winch. When it hits the seafloor, it sinks into the sediment.

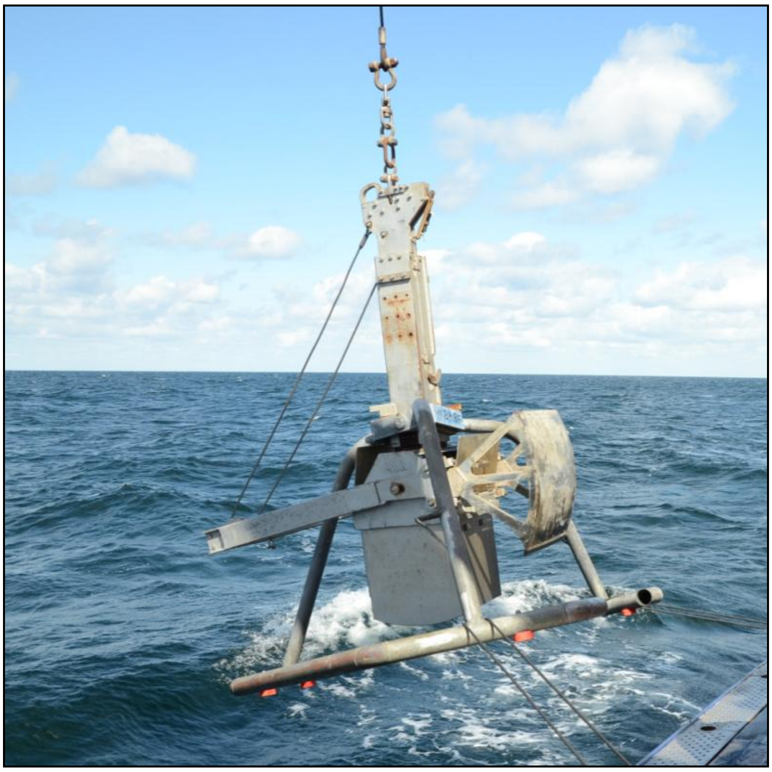

Figure 7: Box corer deploying from the vessel. (Photo: K. Schwarzer)

At a certain depth a mechanism is triggered, which closes the shovel. This closes the bottom of the steel box and captures the sediment inside. While launching the device, the shovel is constantly pulled upward and prevents the sediment of being washed out. The box can be removed on deck and replaced by a new one. Each box was described, photographed and sampled. Altogether 16 stations were successfully approached and sampled (s. Fig. 11 and Tab.2).

4.5 Vibro Corer

There were two different vibro coring systems used, during the cruise. One was supplied by the IFG and the other one by the BSH.

Vibro core systems are mainly used in coarse grained shallow marine environments. The core tube is driven into the sediment by vibration energy, generated by a motor on top of the system. The whole corer is heaved and launched starboardsided of the vessel.
The VK200 from Kiel University has a tube length of 3m and 10x10 cm width and the sediment sample is hosted directly inside the steel tubes. The motor also has the function to pull the tube back out of the sediment after the coring has been done.
The vibro core system from the BSH has to be pulled out by the ship winch, before it can be launched back onto the vessel. This device works with round steel tubes of a length about 6 m. Plastic liner inside the steel tubes make it possible to cut the sediment cores in meter pieces and store them for later description.
Unfortunately the 6 m vibro corer was broken during the second deployment. Due to unfavourable weather conditions, there has been no opportunity to run the 3 m vibro corer. In total only 2 cores could be gained.

4.6 CTD

Sound velocities in the water column depend on water density which is influenced by salinity, temperature and pressure. For this reason, CTD- profiles were taken in order to calculate sound velocity profiles through the water column (Figure 2). These profiles are needed to correctly calculate water depths measured by the multibeam echosounder.

5. Performed work and preliminary results

The research area was surveyed with side scan sonar with 100% coverage, MBES, SES and Boomer seismics for precise large-scale mapping (s. Fig. 2 and Tab. 5). Ground truthing was conducted deploying the grab sampler (45 stations, s. Tab. 1) and box corer (25 stations, s. Tab.2) (s. Fig.3). Due to unfavourable weather conditions, some tracks could only be run with hull mounted MBES and SES. During the cruise problems with the MBES motion sensor occurred, which has to be taken into account during post processing. The vessel's motions have not been correctly added onto the bathymetric data during recording.
The drilling campaign unfortunately had to be stopped after 2 cores with the vibrocorer (s. Fig 3), because of instrument failure and bad weather conditions. The cores are currently being analysed in the frame of a bachelor thesis.

The SSS and SES worked well and were used to display the sorted bedforms (Fig. 8) and e.g. a peat outcrop in the western part of the survey area.
Several sorted bedforms were found. They do not only occur in the survey area AufMod-F, but also reach further west, as it can be seen in the additional SSS profile lines (Fig. 8a)). In the SSS images they occur as large and asymmetric sedimentary features. In figure 8b), dark colours indicate high backscatter, which is characteristic for coarse grained material. Fine material, such as silty or muddy sediments, is indicated by lighter areas (low backscatter).

Those mapped structures are west - east orientated. Together with the processed MBES data, it would be possible to measure their exact height and extension.

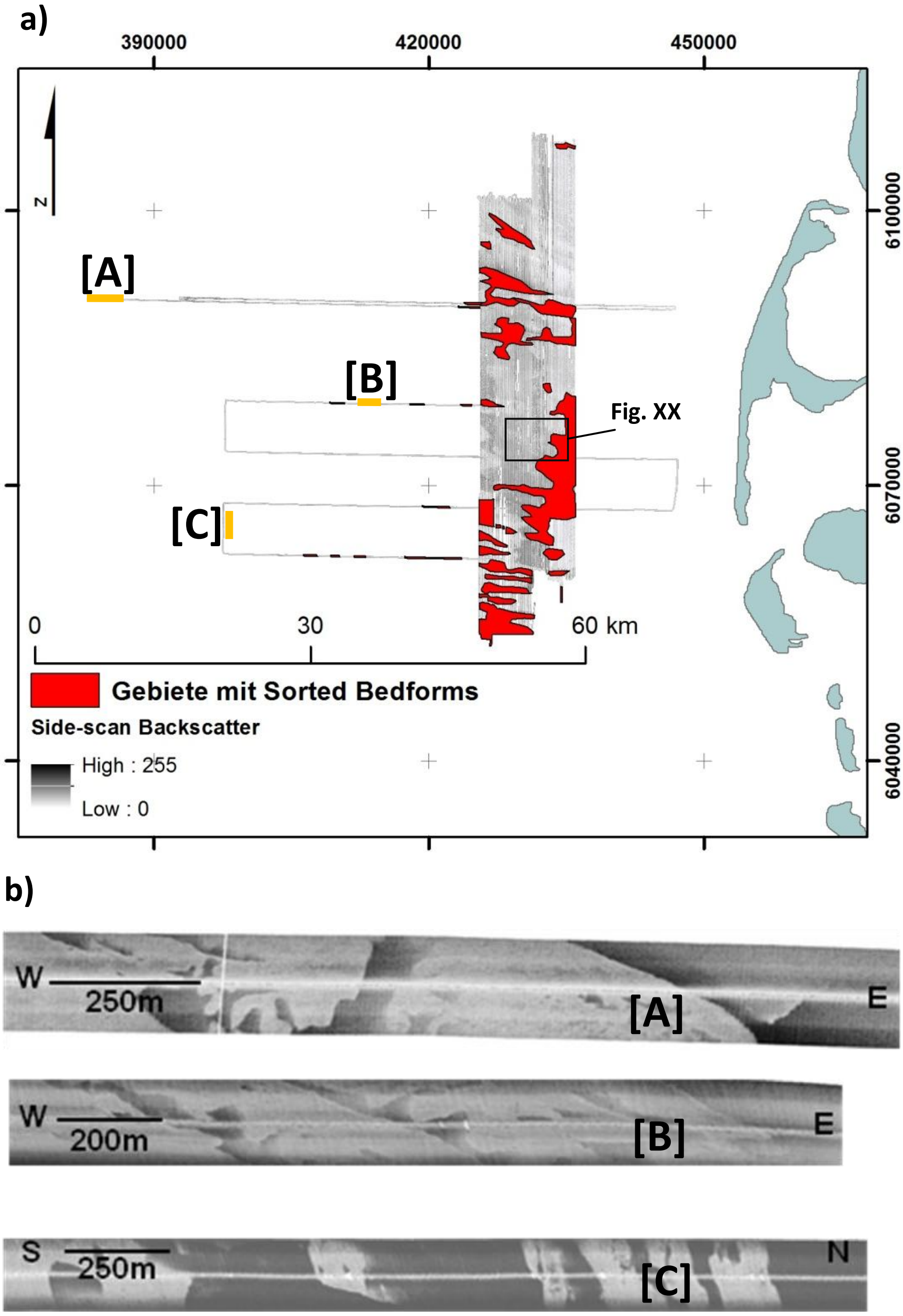

Figure 8: a): The map shows the recorded SSS data. Areas of sorted bedforms were marked in red. In addition to the N-S profiles some W-E profiles were taken. The yellow lines indicate the SSS single sections. The capital letters A-C refer to the respective sections. b): SSS sections indicated in part a. Low backscatter in light colours, refers to coarser sediment. - (A. Krätschell)

Even from the uncorrected MBES data, it can be observed, that those structures are elongated depressions, filled with coarse grained material, so called ripple scour depressions (Cacchione et al., 2005). Inside the depressions, sediments, which are usually covered with pelagic material, are exposed to the surface. They act as a window to the underlying strata.

Sorted bedforms are highly dependent on sand supply and main current direction and typically extend perpendicular to the shoreline (Goff et al., 2005).

The fact that sorted bedforms are not only a bound to the main research area of AufMod-F, shows that even ~40km further to the west the area seems to be influenced by the same morphodynamic processes.

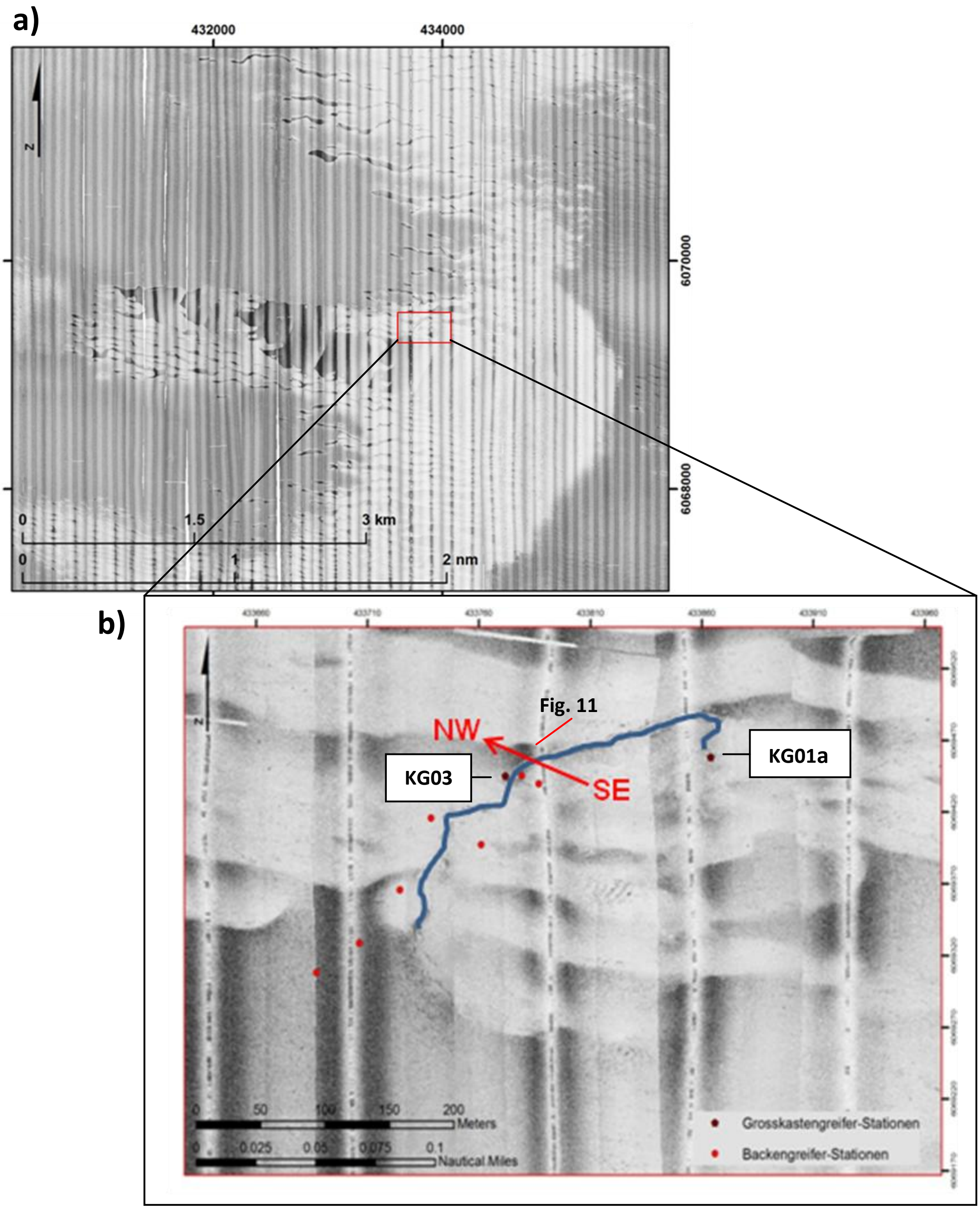

Figure 9: a): The map shows the SS data of the sorted bedform area (for location s. Fig. X a). The red box marks the position of the structure. b): The linear structureis marked in blue, crossed by a SES profile (red). Red dots indicate grab sampler stations, dark red dots box corer stations. – (A. Krätschell)

In between sorted bedforms in the main work area, a distinctive structure was discovered within the SSS and SES data. It extends over 100 metres, cutting several bedform structures

(s. Fig. 9). For further observations, grab- and box coring samples have been taken on both sides of the edge.

The sediment samples show very characteristic material. Only a thin cover of fine grained sand is lying upon a peat layer in box corer sample KG03 (s. Fig. 10). The thickness inside the box corer was about up to 5 cm. Because the sampling device did not reach the base of the peat, the exact thickness cannot be predicted. Inside the sample KG01a (s. Fig. 11), a dark and dense peat built the base of the sample, underneath an approximately 3 cm thick sandy layer.

Figure 10: Sediment sample inside a box corer. The sediment is composed of peat, partly covered with medium to fine sand. (Photo: A. Krätschell)

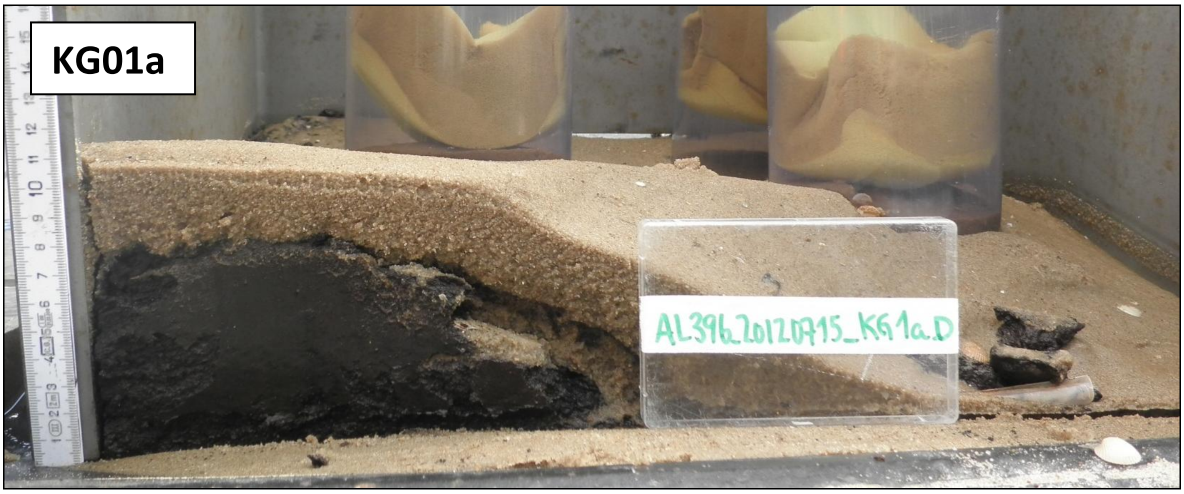

Figure 11: Dark brown to black peat covered by medium sand (for location s. Fig. X). (Photo: A. Krätschell)

The occurrence of peat points to limnic conditions during deposition. Whether the top of the limnic sediment has been eroded or not, is not sure, but very likely. 2 ^{14}C-datings from the peat will help to put the change of conditions into a chronological frame.

The peat-outcrop is displayed in the SES profile (SE-NW), characterized by a steep inclined edge in between sorted bedforms. Above the edge, gas flares are rising into the water column.

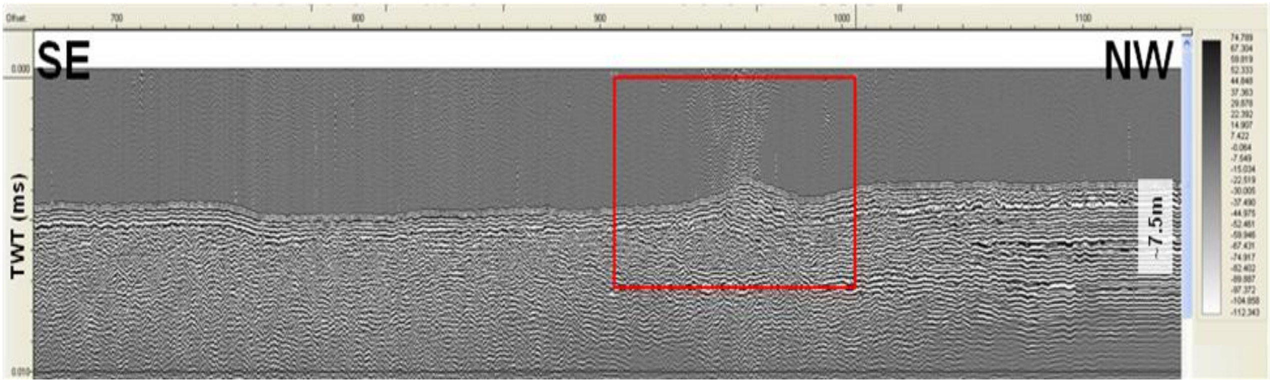

Figure 12: Seismic section of a SES profile (for location s. Fig. X b). The peat edge is marked by the red box. It builds a significant and asymmetric height. Above the edge gas flares escape into the water column. - (A. Krätschell)

Repeated measurements with SSS and SES were conducted in areas where *Lanice conchilega* colonies used to influence the backscatter characteristics of the side scan sonar data in the previous year (s. Tab. 5, "Lanice Profiles"). Additionally, undisturbed surface samples were taken in this area with the box corer and grab sampler to study the influence of this tube dwelling worm on sediment characteristics.

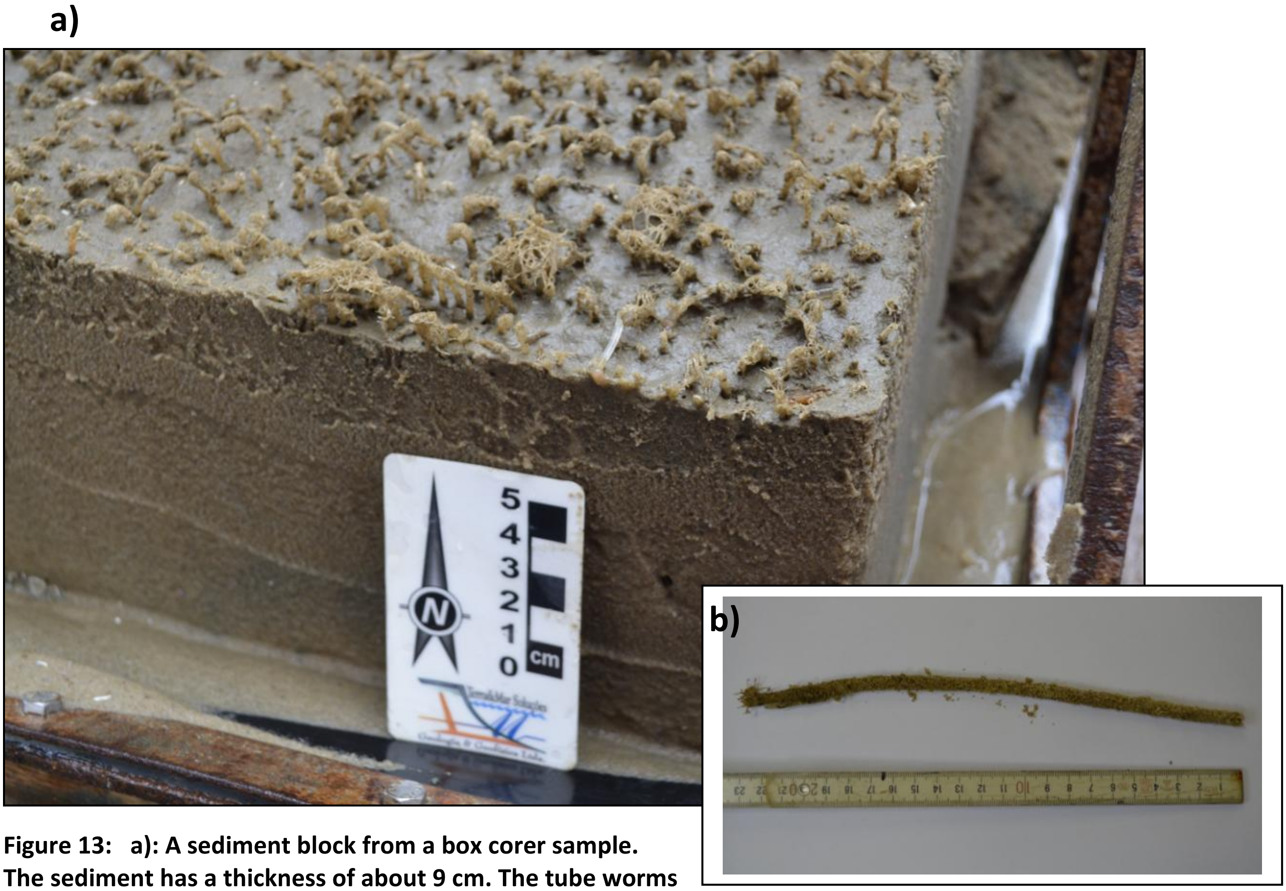

Figure 13: a): A sediment block from a box corer sample. The sediment has a thickness of about 9 cm. The tube worms reach 3 cm deep into the medium sand and protrude from the surface. The surface is covered by a thin layer of fine material. b): A single *Lanice conchilega* tube of agglutinated sand particles. (Photos: C. Heinrich)

It builds tubes inside the sediment of agglutinated sand and protrudes a few centimetres from the ground (s. Fig.13b)). At the top of the tube, a network of branches is developed. Often the bottom sediment was composed of medium sand, with a thin fine-sand cover on the surface. The tubes reached a length of about 23 cm.

Another goal of the cruise AL-396 was to cover old core stations from Köster with SES profiles (Fig.14). Those cores were taken in the 70'ies, reaching in general a depth of 180 cm. All together, 43 stations have been directly covered and the core logs can now be correlated with the SES data, putting them into a larger context.

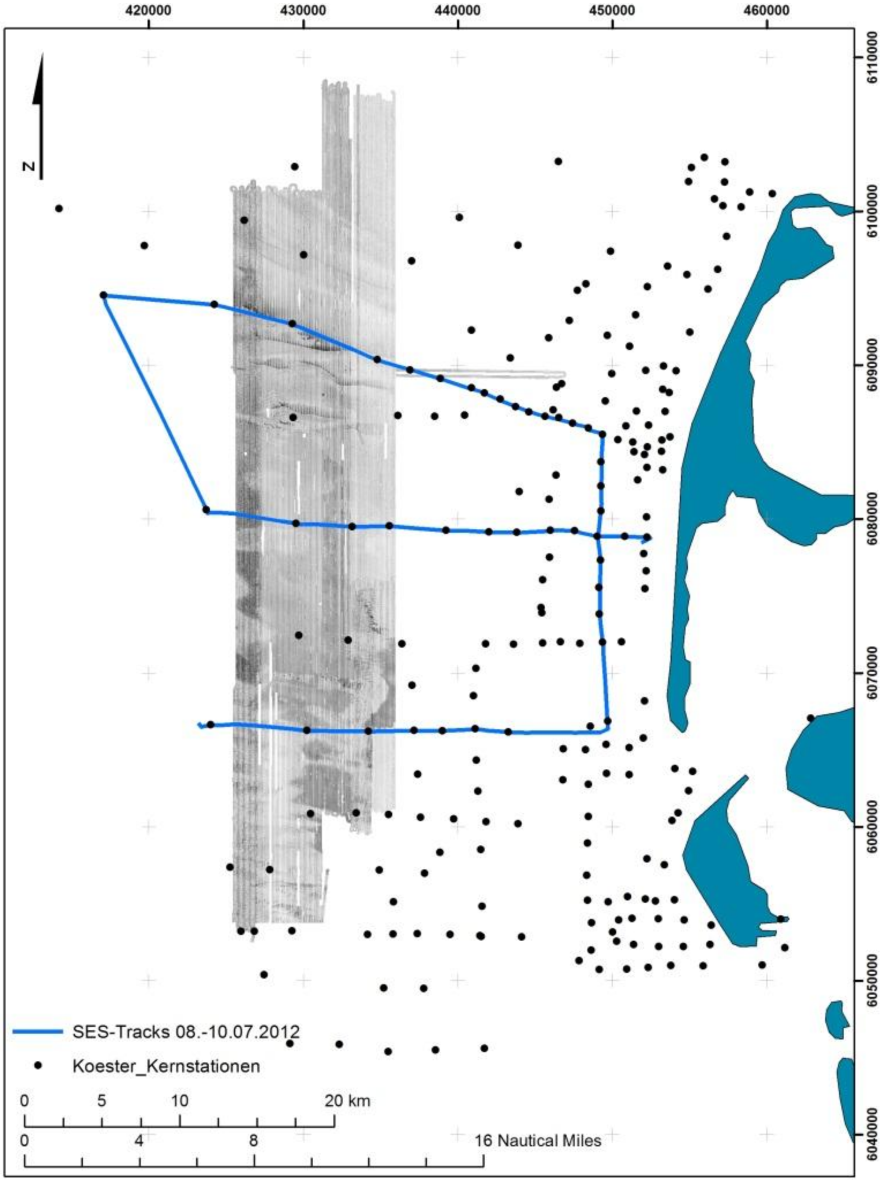

Figure 14: The map shows all core stations from Köster underlain by the SSS data from this cruise. The blue line indicates the SES profiles run over 43 of the core stations. -(A. Krätschell)

6. Acknowledgements

We would like to thank master (N. Hechler) and the crew of RV Alkor for giving us all kind of support during this cruise.

7. References

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8. Appendices

Table 1: Grab Sample Stations from 11.07.2012.

Grab Sample Station	Time [UTC]	Longitude E [dd]	Latitude N [dd]	Longitude E [°dmin]	Latitude N [°dmin]	Water Depth [m]
AL396_20120711_G1	17:30	7.97240	54.81277	7°58.344	54°48.766	17.70
AL396_20120711_G2	17:04	7.97333	54.81295	7°58.4	54°48.777	17.71
AL396_20120711_G3	16:55	7.97357	54.81247	7°58.414	54°48.748	17.60
AL396_20120711_G4	16:42	7.97312	54.81207	7°58.387	54°48.724	17.30
AL396_20120711_G5	16:26	7.97333	54.80877	7°58.4	54°48.526	17.30
AL396_20120711_G6	16:16	7.97425	54.80855	7°58.455	54°48.513	17.55
AL396_20120711_G7	16:05	7.97443	54.80817	7°58.466	54°48.49	17.49
AL396_20120711_G8	15:19	7.97547	54.80818	7°58.466	54°48.490	17.70
AL396_20120711_G9	15:07	7.97818	54.80668	7°58.528	54°48.491	16.81
AL396_20120711_G10	15:02	7.97775	54.80630	7°58.691	54°48.401	17.62
AL396_20120711_G11	14:53	7.97775	54.80587	7°58.665	54°48.378	17.47
AL396_20120711_G12	14:47	7.97893	54.80583	7°58.665	54°48.352	16.92
AL396_20120711_G13	14:31	7.97230	54.79995	7°58.736	54°48.35	16.83
AL396_20120711_G14	14:17	7.97895	54.79155	7°58.338	54°47.997	17.29
AL396_20120711_G15	14:03	7.97577	54.78662	7°58.737	54°47.493	16.90
AL396_20120711_G16	13:53	7.97572	54.78647	7°58.546	54°47.197	17.21
AL396_20120711_G17	13:47	7.97477	54.78573	7°58.543	54°47.188	16.21
AL396_20120711_G18	13:32	7.97573	54.77532	7°58.486	54°47.144	15.45
AL396_20120711_G19	13:15	7.97080	54.76783	7°58.248	54°46.07	15.94
AL396_20120711_G20	13:10	7.97005	54.76762	7°58.203	54°46.057	16.15
AL396_20120711_G21_1	12:57	7.97040	54.76745	7°58.224	54°46.047	15.94
AL396_20120711_G21_2	13:03	7.96983	54.76717	7°58.1898	54°46.0302	16.05
AL396_20120711_G22	12:47	7.96955	54.76683	7°58.173	54°46.01	16.04
AL396_20120711_G23	12:21	7.97867	54.75500	7°58.7202	54°45.3	13.21
AL396_20120711_G24	12:16	7.97883	54.75467	7°58.7298	54°45.2802	13.92
AL396_20120711_G25	12:11	7.97883	54.75417	7°58.7298	54°45.2502	13.31
AL396_20120711_G26	11:56	7.97850	54.74350	7°58.71	54°44.61	14.37
AL396_20120711_G27	11:46	7.97667	54.74267	7°58.6002	54°44.5602	14.22
AL396_20120711_G28	11:33	7.97417	54.74217	7°58.4502	54°44.5302	13.61
AL396_20120711_G29	11:13	7.97250	54.74200	7°58.35	54°44.52	13.72
AL396_20120711_G30	11:02	7.97000	54.74200	7°58.2	54°44.52	14.19
AL396_20120711_G31	10:47	7.97233	54.72967	7°58.3398	54°43.7802	13.96
AL396_20120711_G32	10:37	7.97430	54.72750	7°58.458	54°43.65	13.47
AL396_20120711_G33	10:27	7.97687	54.72577	7°58.612	54°43.546	13.96
AL396_20120711_G34	10:08	7.98120	54.71840	7°58.872	54°43.104	14.32
AL396_20120711_G35	8:11	7.97800	54.70930	7°58.680	54°42.558	14.65
AL396_20120711_G36	8:17	7.97792	54.70895	7°58.675	54°42.537	14.27
AL396_20120711_G37	8:43	7.97818	54.70875	7°58.691	54°42.525	14.38
AL396_20120711_G38	8:24	7.97740	54.70862	7°58.644	54°42.517	14.14
AL396_20120711_G39	7:47	7.97278	54.69797	7°58.367	54°41.878	13.96
AL396_20120711_G40	7:20	7.97450	54.69422	7°58.470	54°41.653	14.21
AL396_20120711_G41	6:45	7.97017	54.68900	7°58.2102	54°41.34	14.16
AL396_20120711_G42	7:00	7.96983	54.68867	7°58.1898	54°41.3202	14.38
AL396_20120711_G43	6:52	7.97017	54.68850	7°58.2102	54°41.31	14.68
AL396_20120711_G44	6:31	7.98133	54.68640	7°58.8798	54°41.184	13.30

Table 2: Box Corer Stations. Bold font indicates stations, where sampling took place.

Box Corer Station	Date	Time [UTC]	Longitude E	Latitude N	Longitude E [°dmin]	Latitude N [°dmin]	Water Depth [m]
AL396_20120714_KG01a	14.07.2012	10:18	7.97798	54.80588	7°58.679	54°48.353	16.80
AL396_20120714_KG01	14.07.2012	10:09	7.97783	54.80588	7°58.670	54°48.353	16.90
AL396_20120714_KG02a	14.07.2012	10:49	7.97577	54.78667	7°58.546	54°47.200	16.50
AL396_20120714_KG02	14.07.2012	11:00	7.97557	54.78647	7°58.534	54°47.188	16.26
AL396_20120714_KG03	14.07.2012	11:27	7.97057	54.76788	7°58.23	54°46.076	15.80
AL396_20120714_KG04	14.07.2012	11:58	7.97907	54.74340	7°58.74	54°44.60	15.30
AL396_20120714_KG04a	14.07.2012	12:20	7.97893	54.74342	7°58.73	54°44.60	15.66
AL396_20120715_KG01	15.07.2012	9:10	7.97152	54.76867	7°58.291	54°46.12	16.66
AL396_20120715_KG01a	15.07.2012	9:17	7.97200	54.76800	7°58.320	54°46.08	16.05
AL396_20120715_KG02	15.07.2012	10:16	7.97428	54.80804	7°58.46	54°48.48	17.20
AL396_20120715_KG02a	15.07.2012	10:24	7.97400	54.80800	7°58.46	54°48.48	17.30
AL396_20120715_KG02b	15.07.2012	10:38	7.97424	54.80809	7°58.4546	54°48.4852	17.20
AL396_20120715_KG03a	15.07.2012	11:45	7.85473	54.84582	7°51.28	54°50.75	18.16
AL396_20120715_KG03b	15.07.2012	11:48	7.85461	54.84576	7°51.27	54°50.74	18.40
AL396_20120715_KG03c	15.07.2012	11:56	7.85448	54.84585	7°51.26	54°50.75	18.10
AL396_20120715_KG04	15.07.2012	12:17	7.86277	54.85299	7°51.76	54°51.18	19.03
AL396_20120715_KG05	15.07.2012	13:08	7.85265	54.91632	7°51.19	54°54.98	19.30
AL396_20120715_KG06	15.07.2012	13:31	7.85240	54.91828	7°51.14	54°55.09	19.90
AL396_20120715_KG06b	15.07.2012	13:41	7.85242	54.91825	7°51.14	54°55.09	20.40
AL396_20120717_KG01	17.07.2012	12:12	7.93233	54.69373	7°55.94	54°41.62	16.50
AL396_20120717_KG02	17.07.2012	12:32	7.92918	54.69178	7°55.75	54°41.51	16.40
AL396_20120717_KG02b	17.07.2012	12:38	7.92885	54.69178	7°55.73	54°41.50	16.07
AL396_20120717_KG03	17.07.2012	12:54	7.92780	54.68867	7°55.67	54°41.32	14.90
AL396_20120717_KG04	17.07.2012	13:10	7.92013	54.68513	7°55.21	54°41.11	14.40
AL396_20120717_KG04b	17.07.2012	13:15	7.92037	54.68515	7°55.22	54°41.11	14.80

Table 3: Vibro Corer Stations.

Vibro Corer Station	Date	Time [UTC]	Longitude E	Latitude N	Longitude E [°dmin]	Latitude N [°dmin]	Water Depth [m]
AL396-K1	06.07.2012	13:35	8.0033	54.7752	8°00.196	54°46.51	16.08
AL396-K2	07.07.2012	8:03	8.0039	54.7653	8°00.234	54°45.92	14.19

Table 4: CTD Stations.

CTD Station	Date	Time [UTC]	Longitude E	Latitude N	Longitude E [°dmin]	Latitude N [°dmin]
20120705_1	05.07.2012	21:27	7.99825	54.3836	7°59.895	54°23.016
20120705_2	05.07.2012	10:53	7.83265	54.8191	7°49.959	54°49.146
20120710_1	10.07.2012	14:05	7.83512	54.7422	7°50.107	54°44.532
20120713_1	13.07.2012	07:51	7.86458	54.53988	7°51.875	54°32.393

Table 5: Survey lines of Parametric Sub-Bottom Profiler (SES), Multibeam Echosounder (MBES), Side Scan Sonar (SSS) and Chirp Sub bottom Sonar (CS) during AL396. Total length of profiles amounts to 1060.437 nm (572.59 km).

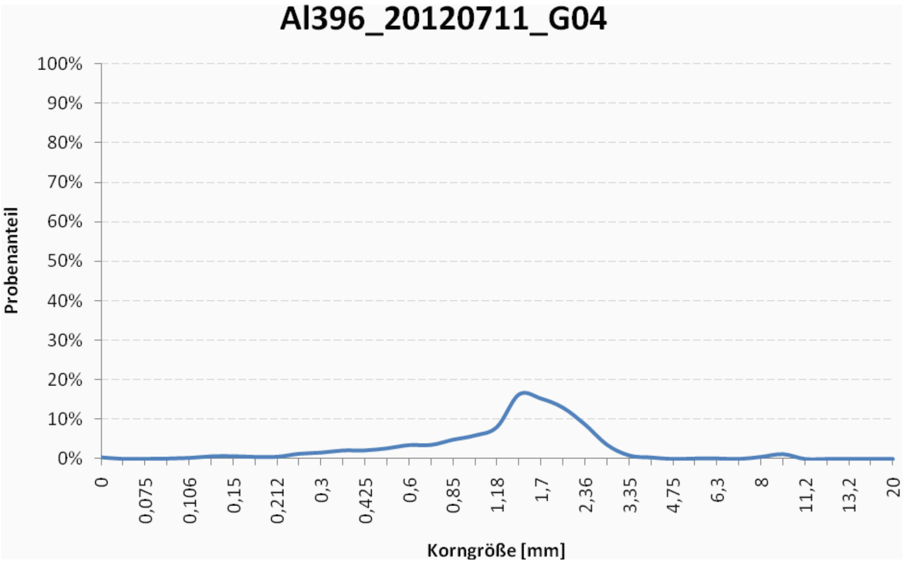
		Startpoints		Endpoints			
Profile	**Date**	**Lat (N)**	**Lon (E)**	**Lat (N)**	**Lon (E)**	**Profile length (nm)**	**Instruments**
1	06.07.2012	54.684882	8.00516	54.80767	8.005058	7.37	SES, MB
2	06.07.2012	54.688885	8.003987	54.806078	8.003987	7.037	SES, MB
3	06.07.2012	54.683638	8.002707	54.81101	8.002852	7.65	SES, MB
4	06.07.2012	54.68383	8.001848	54.807395	8.00192	7.42	SES, MB
5	06.07.2012	54.684038	8.000832	54.808023	8.000573	7.44	SES, MB
8	06.07.2012	54.689243	7.999603	54.810942	7.9995	7.31	SES, MB
8	06.07.2012	54.683893	7.99826	54.811633	7.998377	7.67	SES, MB
8	06.07.2012	54.689087	7.99736	54.809483	7.997303	7.23	SES, MB
8	06.07.2012	54.684152	7.996218	54.81154	7.996185	7.65	SES, MB
8	06.07.2012	54.68939	7.995105	54.809502	7.995105	7.21	SES, MB
8	06.07.2012	54.683887	7.993805	54.813752	7.99393	7.8	SES, MB
8	06.07.2012	54.689762	7.992958	54.808333	7.992835	7.12	SES, MB
8	06.07.2012	54.683993	7.991783	54.81325	7.991703	7.76	SES, MB
8	06.07.2012	54.770233	7.990685	54.816722	7.990912	2.79	SES, MB
17	07.07.2012	54.69012	7.990697	54.77021	7.990685	4.81	SES, MB
18	07.07.2012	54.684075	7.989593	54.81669	7.989583	7.96	SES, MB
19	07.07.2012	54.686092	7.988515	54.816802	7.988567	7.85	SES, MB
20	07.07.2012	54.684057	7.987218	54.815002	7.987343	7.96	SES, MB
21	07.07.2012	54.689752	7.986232	54.816637	7.986048	7.45	SES, MB
25	07.07.2012	54.684115	7.985143	54.813847	7.985108	7.96	SES, MB
28	07.07.2012	54.684003	7.984075	54.816632	7.984037	7.86	SES, MB
28	07.07.2012	54.683982	7.983015	54.814933	7.98285	7.98	SES, MB
29	07.07.2012	54.686077	7.981785	54.816862	7.981787	7.44	SES, MB, SSS
30	07.07.2012	54.683822	7.980458	54.809977	7.980887	7.6	SES, MB, SSS
31	07.07.2012	54.687032	7.979618	54.816655	7.979405	7.78	SES, MB, SSS
31	07.07.2012	54.683852	7.978453	54.812277	7.978425	7.71	SES, MB, SSS
31	07.07.2012	54.756807	7.977388	54.815763	7.977348	3.54	SES, MB, SSS
33	08.07.2012	54.687772	7.977367	54.814915	7.976258	7.63	SES, MB, SSS
33	08.07.2012	54.684613	7.976127	54.815302	7.9752	7.85	SES, MB, SSS
35	08.07.2012	54.689232	7.975163	54.814443	7.97399	7.8	SES, MB, SSS
36	08.07.2012	54.684457	7.97411	54.816607	7.97291	7.94	SES, MB, SSS
37	08.07.2012	54.69079	7.972888	54.8153	7.971778	7.5	SES, MB, SSS

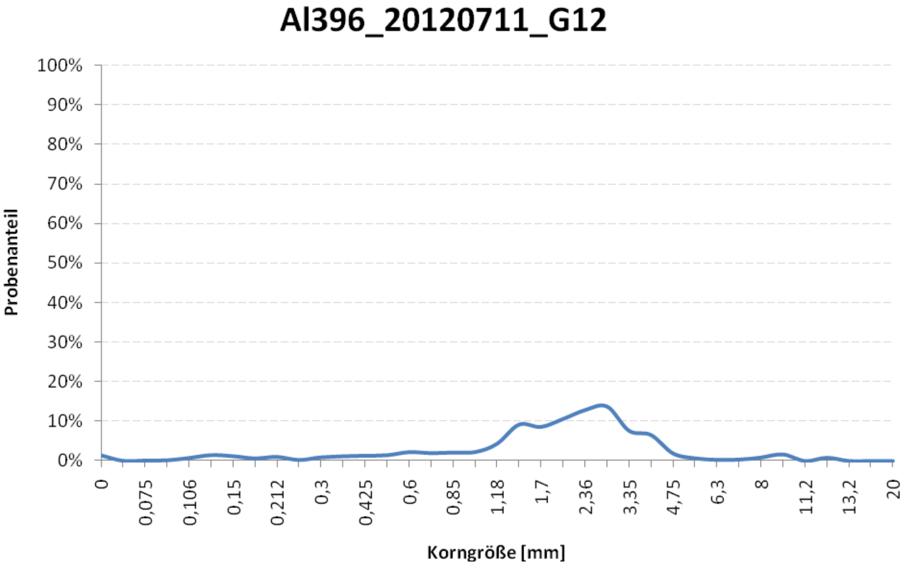
		Startpoints		Endpoints			
Profile	**Date**	**Lat (N)**	**Lon (E)**	**Lat (N)**	**Lon (E)**	**Profile length (nm)**	**Instruments**
38	08.07.2012	54.684072	7.971725	54.815917	7.970627	7.92	SES, MB, SSS
39	08.07.2012	54.6887	7.970773	54.816722	7.969553	7.69	SES, MB, SSS
40	08.07.2012	54.683843	7.96937	54.816798	7.968567	7.98	SES, MB, SSS
41	08.07.2012	54.75092	7.964967	54.73985	7.810387	5.4	SES, MB, SSS
43	08.07.2012	54.743425	7.81832	54.739925	8.211558	13.66	SES, MB
43	08.07.2012	54.74207	8.218947	54.914595	8.209182	10.37	SES, MB
43	08.07.2012	54.914595	8.209182	54.97972	7.866613	12.38	SES, MB
45	09.07.2013	54.738112	8.120683	54.855232	8.252375	8.48	SES, MB
43, 44	09.07.2013	54.853965	8.259002	54.865173	7.816238	15.3	SES, MB
43	09.07.2013	54.865173	7.816238	54.99069	7.703487	8.5	SES, MB
43	09.07.2013	54.99069	7.703487	54.979727	7.866573	5.7	SES, MB
46	10.07.2014	54.684522	7.968462	54.734042	7.96835	2.97	SES, MB, BS, SSS, CS
47, 48	10.07.2014	54.687952	7.967357	54.811583	7.967332	7.42	SES, MB, SSS, CS
48	10.07.2014	54.68944	7.966468	54.811583	7.966303	7.33	SES, MB, SSS, CS
49	10.07.2014	54.689215	7.964768	54.811583	7.964947	7.35	SES, MB, SSS, CS
50	10.07.2014	54.689482	7.964023	54.811583	7.964048	7.33	SES, MB, SSS, CS
50, 51	10.07.2014	54.684047	7.962768	54.756082	7.962832	4.33	SES, MB, SSS, CS
“BG-Profiles” 54, 56	11.07.2012	54.813158	7.97347	54.682165	7.97819	12.6	SES, MB
51, 52	11.07.2012	54.756458	7.962853	54.816932	7.962925	3.63	SES, MB, SSS, CS
53	11.07.2012	54.6864	7.961823	54.816745	7.961897	7.83	SES, MB, SSS, CS
54	11.07.2012	54.683903	7.96084	54.814065	7.960752	7.82	SES, MB, SSS, CS
58	11.07.2012	54.682127	7.959707	54.816887	7.959722	8.1	SES, MB, SSS, CS
60	12.07.2012	54.18342	7.797458	54.623925	7.866212	26.5	SES, MB
59	12.07.2012	54.62605	7.869092	55.0515	7.857818	25.6	SES, MB, SSS, CS
68, 69, 70	13.07.2012	54.625985	7.86637	55.051487	7.854675	25.6	SES, MB, SSS, CS
72	13.07.2012	54.629638	7.863528	55.051057	7.851873	25.3	SES, MB, SSS, CS
73	14.07.2012	54.62589	7.860625	55.046427	7.849137	25.3	SES, MB, SSS, CS
74,, 75, 76, 79	14.07.2012	54.625605	7.858145	55.050365	7.846463	25.5	SES, MB, SSS, CS

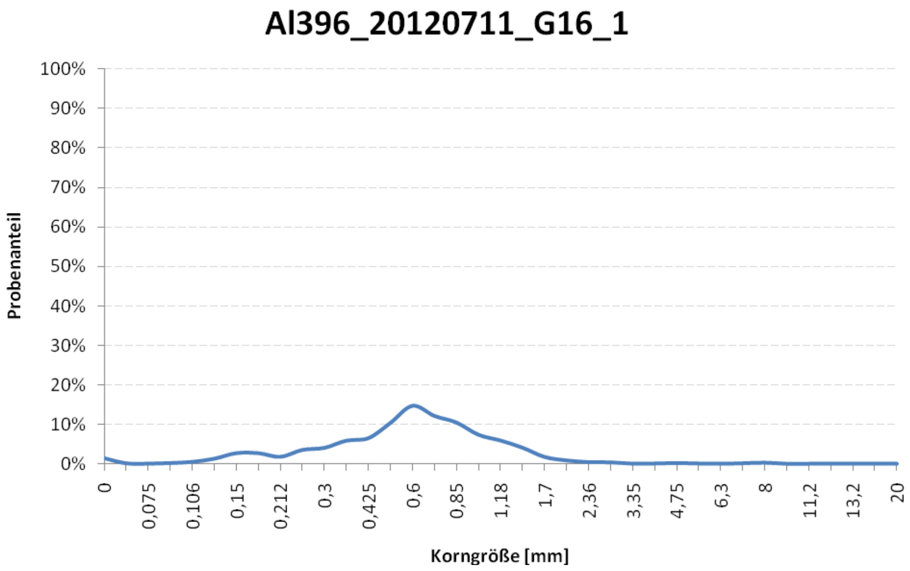
		Startpoints		**Endpoints**			
Profile	**Date**	**Lat (N)**	**Lon (E)**	**Lat (N)**	**Lon (E)**	**Profile length (nm)**	**Instruments**
79	14.07.2012	54.625467	7.85531	55.052128	7.843388	25.42	SES, MB, SSS, CS
NW-SE, 76	14.07.2012	54.814577	7.86291	54.743242	7.97901	5.88	SES, MB
S-N, 75	14.07.2012	54.743242	7.97901	54.806492	7.97767	3.76	SES, MB
E-W, 75	14.07.2012	54.806492	7.97767	54.805797	7.859465	4.1	SES, MB
“HelgToProfile” 87	15.07.2012	54.307347	7.928413	54.625732	7.849665	19.33	SES, MB
80	15.07.2012	54.631377	7.852388	55.043143	7.840852	25.1	SES, MB, SSS, CS
85, 86	15.07.2012	55.045002	7.837982	54.625732	7.849665	25.2	SES, MB, SSS, CS
84	15.07.2012	55.04573	7.83508	54.629487	7.846627	25	SES, MB, SSS, CS
W-E, 80	15.07.2012	54.769052	7.844063	54.767632	7.971617	4.47	SES, MB
S-N, 80	15.07.2012	54.767632	7.971617	54.806843	7.977385	2.34	SES, MB
S-NE, 81, 82	15.07.2012	54.806843	7.977385	54.845652	7.855215	4.86	SES, MB
S-N2, 82, 83	15.07.2012	54.845652	7.855215	54.94599	7.849182	6.18	SES, MB
S-N, 88, 89	16.07.2012	54.2411	7.815662	54.375915	7.830038	8.13	SES, MB
S-NE, 89	16.07.2012	54.375915	7.830038	54.543965	7.68201	11.34	SES, MB
SE-NW, 89	16.07.2012	54.543965	7.68201	54.646247	7.426072	10.83	SES, MB
W-E, 90, 91	16.07.2012	54.650067	7.409267	54.650043	7.709562	10.65	SES, MB, SSS, CS
W-E, 91	17.07.2012	54.650045	7.712298	54.650242	8.167272	15.84	SES, MB, SSS, CS
S-N, 91, 92	17.07.2012	54.650242	8.167272	54.699853	8.166745	2.98	SES, MB, SSS, CS
E-W, 92, 111	17.07.2012	54.699853	8.166745	54.70086	7.411092	26.31	SES, MB, SSS, CS
S-N, 114	17.07.2012	54.70086	7.411092	54.750171	7.410975	2.86	SES, MB, SSS, CS
W-E, 114	17.07.2012	54.750171	7.410975	54.750037	8.157147	25.96	SES, MB, SSS, CS
"Lanice-Profiles" (16 N-S-Profiles in bounding box: left upper, right lower coord.), 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 108, 109, 110	17.07.2012	54.694075	7.918805	54.677372	7.935658	each ~8.5	SES, MB, SSS, CS
S-N, 115	18.07.2012	54.750042	8.168275	54.798988	8.17791	2.99	SES, MB, SSS, CS
E-W, 115	18.07.2012	54.798988	8.17791	54.799649	7.412401	26.57	SES, MB, SSS, CS

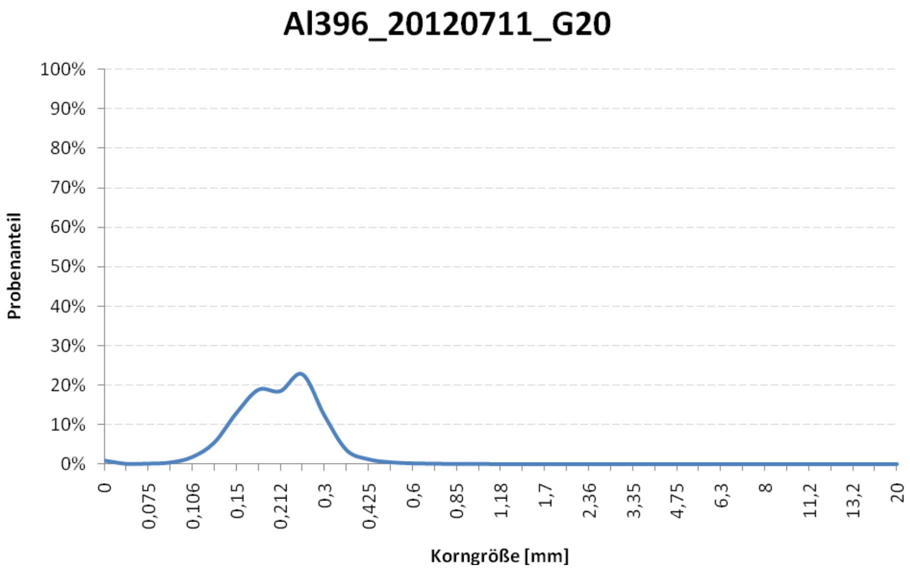
		Startpoints		Endpoints			
Profile	**Date**	**Lat (N)**	**Lon (E)**	**Lat (N)**	**Lon (E)**	**Profile length (nm)**	**Instruments**
S-N2, 116	18.07.2012	54.802652	7.409411	54.849613	7.408227	2.81	SES, MB, SSS, CS
W-E, 116	18.07.2012	54.849613	7.408227	54.8501	7.996942	20.4	SES, MB, SSS, CS
N-S, 118, 117, 116	18.07.2012	54.777067	8.026477	54.125403	8.069363	39.16	SES, MB

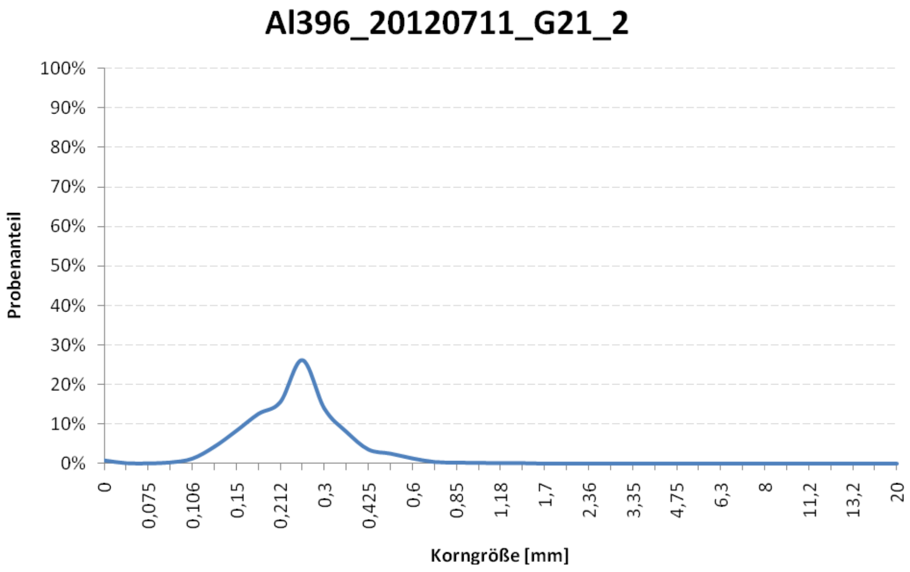
Table 6: Grain size distribution of already analyzed box corer samples.



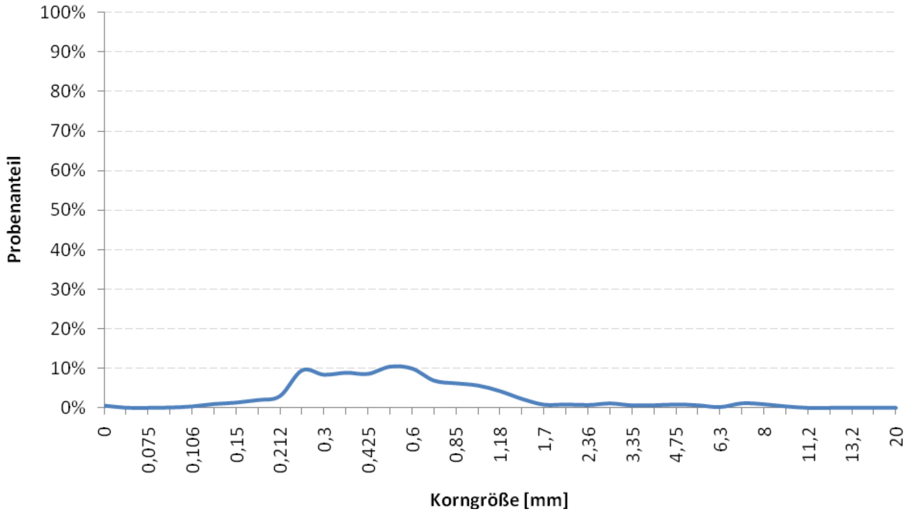



Al396_20120711_G16_1
Probenanteil
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
0,075
0,106
0,15
0,212
0,3
0,425
0,6
0,85
1,18
1,7
2,36
3,35
4,75
6,3
8
11,2
13,2
20
Korngröße [mm]

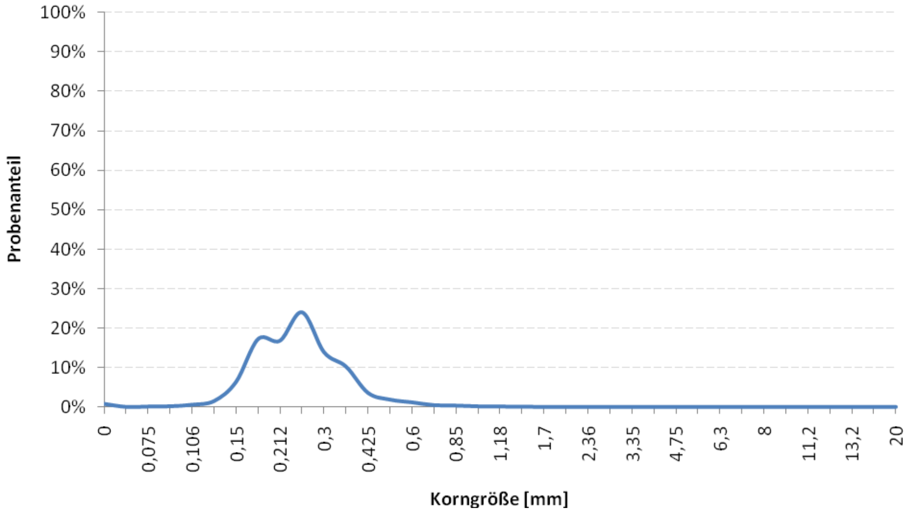

Al396_20120711_G20
Probenanteil
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
0,075
0,106
0,15
0,212
0,3
0,425
0,6
0,85
1,18
1,7
2,36
3,35
4,75
6,3
8
11,2
13,2
20
Korngröße [mm]


Al396_20120711_G21_2
Probenanteil
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
0,075
0,106
0,15
0,212
0,3
0,425
0,6
0,85
1,18
1,7
2,36
3,35
4,75
6,3
8
11,2
13,2
20
Korngröße [mm]

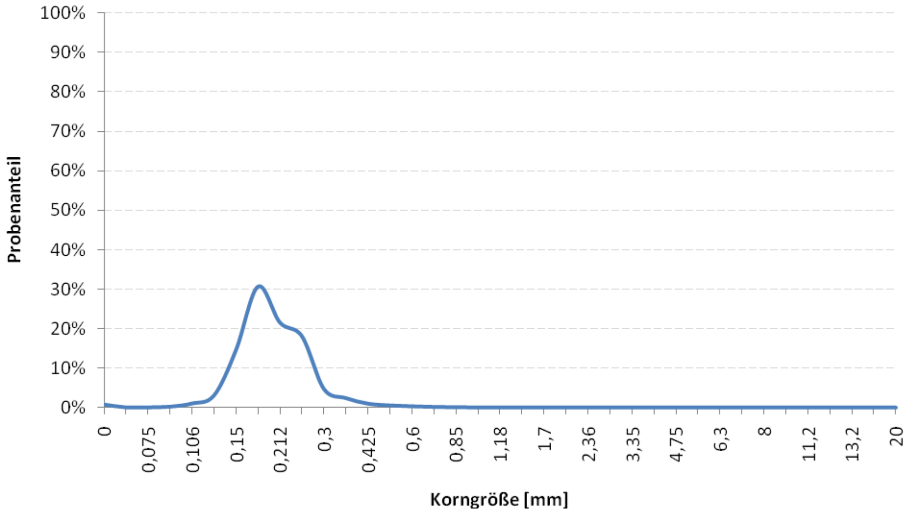
Al396_20120711_G22_3

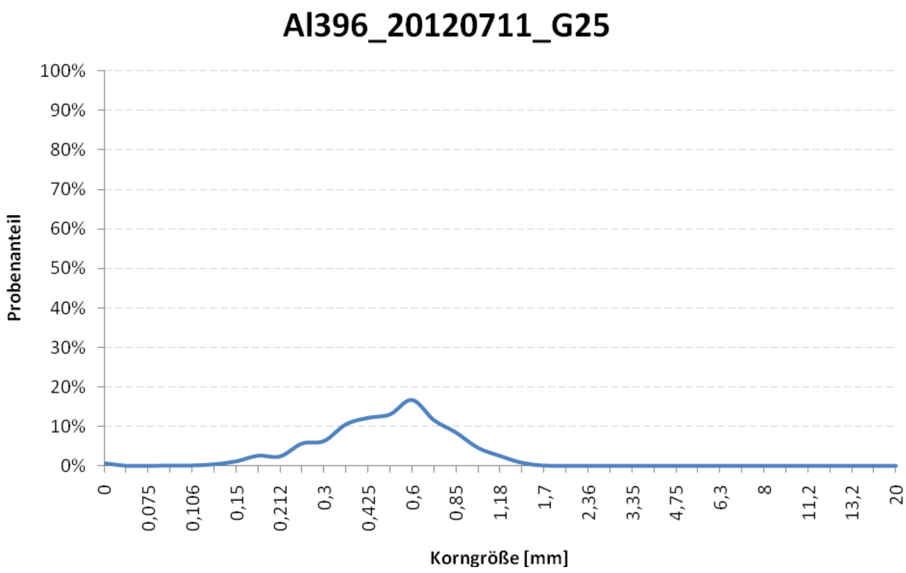


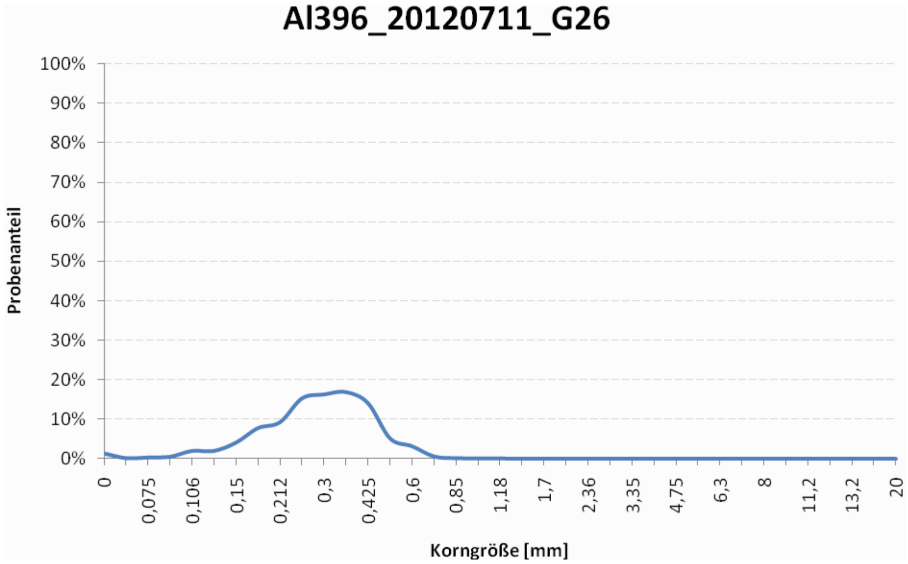
Al396_20120711_G23



Al396_20120711_G24




Al396_20120711_G25
Probenanteil
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
0,075
0,106
0,15
0,212
0,3
0,425
0,6
0,85
1,18
1,7
2,36
3,35
4,75
6,3
8
11,2
13,2
20
Korngröße [mm]


Al396_20120711_G26
Probenanteil
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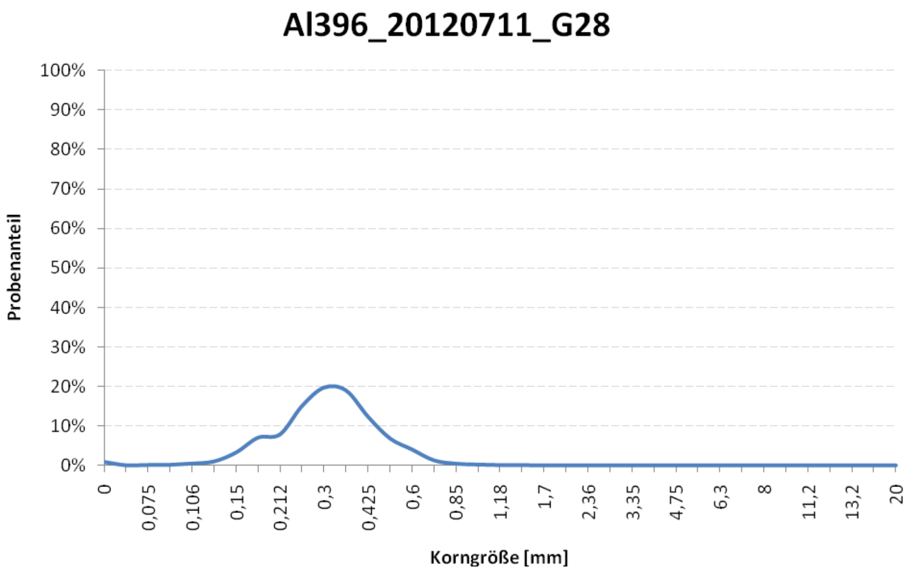
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
0,075
0,106
0,15
0,212
0,3
0,425
0,6
0,85
1,18
1,7
2,36
3,35
4,75
6,3
8
11,2
13,2
20
Korngröße [mm]


Al396_20120711_G28
Probenanteil
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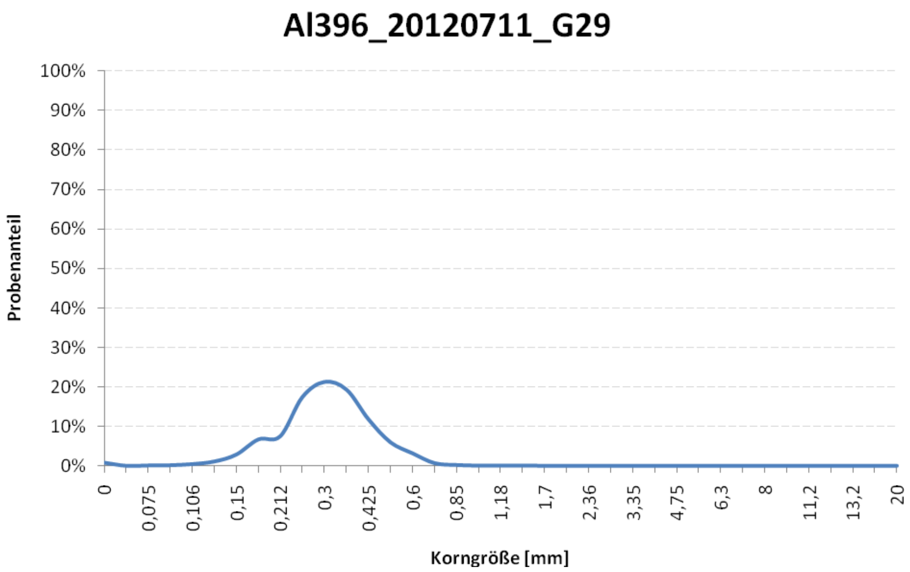
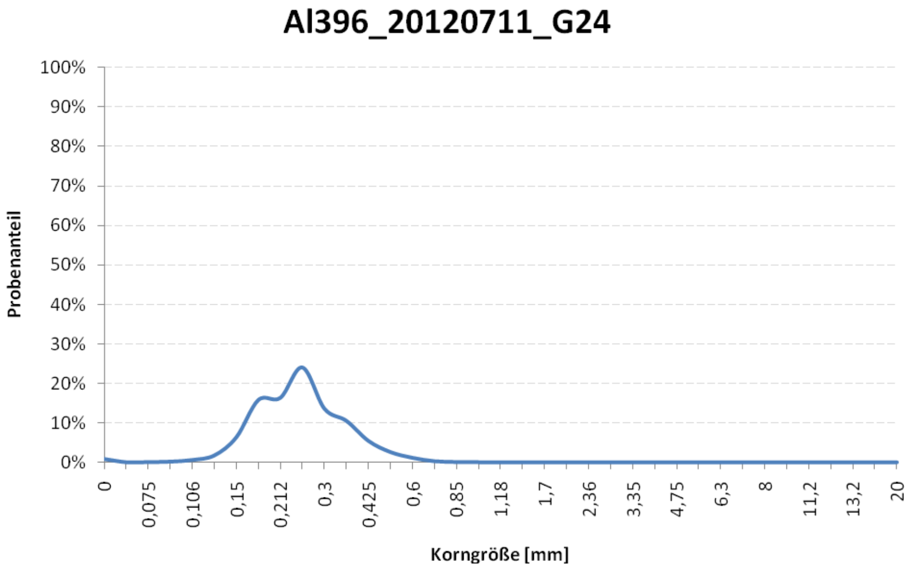
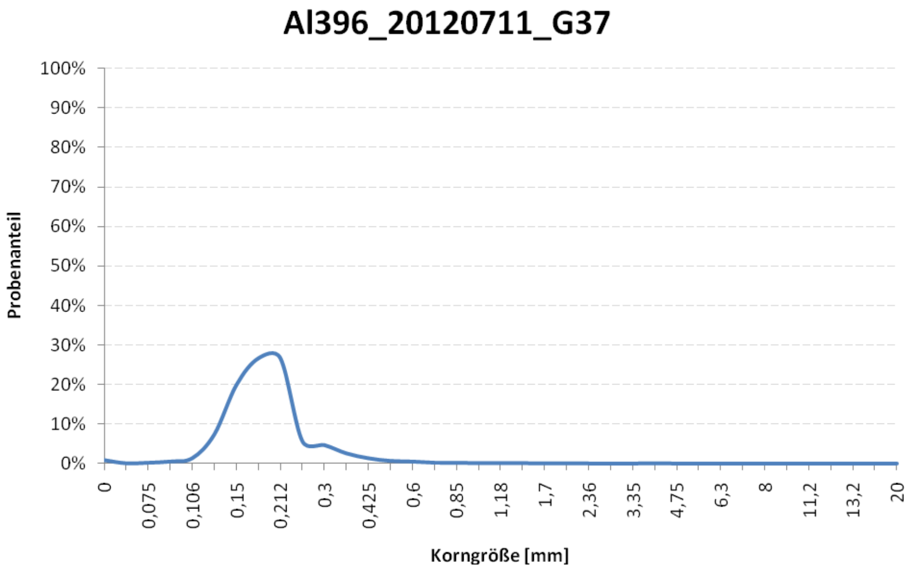
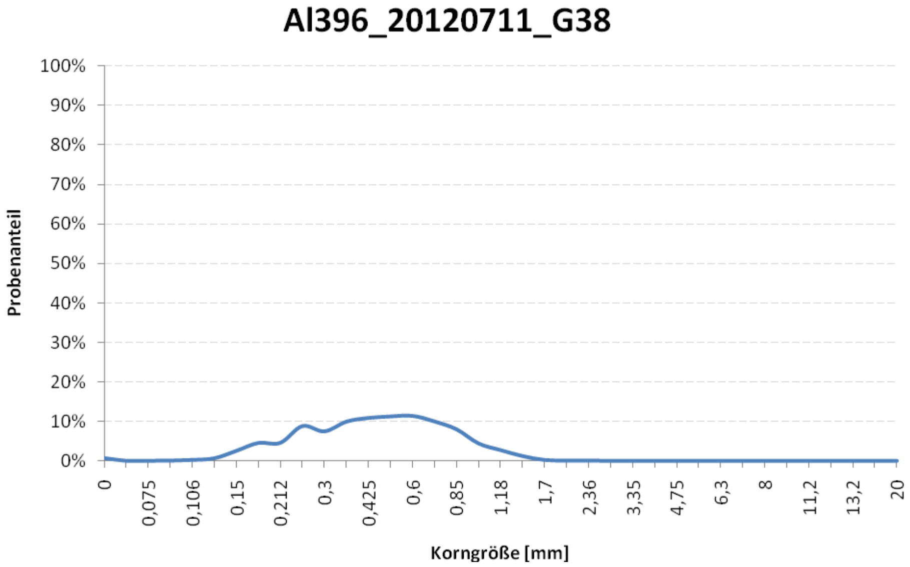
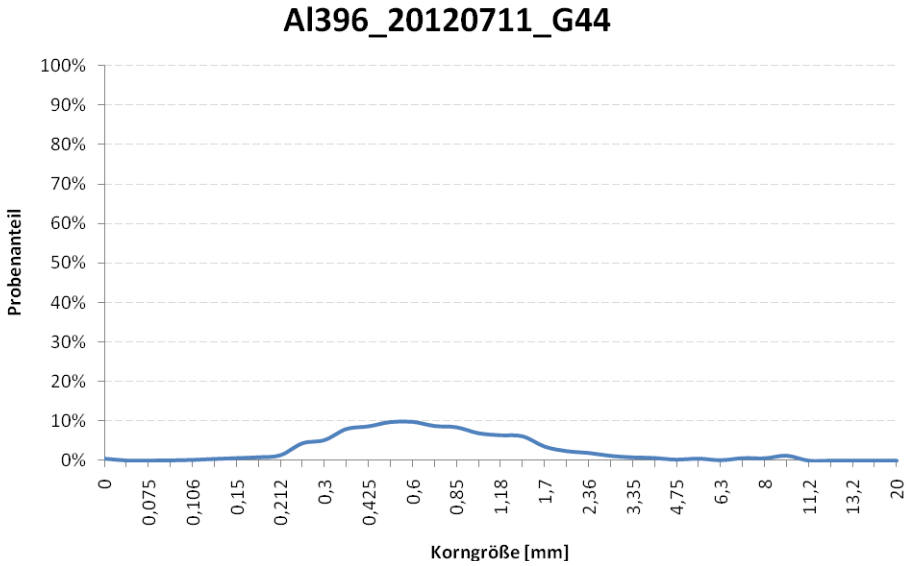
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
0,075
0,106
0,15
0,212
0,3
0,425
0,6
0,85
1,18
1,7
2,36
3,35
4,75
6,3
8
11,2
13,2
20
Korngröße [mm]


Al396_20120711_G29


Al396_20120711_G24


Al396_20120711_G37


Al396_20120711_G38
Probenanteil
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
0,075
0,106
0,15
0,212
0,3
0,425
0,6
0,85
1,18
1,7
2,36
3,35
4,75
6,3
8
11,2
13,2
20
Korngröße [mm]


Al396_20120711_G44
Probenanteil
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80%
70%
60%
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40%
30%
20%
10%
0%
0
0,075
0,106
0,15
0,212
0,3
0,425
0,6
0,85
1,18
1,7
2,36
3,35
4,75
6,3
8
11,2
13,2
20
Korngröße [mm]