

FS Poseidon

Cruise Report POS 505

SEDINO II - North Sea (west of Sylt)

12.09. – 26.09.2016

Institute of Geosciences (IfG)

Christian-Albrechts-Universität (CAU), Kiel



Dr. Peter P. Richter

Kiel, 10.02.2017

Table of contents

| | |
|------------------------------------------------|----|
| 1. Participants | 3 |
| 2. Cruise narrative | 4 |
| 3. Introduction | 7 |
| 4. Equipment | 9 |
| 5. Performed work and preliminary Results..... | 12 |
| 6. Acknowledgements..... | 14 |
| 7. References | 15 |
| 8. Appendix | 17 |

1. Participants

| | | |
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IFG: Institute of Geosciences – Sedimentology, Coastal– and Continental Shelf Research,
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IOW: Leibniz Institute for Baltic Sea Research, Warnemünde

Abbreviations

| | |
|----------------------------------------------|-------------|
| Sidescan Sonar (towed) | SSS |
| Multibeam Echosounder (hull mounted)..... | MBES |
| Innomar Subbottom Profiler (Moon Pool) | SES |
| Grab Sampler..... | GS |
| Giant Box Corer..... | GBC |
| Underwater Video | UWV |
| Conductivity Temperature Depth..... | CTD |

2. Cruise Narrative (Time in UTC)

12th September 2016

- 6:00 Loading ship; installation of devices
- 13:30 Visit of the Federal Minister of Education and Research, Prof. Dr. Johanna Wanka together with the director of GEOMAR, Prof. Dr. Peter Herzig.
- 15:00: Departure from IFM Geomar
- Transit to study site

Weather: Sunny, 2 Bft E

13th September 2016

- Transit to study site via Skagerrak
- Installation of devices

Weather: Sunny, 3 Bft E - NE

14th September 2016

- 12:50 CTD measurement
- 13:30 Hydroacoustic Profiles: SSS, SES, MBES

Weather: Sunny, 4 - 5 Bft E - NE

- During night: Profiles of SSS, SES and MBES

15th September 2016

- Hydroacoustic Profiles: SSS, SES, MBES

Weather: Partly cloudy, 5 Bft E

- During night: Profiles of SSS, SES and MBES

16th September 2016

Hydroakustic Profiles: SSS, SES, MBES

- 10:30 UWV
 - 14:30 Hydroacoustic Profiles: SSS, SES, MBES
- Weather: Partly cloudy, 4-5 Bft E
- During night: Profiles of SSS, SES and MBES

17th September 2016

- 6:00 GS (20 stations)
- 15:30 Hydroacoustic Profiles: SSS, SES, MBES

Weather: Partly cloudy, 6 Bft E

- During night: Profiles of SSS, SES and MBES

18th September 2016

- Hydroacoustic Profiles: SSS, SES, MBES

Weather: Partly cloudy, 4- 5 Bft E

- During night: Profiles of SSS, SES and MBES

19th September 2016

- 10:00: UWV
- 14:30 Hydroacoustic Profiles: SSS, SES, MBES

Weather: Partly cloudy, 5 Bft E

- During night: Profiles of SSS, SES and MBES

Weather: Sunny, 3Bft E

20th September 2016

- 6:00 GS (19 Stations)
- 15:30 Hydroacoustic Profiles: SSS, SES, MBES

Weather: Partly cloudy, 4 Bft E

- During night: Profiles of SSS, SES and MBES

21st September 2016

- 6:00 CTD
- 6:20 GBC (5 Stations)

- 11:30 Hydroacoustic Profiles: SSS, SES, MBES

Weather: Partly cloudy, 3 Bft E

- During night: Profiles of SSS, SES and MBES

22nd September 2016

- Hydroacoustic Profiles: SSS, SES, MBES

Weather: Partly cloudy, 3 - 4 Bft SW

- During night: Profiles of SSS, SES and MBES

23rd September 2016

- 6:00 GS (10 Stations)
- 15:30 Hydroacoustic Profiles: SSS, SES, MBES

Weather: Partly cloudy, 4 Bft W

- During night: Profiles of SSS, SES and MBES

24th September 2016

- 8:00: UW
- 13:30 Transit to Kiel via Skagerrak

Weather: Sunny, 4 Bft W

- During night: Profiles of SSS, SES and MBES

Wetter: Sunny, 3Bft E

25th September 2016

- Transit to Kiel, deinstallation of devices

Weather: Cloudy, partly sunny, 4 Bft S

- In der Nacht: Profile mit SSS, SES und MBES

26th September 2016

- Transit to Kiel
- 14:00 Arrival at IFM-Geomar Kiel

Weather: Sunny, 3 Bft SE

3. Introduction

Shallow coastal zones represent some of the most productive environments of the ocean and are characterized by complex distribution of benthic habitats (Gray 1997; Eyre and Maher, 2011; Micallef et al., 2012). As the quality, quantity and spatial distribution of these habitats becomes more and more important for the understanding of marine ecosystems, habitat mapping has become a major tool for investigating coastal marine environments (Jackson et al. 2001; Micallef et al., 2012). Acoustic backscatter data are nowadays the most widely used form of remote-sensed data (Brown et al. 2011). They provide a framework for mapping the distribution of benthic habitats and species (Kostylev et al., 2001; Valentine et al., 2005; Todd and Kostylev, 2011).

Historically, information on surface sediment distribution in the German Bight has been based on sampling on grids in combination with interpolation methods, initially without relation to benthic habitat distribution. The BSH-chart 2900 (Figge, 1981), which is originally based on ~25.000 grab samples, taken in a ten years period between 1964 and 1974, has been recently updated by Laurer et al. (2013) with an extended data set of 37.500 data points. Until now it is the only map showing a comprehensive surface sediment distribution of the German Bight. Gaps have been recently closed in the frame of the R & D project „Geopotenziale Deutsche Nordsee“. However, information on structure and distribution of potential habitats cannot be derived from this map. Investigations about habitat distributions on larger scales, like the “ICES North Sea Benthos Project 2000: Structure and dynamics of the North Sea benthos” - project (Rees et al., 2007) are based on grab sampling on even coarser grids than the BSH chart 2900, as this program is covering the entire North Sea. Furthermore, as there was interpolation between the sampling stations, a spatially undisturbed and comprehensive information is not available. Especially small- and meso scaled sedimentary structures, which allow conclusions on sediment dynamics, for instance sorted bedforms (Diesing 2006, Mielck et al, 2015) are not included in the BSH chart 2900. In consequence, sediment surface distribution can neither be correlated to sediment dynamic processes nor to the distribution of benthic communities.

The research cruise POS505 aims to investigate the impact of sediment- and morphodynamics on the distribution of benthic habitats. Based on comprehensive and high resolution acoustic backscatter data, a synoptic sampling campaign was accomplished, to provide information about the occurrence of different macrofauna communities. The purpose of here applied research is twofold: Firstly the surficial geology will be described as interpreted from geological and hydroacoustic data. Secondly the benthic habitats will be characterized based on statistical analyses of biological data. The second part will be supported and implemented by the working group on ecology of benthic organisms of the Leibniz Institute for Baltic Sea Research Warnemünde (IOW).

The study site is located in an area northwest of Sylt Island and focusses on an area where underlying moraine deposits of Saalian ages crop out to the surface (Figge 1981, Zeiler, 2008,). Hydroacoustic measurements carried out during cruise P474 (Schwarzer & Richter, 2014) cover the periphery of these pleistocene deposits and show small scaled alternations in the sediment surface distribution. Hydroacoustic measurements of cruise POS 489 (Schwarzer, Kiefer, Richter, 2015)) are located in the south. The grain size composition ranges from very fine sand to gravel and suggests a large number of structure related habitats. It can be assumed, that the highest diversity can be found in the central area of these Pleistocene deposits and is therefore most suitable to verify possible correspondences with the distribution of different macrofaunal communities.

Cruise POS505 was performed in the frame of the project SEDINO II (**SE**dimentdynamik In Nord- und **O**stsee). The project is funded by the Federal Agency of Nature Conservation (BfN) via the Federal Maritime Agency (BSH).

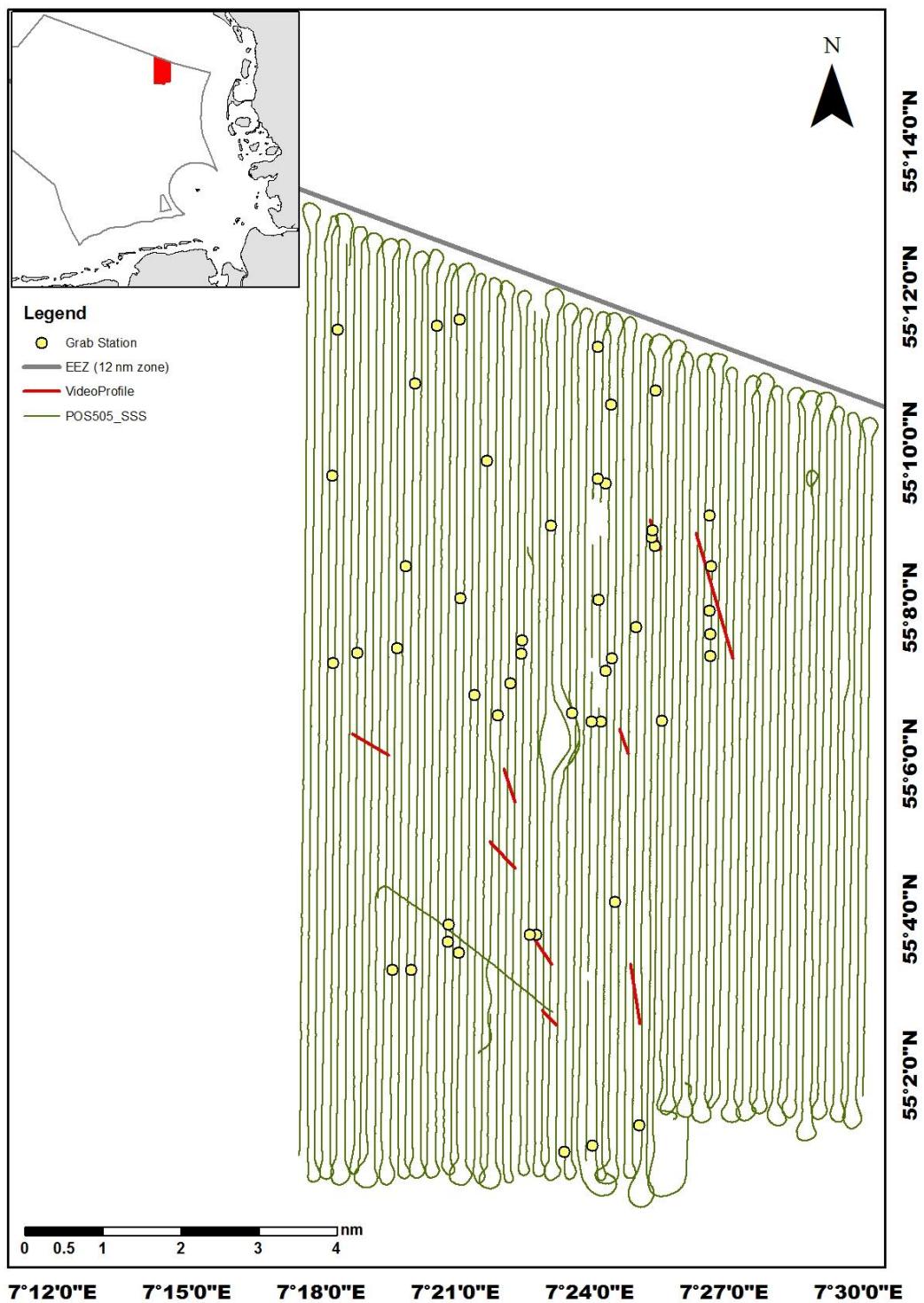


Fig. 1: Hydroacoustic Profiles and sampling locations of cruise POS 505.

4. Equipment

To provide information about the spatial distribution of bathymetry, sediment consistency and sedimentary texture, the application of high resolution hydroacoustic measuring techniques is common (Kenny et al. 2002, Hamilton 2005, Boyed et al. 2007, Blondel 2009, Lamarche, 2011). This method offers new detailed insights in the sedimentary structure and the sea bed properties (Diesing & Schwarzer 2006, Schwarzer & Diesing 2003, 2004, Feldens et al. 2010; Mielck 2014), and allow conclusions on recent sediment dynamics (Zeiler et al. 2000, Chang et al. 2006, Bartholomä, 2006, Mienert & Weaver 2012). Moreover, these modern methods can be used in combination with sediment classification systems and under water video systems, for mapping habitats and benthic communities (Cochrane & Lafferty 2002, Ehrhold et al. 2006, Rooper & Zimmermann 2007, Degraer et al. 2008a,b, Le Bas & Huvenne 2009, van Overmeeren 2009, van Rein et al. 2011, Barberá 2012).

Sidescan Sonar (SSS)

The seafloor is imaged by using a Side-Scan Sonar, Teledyne Benthos, SIS-1624 - dual frequency (Fig. 2). The device is commonly referred to as “towfish” which is towed behind the vessel. Transducers on each side of the device generate and transmit acoustic beams into the water-column and record them after their reflection and refraction from the seafloor. The travel time to reach the seabottom is converted into water depth, whereas the energy of the reflected acoustic signal provides information about sediment surface properties. Generating acoustic signals in different frequencies display different features of the same seafloor properties. The applied frequencies during this cruise accounted for 160kHz and 400kHz. Since ships movement are reflected in the raw data of acoustic signals, the tow vehicle includes pitch, roll and heading sensors to correct the collected signals.

The range, the length of the profiled area to each side, was set to 100 m. By setting the distance between the Profiles to 0.1 nautical mile (app. 185 m), overlap of approximately 20 m between neighboring profiles was intended. The altitude of the towfish above the seafloor is adjusted to the water depth and prevailing wave conditions. The layback of the towfish behind the ship during Profiling was in the range of 10 to 15 m. The layback was controlled by IfG's own winch (Cormac Q, Mac Artney Underwater Technology). The ship's speed was kept between 4 to 5 knots.

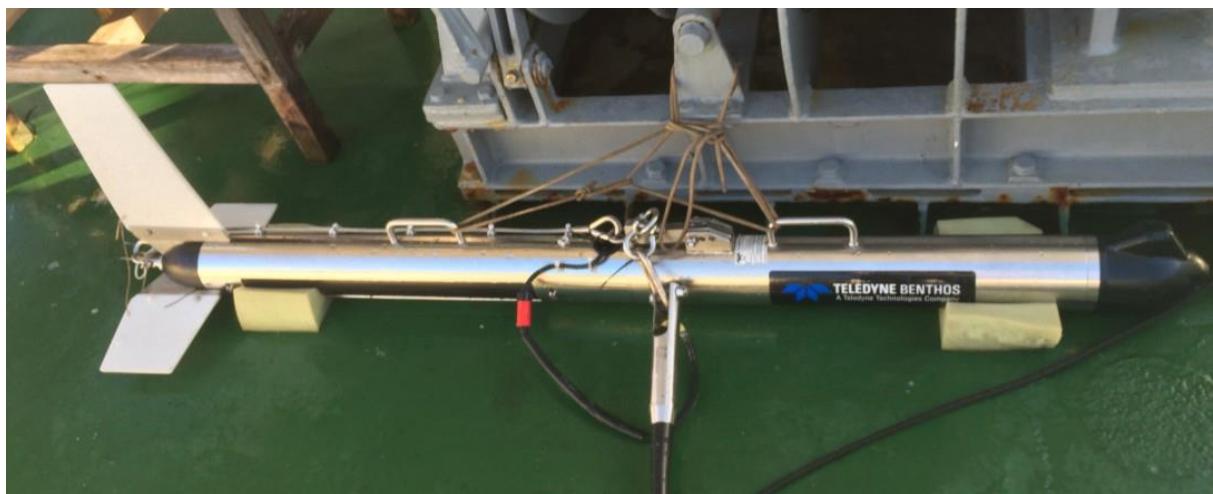


Figure 2: The employed Sidescan Sonar Teledyne Benthos, SIS-1624

Multibeam Echo Sounder (MBES)

The hull mounted MBS-system SeaBeam 3050 from ELAC Nautik GmbH was used to acquire bathymetrical data. The MBES transmits multiple pings, which are separated into two swaths (dual swath), into the water column. The applied frequency was 53 kHz. The bathymetric data is corrected for the ships pitch and roll. CTD Profiles are used to calibrate the sound velocity which depends on the actual water mass density. The water density in turn is a function of pressure, temperature and salinity.

Sediment Echo Sounder (SES)

The sub-bottom is profiled by a SES-2000 standard narrow beam parametric sub bottom profiler (Innomar Technologie GmbH). Sub-seafloor sediment structures are surveyed by the reflection of echo-signals at layers and/or objects. The travel-time of the reflected signal through the water column is converted into distances. The penetration depth of the sound signal depends on the transmitted frequency, where the lower frequency (4-15kHz) using the parametric acoustical effect is used to detect deeper structures in contrast to the higher frequency (100kHz) which primary follows the seafloor. A Kongsberg-EM 3000 motion sensor is used for correction of heave, roll and pitch of the ships movement

Grab Sampler (GS)

Van Veen grab sampling (here a HELCOM grab sampler) is a fast method to sample surface sediments precisely with low effort. During POS505 the sampling stations were chosen based on a roughly prepared Side-Scan Sonar mosaic. The grab sampler is deployed from the ship by a winch. Due its own weight the shovels penetrate into the sediment. Obviously, the sediment surface gets partly disturbed under these conditions. Sediment samples are used to validate the data of the performed hydroacoustic survey. The samples are described on board and prepared for further laboratory analysis at Kiel University.

Giant Box Corer (GBC)

The giant box corer allows to investigate undisturbed samples from the sediment surface. The surface area which is sampled amounts to 0.25 m² (50 cm x 50 cm); the maximum penetration is 60cm in soft sediments. On a sandy seafloor the penetration seldom reaches more than 20 – 30 cm.



Figure 3: The employed giant box corer (box not installed) during the cruise POS505.

Underwater Video (UWV)

Video tracks are recorded and displayed in real time with a „1Cam Alpha SubC Imaging“ underwater video camera from the IOW. The ship velocity during this procedure is below 1 nm. Underwater video survey is applied to validate the sediment properties inferred by backscatter data and for detailed imaging of marine habitat areas.

Conductivity Temperature Depth (CTD) probe

In order to calibrate the sound velocity of all hydroacoustic devices, sound-velocity Profilees are taken by a CTD (“Sea & Sun Technology”), which measures the parameters pressure, salinity and temperature with depth, defining the sound velocity. The CTD probe is lowered in the water with a wire cable, where the data cable is attached, down to 1 m above the sea-floor.

5. Performed work and preliminary Results

During POS 505 in total an area of 275 km² was covered by comprehensive and high resolution Sidescan Sonar measurements, which corresponds to a distance of ~840 nm of hydroacoustic profiles. Sediment sampling was done based on the Sidescan Sonar mosaic (Fig. 2), consisting of a processed 400 kHz frequency. Overall 49 grab samples and 5 giant box corer samples were taken. The Side Scan Sonar mosaic shows a pattern of mainly WNW – ESE striking areas of different sediment properties, which indicate an alteration of fine grained and coarse grained sediments. This sediment distribution patterns are separated by huge homogeneous sandy areas. This reflects, that the overlying Holocene sedimentary sequence consists of large scale areas of fine- to medium-grained marine sands (bright backscatter), formed after the last glacial period, and reworked Pleistocene material also containing coarser sand fractions. Certainly, the Pleistocene subsurface still imprints the seafloor. Partly areas are noticed where the underlying Pleistocene sediments are cropping out or are at least coming up close to the surface (dark backscatter) (Fig. 4).

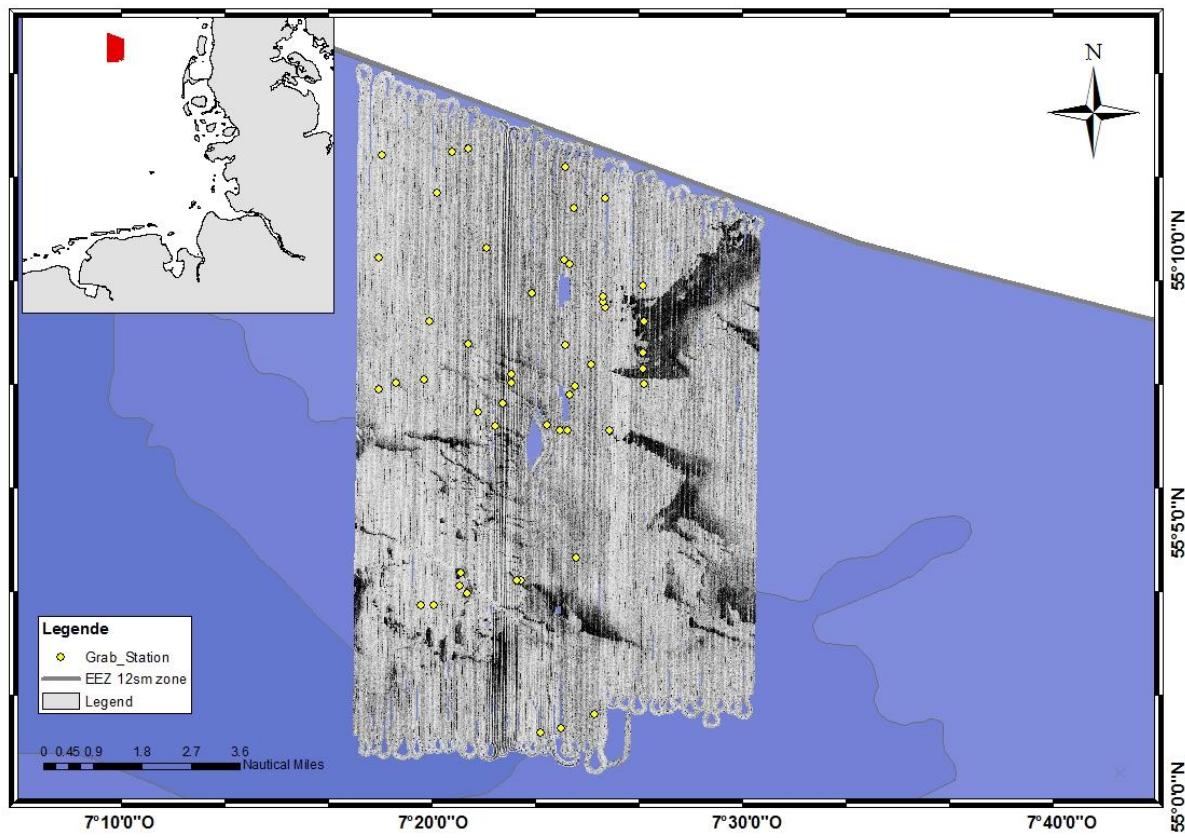
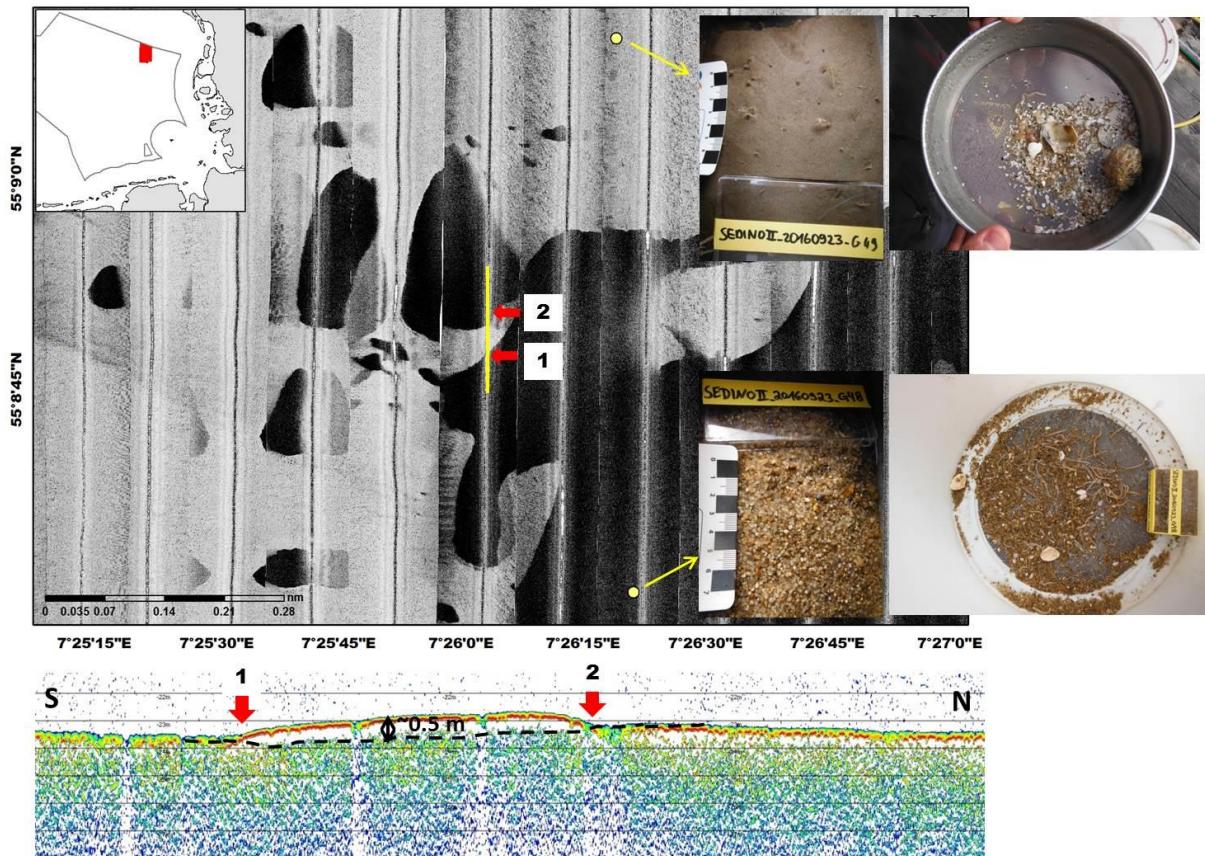


Fig. 4: Side Scan Sonar Mosaic of POS505 with grab sample stations.

The outcrop of these sediments is mainly composed of coarse sand and gravel, sometimes merging with areas of medium to coarse sand. In the Sidescan Sonar Mosaic not only parts with fine and coarse material can be differentiated, also different kind of fine sand can be distinguished. In this case, the major differentiator is the density of the fine sand areas, accompanying with slight differences in grain size composition. Predominantly the surface sediments consist of dense fine sand, disturbed with expanded areas of fine sand with medium density. These areas are slightly elongated and show as well an ESE – WNW orientated striking directions.

On an average in the working area the mobile sand coverage has a thickness of ~0,5 m (Fig. 5). At the sharp borders of the different sequences this offset is clearly visible in the SES data. Moreover, to the different sediment types different benthic communities can be assigned. The fine sand in this area is mainly characterized by only a few organisms of the tube worm *Lanice conchilega* and some urchins. In contrast the coarse sand and gravel fractions are characterized by a huge amount of *Amphioxus*. These organisms and additional other occurring species are currently counted and statistically analyzed.



*Fig. 5: SES profile in combination with Side Scan Sonar mosaic, showing a thickness of ~0,5 m, of the mobile sand coverage. The bright backscatter reflects grain size fractions of fine sand, including organisms of *Lanice conchilega*. The dark backscatter reflects coarse sand to gravel and is providing a habitat for *Amphioxus*.*

Profiles of underwater video illustrate that areas of different backscatter can be assigned to different benthic communities (Fig. 6). Areas of coarse sand to gravel corresponding to the dark backscatter can also occur including ripple marks. In the ripple through huge amounts of *Ensis* shells can be noticed, presumably beside the gravel also responsible for the dark backscatter (Fig. 6 (1)). In the fine sand areas with medium density, organisms of the tube worm *Lanice conchilega* can be found (Fig. 6 (2)). In contrast the areas with very dense fine sand shows a considerably limited population of benthic organisms (Fig. 6 (3)).

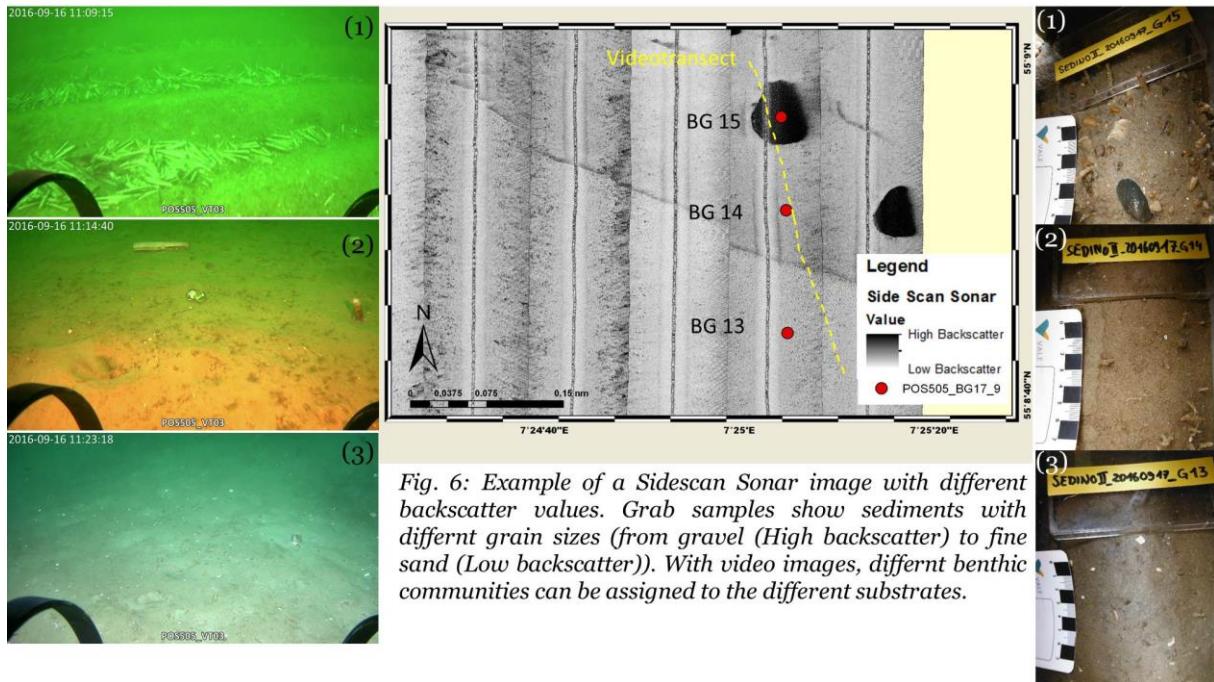


Fig. 6: Example of a Sidescan Sonar image with different backscatter values. Grab samples show sediments with different grain sizes (from gravel (High backscatter) to fine sand (Low backscatter)). With video images, different benthic communities can be assigned to the different substrates.

6. Acknowledgements

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7. References

- BARBERÁ C.; MORANTA J; ORDINES F., RAMÓN M.; DE MESA A., DÍAZ-VALDE'S M.; GRAU A.M; MASSUTÍ, E. 2012. Biodiversity and habitat mapping of Menorca Channel (western Mediterranean): implications for conservation. *Biodivers. Conserv.* (2012) 21, p. 701–728
- BARTHOLOMÄ, A., 2006. Acoustic bottom detection and seabed classification in the German Bight. *Geo-Marine Letters*, 26, 177-184.
- BLONDEL, P., 2009. *The Handbook of Sidescan Sonar*. – Springer, 316 pp.
- BOYED, S.E., COGGAN, R.A., BIRCHENOUGH, S.N.R., LIMPENNY, D.S., EASTWOOD, P.E., FOSTER-SMITH, R.L., PHILPOTT, S., MEADOWS, W.J., JAMES, J.W.C., VANSTAEN, K., SOUSSI, S., ROGERS, S., 2007. The role of seabed mapping techniques in environmental monitoring and management. – *Sci. Ser. Tech Rep.*, Cefas Lowestoft, 127; 170 pp.
- BROWN C.J., SMITH, S.J., LAWTON P., ANDERSON J.T., 2011. Benthic habitat mapping: A review of progress towards improved understanding of the spatial ecology of the seafloor using acoustic techniques. - *Estuarine, Coastal and Shelf Science* 92 (2011) 502-520
- CHANG, T.S., BARTHOLOMÄ, A., FLEMMING, B.W., 2006. Seasonal dynamics of fine-grained sediments in a back-barrier tidal basin of the German Wadden Sea (southern North Sea). *J. Coastal Res.*, 22, 328-338.
- COCHRANE, G.R., LAFFERTY, K.D., 2002. Use of acoustic classification of sidescan sonar data for mapping benthic habitat in the Northern Channel Islands, California. – *Continental Shelf Research*, 22, 683 – 690.
- DEGRAER, S., VERFAILLIE, E., WILLEMS, W., ADRIANS, E., VINCX, M., VAN LANCKER, V. 2008A. Habitat suitability modelling as a mapping tool for macrobenthic communities: An example from the Belgian part of the North Sea. *Continental Shelf Research*, 28, 369 – 379.
- DEGRAER, S., MOERKERKE, G., RABAUT, M., VAN HOEY, G., DU FOUR, I., VINCX, M., HENRIET, J.P., VAN LANCKER, V., 2008B. Very-high resolution side-scan sonar mapping of biogenic reefs of the tube-worm *Lanice conchilega*. – *Remote sensing of Environment* 112, 3323 – 3328.
- DIESING, M., KUBICKI, A., WINTER, C., SCHWARZER, K., 2006. Decadal scale stability of sorted bedforms, German Bight, southeastern North Sea. *Cont. Shelf Res.*, 26, 902-916.
- EHRHOLD, A., HAMNO, D., GUILLAUMONT, B., 2006. The REBENT monitoring network, a spatially integrated, acoustic approach to surveying nearshore macrobenthic habitats. Application to the Bay of Concarneau (South Brittany, France). – *ICES Journal of marine Science*, 63, 1604 – 2615, doi:10.1016/j.icesjms.2006.06.010.
- EYRE, B.D., MAHER, D., 2011. Mapping ecosystem processes and function across shallow seascapes. *Continental Shelf Research* 31, S162–S172.
- GRAY, J.S., 1997. Marine biodiversity: patterns, threats and conservation needs. *Biodiversity and Conservation* 6, 153–175.
- FELDENS, P., SAKUNA, D., Sompongchaiyakul, P., Schwarzer, K., 2010. Shallow water sediment structures in a tsunami-affected area (Pakarang Cape, Thailand). – *Coastline Reports* 16, 15 – 24.
- FIGGE, K., 1981. *Sedimentverteilung in der Deutschen Bucht*. Maßstab 1 : 250.000. DHI Karte Nr. 2900 mit Begleitheft.
- HAMILTON, L.J., 2005. A bibliography of acoustic seabed classification. *Cooperative Research*
- JACKSON, J.B.C., KIRBY, M.X., BERGER, W.H., BJORNDAL, K.A., BOTSFORD, L.W., BOURQUE, B.J., BRADBURY, R.H., COOKE, R., ERLANDSON, J., ESTES, J.A., HUGHES, T.P., KIDWELL, S., LANGE, C.B., LENIHAN, H.S., PANDOLFI, J.M., PETERSON, C.H., STENECK, R.S., TEGNER, M.J., WARNER, R.R., 2001. Historical overfishing and the recent collapse of coastal ecosystems. *Science* 293, 629–638.

- KENNY, A.J., CATO, I., DESPREZ, M., FADERA, G., SCHÜTTENHELM, R.T.E., SIDE, J., 2002. An overview of seabed-mapping technologies in the context of marine habitat classification. ICES, J. of Marine Science 60 (2), 411 – 418
- KOSTYLEV, V.E., TODD, B., FADER, J., COURTNEY, G.B., CAMERON, R.C., PICKRILL, R.A., G.D., 2001. Benthic habitat mapping on the Scotian Shelf based on multibeam bathymetry, surficial geology and seafloor photographs. Marine Ecology Progress Series 219, 121–137.
- LAMARCHE, G., LURTON, X., VERDIER A., AUGUSTIN, J., 2011. Quantitative characterisation of seafloor substrate and bedforms using advanced processing of multibeam backscatter—Application to Cook Strait, New Zealand. Continental Shelf Research 31(2011), S. 93–S109
- LAURER, U., NAUMANN, M., ZEILER, M. 2013. Geopotenzziale Deutsche Nordsee, Modul B, Dokumentation Nr. 1; Erstellung der Karte zur Sedimentverteilung auf dem Meeresboden in der deutschen Nordsee nach der Klassifikation von FIGGE (1981).
- LE BAS, T.P., HUVENNE, V.A.I., 2009. Acquisition and processing of backscatter data for habitat mapping—Comparison of multibeam and sidescan systems. Applied Acoustics, 70, 1248-1257
- MICALLEF A., LEVAS T.P., HUVENNE V.A.I., BLONDEL P., HÜHNERBACH V., DEIDUN A. 2012. A multi-method approach for benthic habitat mapping of shallow coastal areas with high-resolution multibeam data - Continental Shelf Research 39–40 (2012) 14–26
- MIELCK, F., HASS, H.C., AND BETZLER, C., 2014. High-resolution hydroacoustic seafloor classification of sandy environments in the German Wadden Sea. Journal of Coastal Research, 30(6), 1107–1117.
- MIELCK, F., HOLLER, P., BÜRK, D., HASS, C., 2015. Interannual variability of sorted bedforms in the coastal German Bight (SE North Sea). Continental Shelf Res., <http://dx.doi.org/10.1016/j.csr.2015.10.016>
- MIENERT, J. & WEAVER, P. (EDS.) 2012. European margin sediment dynamics: side-scan sonar and seismic images. Springer Science & Business Media, 2012 - 309 pp.
- REES H.L., EGGLERSON J.D., RACHOR E., VANDEN BERGHE, E.(Eds.) 2007. Structure and dynamics of the Northern Sea benthos, ICES Cooperative Research Report No. 288, Copenhagen, Denmark (2007).
- ROOPER, C.N., ZIMMERMANN, M., 2007. A bottom-up methodology for integrating underwater video and acoustic mapping for seafloor substrate classification. Continental Shelf Research, 27, 947 – 957.
- SCHWARZER, K., DIESING, M., 2003. Erforschung der FFH Lebensraumtypen Sandbank und Riff in der AWZ der deutschen Nord- und Ostsee. FKZ, 80, 285 – 270.
- SCHWARZER, K., DIESING, M., 2004. Erforschung der FFH Lebensraumtypen Sandbank und Riff in der AWZ der deutschen Nord- und Ostsee. 4. Zwischenbericht, 31.S.
- Schwarzer, K., Richter, P.P. 2014. Cruise Report POSEIDON 474, 6.09.-21.09.2014. DOI: [10.13140/RG.2.2.27009.45928](https://doi.org/10.13140/RG.2.2.27009.45928)
- Schwarzer, K., Kiefer, J., Richter, P.P. Cruise Report POSEIDON 489, Sept. 9th - 24th, 2015. DOI: [10.13140/RG.2.2.17808.20488](https://doi.org/10.13140/RG.2.2.17808.20488)
- TODD, B.J., KOSTYLEV, V.E. 2011. Surficial geology and benthic habitat of the German Bank seabed, Scotian Shelf, Canada - Continental Shelf Research 31 (2011) S54–S68
- VALENTINE, P.C., TODD, B.J., KOSTYLEV, V.E., 2005. Classification of marine sublittoral habitats, with application to the northeastern North America region. In: Barnes, P.W., Thomas, J.P. (Eds.), Benthic Habitats and the Effects of Fishing, Symposium 41. American Fisheries Society, Bethesda, MD, 183–200.
- VAN OVERMEEREN, R., CRAEMERSCH, J., VAN DALSEN, J., FEY, F., 2009. Acoustic habitat and shellfish mapping and monitoring in shallo coastal water – Sidescan sonar experiences in The Netherlands. – Estuarine, Coastal and Shelf Science, 85, 437 – 448.

VAN REIN, H., BROWN, C.J., QUINN, R., BREEN, J., SCHOEMAN, D., 2011. An evaluation of acoustic seabed classification techniques for marine biotope monitoring over broad-scales (> 1km²) and meso-scales (10 m²-1 km²). – Estuarine Coastal and Shelf Science, 93, 336 – 349.

ZEILER, M., SCHULZ-OHLBERG, J., FIGGE, K., 2000. Mobile sand deposits and shoreface sediment dynamics in the inner German Bight (North Sea). Mar. Geol., 170, 363-380.

ZEILER, M., SCHWARZER, K., BARTHOLOMÄ, A., RICKLEFS, K., 2008. Seabed morphology and sediment dynamics. Die Küste, 74, 31 – 44.

8. Appendix

(Time in UTC)

Samples

A) Grab samples

| Name | Latitude | Longitude |
|-----------------------|-----------|------------|
| SEDINOII_20160817_G1 | 7° 23.714 | 55° 11.267 |
| SEDINOII_20160817_G2 | 7° 25.024 | 55° 10.724 |
| SEDINOII_20160817_G3 | 7° 24.036 | 55° 10.555 |
| SEDINOII_20160817_G4 | 7° 23.787 | 55° 9.582 |
| SEDINOII_20160817_G5 | 7° 23.928 | 55° 9.505 |
| SEDINOII_20160817_G6 | 7° 25.061 | 55° 8.937 |
| SEDINOII_20160817_G7 | 7° 25.073 | 55° 8.845 |
| SEDINOII_20160817_G8 | 7° 25.080 | 55° 8.723 |
| SEDINOII_20160817_G9 | 7° 23.906 | 55° 8.020 |
| SEDINOII_20160817_G10 | 7° 24.741 | 55° 7.696 |
| SEDINOII_20160817_G11 | 7° 24.126 | 55° 7.267 |
| SEDINOII_20160817_G12 | 7° 24.096 | 55° 7.119 |
| SEDINOII_20160817_G13 | 7° 23.911 | 55° 6.577 |
| SEDINOII_20160817_G14 | 7° 23.704 | 55° 6.479 |
| SEDINOII_20160817_G15 | 7° 23.936 | 55° 6.479 |
| SEDINOII_20160817_G16 | 7° 25.272 | 55° 6.518 |
| SEDINOII_20160817_G17 | 7° 24.276 | 55° 4.191 |
| SEDINOII_20160817_G18 | 7° 23.320 | 55° 3.551 |
| SEDINOII_20160817_G19 | 7° 25.025 | 55° 1.312 |
| SEDINOII_20160817_G20 | 7° 23.968 | 55° 1.041 |
| SEDINOII_20160820_G21 | 7° 20.597 | 55° 11.594 |
| SEDINOII_20160820_G22 | 7° 20.065 | 55° 11.495 |
| SEDINOII_20160820_G23 | 7° 19.639 | 55° 10.773 |
| SEDINOII_20160820_G24 | 7° 21.342 | 55° 9.796 |
| SEDINOII_20160820_G25 | 7° 22.753 | 55° 8.995 |
| SEDINOII_20160820_G26 | 7° 19.520 | 55° 8.462 |

| | | |
|-----------------------|-----------|------------|
| SEDINOII_20160820_G27 | 7° 20.742 | 55° 8.017 |
| SEDINOII_20160820_G28 | 7° 19.347 | 55° 7.349 |
| SEDINOII_20160820_G29 | 7° 22.136 | 55° 7.517 |
| SEDINOII_20160820_G30 | 7° 22.160 | 55° 7.286 |
| SEDINOII_20160820_G31 | 7° 21.919 | 55° 6.941 |
| SEDINOII_20160820_G32 | 7° 21.059 | 55° 6.777 |
| SEDINOII_20160820_G33 | 7° 21.672 | 55° 6.516 |
| SEDINOII_20160820_G34 | 7° 20.650 | 55° 3.809 |
| SEDINOII_20160820_G35 | 7° 20.688 | 55° 3.608 |
| SEDINOII_20160820_G36 | 7° 20.896 | 55° 3.468 |
| SEDINOII_20160820_G37 | 7° 20.623 | 55° 2.808 |
| SEDINOII_20160820_G38 | 7° 20.149 | 55° 2.793 |
| SEDINOII_20160820_G39 | 7° 19.711 | 55° 2.732 |
| SEDINOII_20160823_G40 | 7° 23.359 | 55° 0.932 |
| SEDINOII_20160823_G41 | 7° 17.885 | 55° 11.368 |
| SEDINOII_20160823_G42 | 7° 17.858 | 55° 9.535 |
| SEDINOII_20160823_G43 | 7° 18.506 | 55° 7.282 |
| SEDINOII_20160823_G44 | 7° 17.958 | 55° 7.132 |
| SEDINOII_20160823_G45 | 7° 17.421 | 55° 3.526 |
| SEDINOII_20160823_G46 | 7° 26.364 | 55° 7.625 |
| SEDINOII_20160823_G47 | 7° 26.318 | 55° 7.928 |
| SEDINOII_20160823_G48 | 7° 26.356 | 55° 8.510 |
| SEDINOII_20160823_G49 | 7° 26.278 | 55° 9.161 |

B) *Giant Box Corer samples*

| Name | Longitude | Latitude |
|-----------------------|---------------|---------------|
| SEDINOII_20160921_GK1 | 55° 06,775' N | 07° 21,199' E |
| SEDINOII_20160921_GK2 | 55° 07,288' N | 07° 24,182' E |
| SEDINOII_20160921_GK3 | 55° 08,410' N | 07° 19,512' E |
| SEDINOII_20160921_GK4 | 55° 08,848' N | 07° 25,015' E |
| SEDINOII_20160921_GK5 | 55° 08,973 N | 07° 22,741' E |

C) *Hydroacoustic Profiles*

| Description | Longitude | Latitude | Date/Time |
|-------------------|-----------|----------|------------------|
| Profile 1 , Begin | 55.014435 | 7.42241 | 14.09.2016 12:50 |
| Profile 1 , End | 55.185522 | 7.41655 | 14.09.2016 15:06 |
| Profile 2 , Begin | 55.185522 | 7.41655 | 14.09.2016 15:06 |
| Profile 2 , End | 55.01476 | 7.417905 | 14.09.2016 17:26 |
| Profile 3 , Begin | 55.01476 | 7.417905 | 14.09.2016 17:26 |

| | | | |
|-------------------|-----------|----------|------------------|
| Profile 3 , End | 55.184628 | 7.41116 | 14.09.2016 19:40 |
| Profile 4, Begin | 55.184628 | 7.41116 | 14.09.2016 19:40 |
| Profile 4, End | 55.015043 | 7.411813 | 14.09.2016 21:55 |
| Profile 5, Begin | 55.015043 | 7.411813 | 14.09.2016 21:55 |
| Profile 5, End | 55.187462 | 7.405185 | 15.09.2016 00:15 |
| Profile 6, Begin | 55.187462 | 7.405185 | 15.09.2016 00:15 |
| Profile 6, End | 55.015352 | 7.406447 | 15.09.2016 02:36 |
| Profile 7, Begin | 55.015352 | 7.406447 | 15.09.2016 02:36 |
| Profile 7, End | 55.189467 | 7.399723 | 15.09.2016 04:58 |
| Profile 8, Begin | 55.189467 | 7.399723 | 15.09.2016 04:58 |
| Profile 8, End | 55.015013 | 7.400858 | 15.09.2016 07:14 |
| Profile 9, Begin | 55.015013 | 7.400858 | 15.09.2016 07:14 |
| Profile 9, End | 55.190155 | 7.393833 | 15.09.2016 09:37 |
| Profile 10, Begin | 55.190155 | 7.393833 | 15.09.2016 09:37 |
| Profile 10, End | 55.01413 | 7.397647 | 15.09.2016 12:22 |
| Profile 11, Begin | 55.01413 | 7.397647 | 15.09.2016 12:22 |
| Profile 11, End | 55.1913 | 7.388287 | 15.09.2016 14:01 |
| Profile 12, Begin | 55.1913 | 7.388287 | 15.09.2016 14:01 |
| Profile 12, End | 55.014995 | 7.389698 | 15.09.2016 16:48 |
| Profile 13, Begin | 55.014995 | 7.389698 | 15.09.2016 16:48 |
| Profile 13, End | 55.192077 | 7.382573 | 15.09.2016 19:38 |
| Profile 14, Begin | 55.192077 | 7.382573 | 15.09.2016 19:38 |
| Profile 14, End | 55.01438 | 7.383752 | 15.09.2016 22:46 |
| Profile 15, Begin | 55.0144 | 7.383748 | 15.09.2016 22:46 |
| Profile 15, End | 55.19362 | 7.376135 | 16.09.2016 01:42 |
| Profile 16, Begin | 55.19362 | 7.376135 | 16.09.2016 01:42 |
| Profile 16, End | 55.013832 | 7.378228 | 16.09.2016 04:29 |
| Profile 17, Begin | 55.013832 | 7.378228 | 16.09.2016 04:29 |
| Profile 17, End | 55.193958 | 7.373857 | 16.09.2016 07:10 |
| Profile 18, Begin | 55.194895 | 7.371018 | 16.09.2016 07:22 |
| Profile 18, End | 55.014352 | 7.372755 | 16.09.2016 17:04 |
| Profile 19, Begin | 55.01437 | 7.37276 | 16.09.2016 17:04 |
| Profile 19, End | 55.195168 | 7.36551 | 16.09.2016 19:36 |
| Profile 20, Begin | 55.195145 | 7.365517 | 16.09.2016 19:36 |
| Profile 20, End | 55.014407 | 7.36657 | 16.09.2016 22:16 |
| Profile 21, Begin | 55.014407 | 7.36657 | 16.09.2016 22:16 |
| Profile 21, End | 55.196075 | 7.35992 | 17.09.2016 00:54 |
| Profile 22, Begin | 55.196075 | 7.35992 | 17.09.2016 00:54 |
| Profile 22, End | 55.014352 | 7.360787 | 17.09.2016 03:33 |
| Profile 23, Begin | 55.014352 | 7.360787 | 17.09.2016 03:33 |
| Profile 23, End | 55.1978 | 7.354153 | 17.09.2016 16:50 |
| Profile 24, Begin | 55.1978 | 7.354153 | 17.09.2016 16:50 |
| Profile 24, End | 55.014355 | 7.356078 | 17.09.2016 19:31 |
| Profile 25, Begin | 55.014355 | 7.356078 | 17.09.2016 19:31 |
| Profile 25, End | 55.19856 | 7.34829 | 17.09.2016 22:08 |

| | | | |
|-------------------|-----------|----------|------------------|
| Profile 26, Begin | 55.19856 | 7.34829 | 17.09.2016 22:08 |
| Profile 26, End | 55.014762 | 7.349813 | 18.09.2016 00:49 |
| Profile 27, Begin | 55.014762 | 7.349813 | 18.09.2016 00:49 |
| Profile 27, End | 55.20028 | 7.34222 | 18.09.2016 03:26 |
| Profile 28, Begin | 55.20028 | 7.34222 | 18.09.2016 03:26 |
| Profile 28, End | 55.014168 | 7.344358 | 18.09.2016 06:02 |
| Profile 29, Begin | 55.014168 | 7.344358 | 18.09.2016 06:02 |
| Profile 29, End | 55.20095 | 7.33741 | 18.09.2016 08:40 |
| Profile 30, Begin | 55.20095 | 7.33741 | 18.09.2016 08:40 |
| Profile 30, End | 55.014545 | 7.338417 | 18.09.2016 11:23 |
| Profile 31, Begin | 55.014545 | 7.338417 | 18.09.2016 11:23 |
| Profile 31, End | 55.201863 | 7.330632 | 18.09.2016 13:59 |
| Profile 32, Begin | 55.201863 | 7.330632 | 18.09.2016 13:59 |
| Profile 32, End | 55.01411 | 7.33306 | 18.09.2016 16:31 |
| Profile 33, Begin | 55.014132 | 7.333058 | 18.09.2016 16:31 |
| Profile 33, End | 55.203357 | 7.325705 | 18.09.2016 19:14 |
| Profile 34, Begin | 55.203357 | 7.325705 | 18.09.2016 19:14 |
| Profile 34, End | 55.013882 | 7.327728 | 18.09.2016 22:00 |
| Profile 35, Begin | 55.013882 | 7.327728 | 18.09.2016 22:00 |
| Profile 35, End | 55.205597 | 7.319937 | 19.09.2016 00:43 |
| Profile 36, Begin | 55.205597 | 7.319937 | 19.09.2016 00:43 |
| Profile 36, End | 55.012112 | 7.321378 | 19.09.2016 03:29 |
| Profile 37, Begin | 55.012112 | 7.321378 | 19.09.2016 03:29 |
| Profile 37, End | 55.205218 | 7.31431 | 19.09.2016 06:15 |
| Profile 38, Begin | 55.205218 | 7.31431 | 19.09.2016 06:15 |
| Profile 38, End | 55.187417 | 7.312262 | 19.09.2016 15:42 |
| Profile 39, Begin | 55.187417 | 7.312262 | 19.09.2016 15:42 |
| Profile 39, End | 55.121065 | 7.310913 | 19.09.2016 17:16 |
| Profile 40, Begin | 55.121045 | 7.310917 | 19.09.2016 17:16 |
| Profile 40, End | 55.101858 | 7.308403 | 19.09.2016 19:58 |
| Profile 41, Begin | 55.101858 | 7.308403 | 19.09.2016 19:58 |
| Profile 41, End | 55.122215 | 7.305107 | 19.09.2016 22:42 |
| Profile 42, Begin | 55.122215 | 7.305107 | 19.09.2016 22:42 |
| Profile 42, End | 55.09997 | 7.302665 | 20.09.2016 01:30 |
| Profile 43, Begin | 55.09997 | 7.302665 | 20.09.2016 01:30 |
| Profile 43, End | 55.210362 | 7.29742 | 20.09.2016 15:06 |
| Profile 44, Begin | 55.210362 | 7.29742 | 20.09.2016 15:06 |
| Profile 44, End | 55.013698 | 7.299362 | 20.09.2016 17:52 |
| Profile 45, Begin | 55.013698 | 7.299362 | 20.09.2016 17:52 |
| Profile 45, End | 55.209687 | 7.292473 | 20.09.2016 20:44 |
| Profile 46, Begin | 55.209667 | 7.292455 | 20.09.2016 20:44 |
| Profile 46, End | 55.01366 | 7.293835 | 20.09.2016 23:36 |
| Profile 47, Begin | 55.01366 | 7.293835 | 20.09.2016 23:36 |
| Profile 47, End | 55.210482 | 7.2863 | 21.09.2016 02:25 |
| Profile 48, Begin | 55.210482 | 7.2863 | 21.09.2016 02:25 |

| | | | |
|-------------------|-----------|----------|------------------|
| Profile 48, End | 55.029018 | 7.424908 | 21.09.2016 10:16 |
| Profile 49, Begin | 55.029018 | 7.424908 | 21.09.2016 10:16 |
| Profile 49, End | 55.182283 | 7.424958 | 21.09.2016 12:33 |
| Profile 50, Begin | 55.182283 | 7.424958 | 21.09.2016 12:33 |
| Profile 50, End | 55.02938 | 7.429357 | 21.09.2016 14:45 |
| Profile 51, Begin | 55.02938 | 7.429357 | 21.09.2016 14:45 |
| Profile 51, End | 55.18232 | 7.430118 | 21.09.2016 16:56 |
| Profile 52, Begin | 55.18232 | 7.430118 | 21.09.2016 16:56 |
| Profile 52, End | 55.029085 | 7.435113 | 21.09.2016 19:09 |
| Profile 53, Begin | 55.029085 | 7.435113 | 21.09.2016 19:09 |
| Profile 53, End | 55.181405 | 7.436252 | 21.09.2016 21:24 |
| Profile 54, Begin | 55.181385 | 7.43625 | 21.09.2016 21:24 |
| Profile 54, End | 55.028187 | 7.441235 | 21.09.2016 23:41 |
| Profile 55, Begin | 55.028187 | 7.441235 | 21.09.2016 23:41 |
| Profile 55, End | 55.181642 | 7.442182 | 22.09.2016 01:55 |
| Profile 56, Begin | 55.181622 | 7.44218 | 22.09.2016 01:55 |
| Profile 56, End | 55.030632 | 7.446803 | 22.09.2016 04:06 |
| Profile 57, Begin | 55.030655 | 7.4468 | 22.09.2016 04:06 |
| Profile 57, End | 55.178782 | 7.447068 | 22.09.2016 06:17 |
| Profile 58, Begin | 55.178782 | 7.447068 | 22.09.2016 06:17 |
| Profile 58, End | 55.028812 | 7.452148 | 22.09.2016 08:28 |
| Profile 59, Begin | 55.028812 | 7.452148 | 22.09.2016 08:28 |
| Profile 59, End | 55.177653 | 7.453197 | 22.09.2016 10:38 |
| Profile 60, Begin | 55.177653 | 7.453197 | 22.09.2016 10:38 |
| Profile 60, End | 55.028525 | 7.457918 | 22.09.2016 12:50 |
| Profile 61, Begin | 55.028525 | 7.457918 | 22.09.2016 12:50 |
| Profile 61, End | 55.176882 | 7.459275 | 22.09.2016 15:01 |
| Profile 62, Begin | 55.17686 | 7.459267 | 22.09.2016 15:01 |
| Profile 62, End | 55.029175 | 7.463328 | 22.09.2016 17:09 |
| Profile 63, Begin | 55.029175 | 7.463328 | 22.09.2016 17:09 |
| Profile 63, End | 55.175428 | 7.464247 | 22.09.2016 19:18 |
| Profile 64, Begin | 55.175428 | 7.464247 | 22.09.2016 19:18 |
| Profile 64, End | 55.02899 | 7.468817 | 22.09.2016 21:28 |
| Profile 65, Begin | 55.029012 | 7.46882 | 22.09.2016 21:28 |
| Profile 65, End | 55.174513 | 7.470795 | 22.09.2016 23:38 |
| Profile 66, Begin | 55.174513 | 7.470795 | 22.09.2016 23:38 |
| Profile 66, End | 55.029387 | 7.47516 | 23.09.2016 01:40 |
| Profile 67, Begin | 55.029387 | 7.47516 | 23.09.2016 01:40 |
| Profile 67, End | 55.17333 | 7.475977 | 23.09.2016 03:48 |
| Profile 68, Begin | 55.17333 | 7.475977 | 23.09.2016 03:48 |
| Profile 68, End | 55.028543 | 7.480552 | 23.09.2016 13:15 |
| Profile 69, Begin | 55.028543 | 7.480552 | 23.09.2016 13:15 |
| Profile 69, End | 55.172062 | 7.48184 | 23.09.2016 15:24 |
| Profile 70, Begin | 55.172038 | 7.481828 | 23.09.2016 15:24 |
| Profile 70, End | 55.029108 | 7.485847 | 23.09.2016 17:30 |

| | | | |
|-------------------|-----------|----------|------------------|
| Profile 71, Begin | 55.029108 | 7.485847 | 23.09.2016 17:30 |
| Profile 71, End | 55.170972 | 7.487 | 23.09.2016 19:35 |
| Profile 72, Begin | 55.170972 | 7.487 | 23.09.2016 19:35 |
| Profile 72, End | 55.029023 | 7.492093 | 23.09.2016 21:38 |
| Profile 73, Begin | 55.029023 | 7.492093 | 23.09.2016 21:38 |
| Profile 73, End | 55.169708 | 7.493852 | 23.09.2016 23:42 |
| Profile 74, Begin | 55.169708 | 7.493852 | 23.09.2016 23:42 |
| Profile 74, End | 55.029 | 7.497502 | 24.09.2016 01:45 |
| Profile 75, Begin | 55.029 | 7.497502 | 24.09.2016 01:45 |
| Profile 75, End | 55.168668 | 7.498207 | 24.09.2016 03:46 |
| Profile 76, Begin | 55.168668 | 7.498207 | 24.09.2016 03:46 |
| Profile 76, End | 55.028618 | 7.500018 | 24.09.2016 05:43 |

VideoProfiles

| Description | Longitude | Latitude | Date/Time |
|---------------|-----------|----------|---------------------|
| Video 1 Start | 55.056288 | 7.412210 | 16.09.2016 10:53:55 |
| Video 1 Ende | 55.043400 | 7.416707 | 16.09.2016 11:23:31 |
| Video 2 Start | 55.106452 | 7.406963 | 16.09.2016 12:16:38 |
| Video 2 Ende | 55.101050 | 7.409972 | 16.09.2016 13:11:51 |
| Video 3 Start | 55.151557 | 7.415010 | 16.09.2016 14:18:02 |
| Video 3 Ende | 55.145837 | 7.419612 | 16.09.2016 15:07:27 |
| Video 4 Start | 55.097118 | 7.363643 | 19.09.2016 11:11:56 |
| Video 4 Ende | 55.090208 | 7.368225 | 19.09.2016 11:43:57 |
| Video 5 Start | 55.081638 | 7.359255 | 19.09.2016 12:12:12 |
| Video 5 Ende | 55.075985 | 7.368628 | 19.09.2016 12:43:42 |
| Video 6 Start | 55.063043 | 7.374088 | 19.09.2016 13:10:59 |
| Video 6 Ende | 55.055675 | 7.383255 | 19.09.2016 13:47:19 |
| Video 7 Start | 55.046002 | 7.379762 | 19.09.2016 14:10:16 |
| Video 7 Ende | 55.148992 | 7.433117 | 24.09.2016 13:30:59 |
| Video 8 Start | 55.099667 | 7.320395 | 24.09.2016 09:23:47 |
| Video 8 Ende | 55.104020 | 7.306790 | 24.09.2016 10:01:02 |
| Video 9 Start | 55.123033 | 7.448155 | 24.09.2016 11:23:02 |
| Video 9 Ende | 55.137997 | 7.439138 | 24.09.2016 11:23:02 |