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# Geological processes and risks for war wrecks

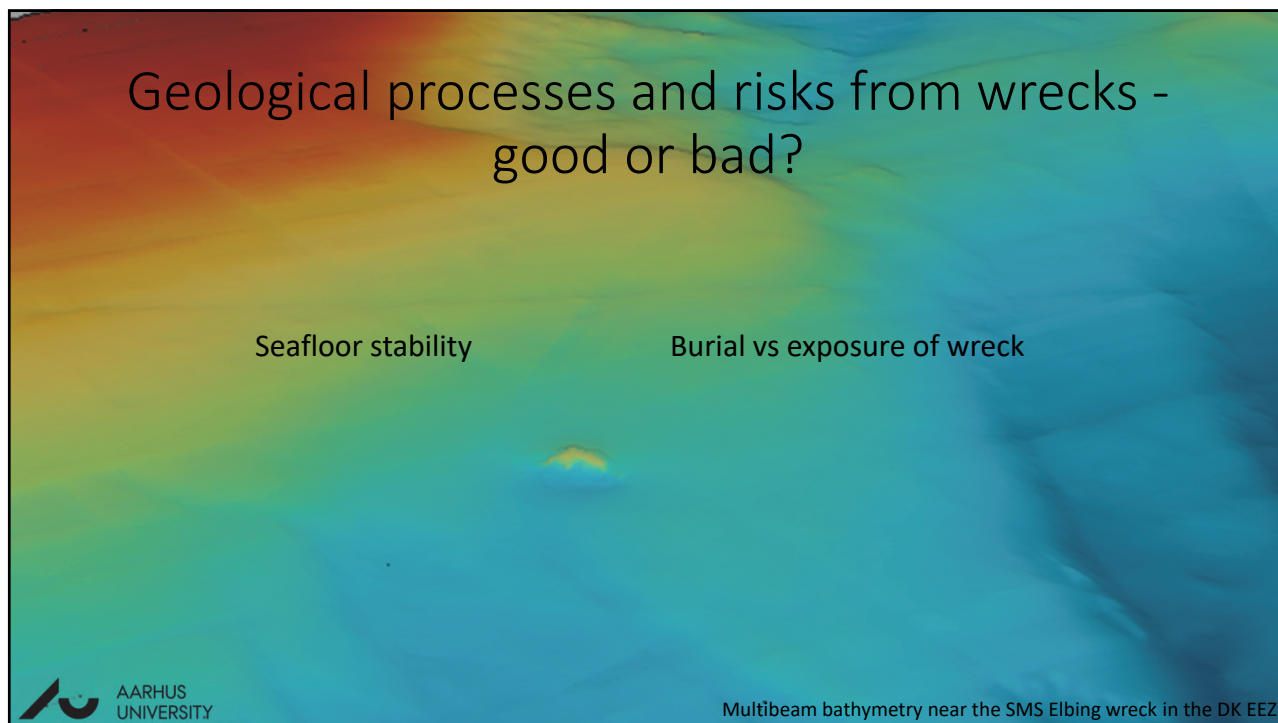
– insights from two wrecks in the Danish North Sea

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**NORTH SEA WRECKS**



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## Geological processes and risks from wrecks - good or bad?

Seafloor stability      Burial vs exposure of wreck

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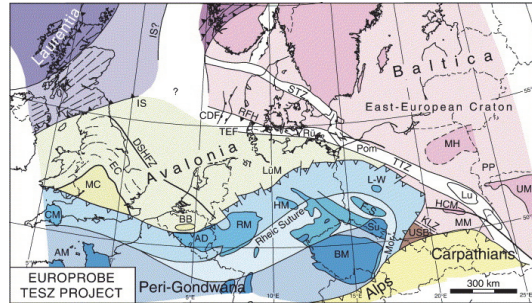
Multibeam bathymetry near the SMS Elbing wreck in the DK EEZ

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## Seafloor stability

- Faulting
  - Deep tectonic faulting
  - Earthquakes

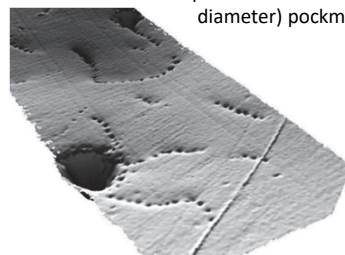
Geological tectonic basement structure of northern Europe showing the Sorgenfrei-Tornquist fault zone (STZ), Shomali et al., 2006



## Seafloor stability

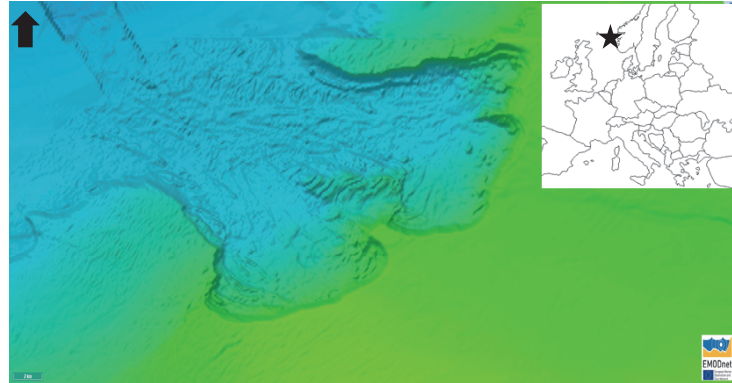
- Pockmarks
  - Subsurface fluid migration

Seafloor mapping from multibeam echosounder data showing strings of smaller (ca. 1 m diameter) pockmarks and discrete larger (ca. 10 m diameter) pockmarks, offshore Norway  
Hovland et al., 2002



## Seafloor stability

- Mass wasting
  - Submarine landslides

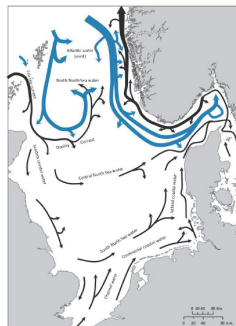


Bathymetry (EMODnet) showing slide scarps offshore Norway

## Burial vs exposure of wrecks

- Sedimentation processes around wrecks
- Deposition vs erosion
- Mobile sand
- Oceanography
  - Waves, tides, currents,
  - Salinity, temperature

# North Sea oceanography

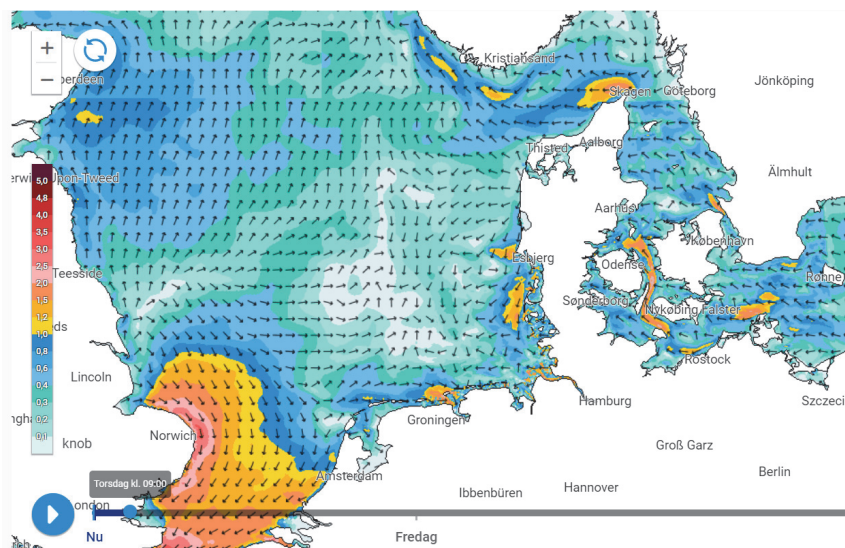


Ocean circulation in the North Sea  
(Bloomfield et al., 2011 (based on Turrell, 1992))

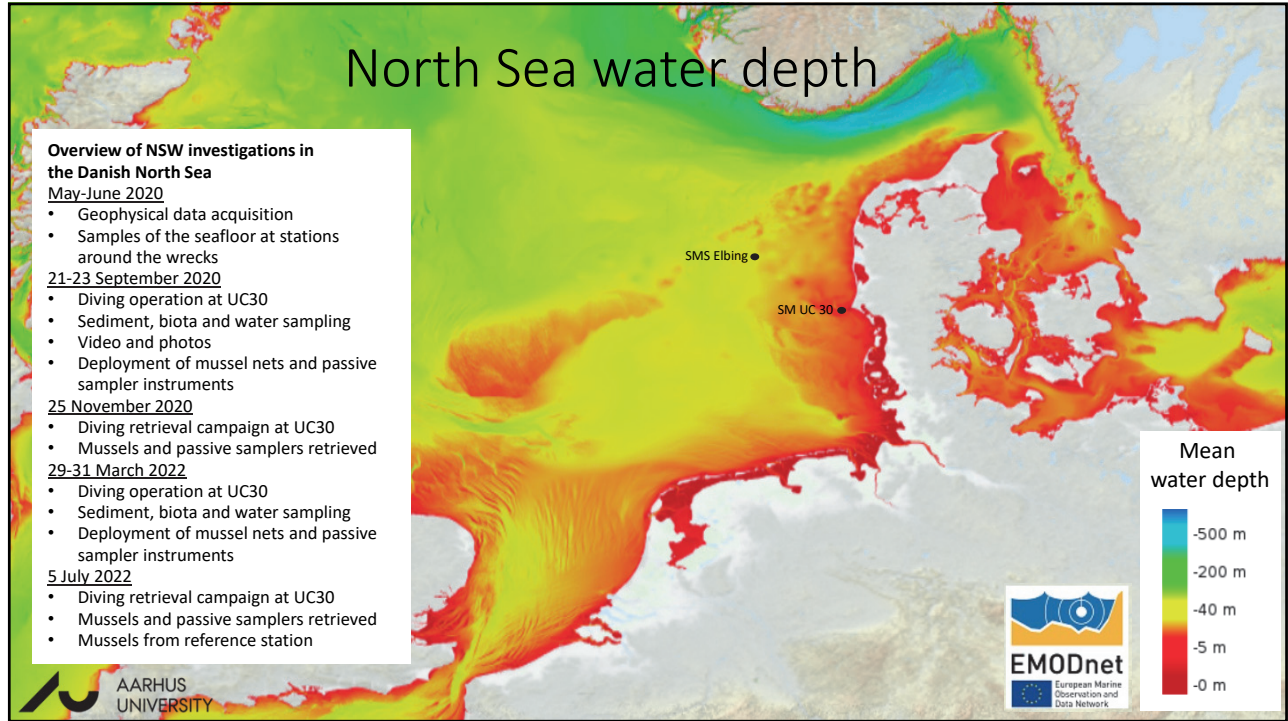


The North Sea amphidromic tidal system  
(Kvale, 2006 (modified from Dalrymple, 1992))

# North Sea oceanography



Ocean current forecast, dmi.dk



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## SMS ELBING

Photo Archive, German Maritime Museum

- German WWI light cruiser, 442 crew, 136 m long
- Sunk during the Battle of Jutland, 1 June, 1916
- Located at 43 m water depth
- 10 Quickfiring Guns (eight 1cm, two 8.8 cm)
- Two deck torpedo tubes, each 50 cm diameter (torpedo type G6 or G7)
- Ship capable to carry 120 Mines

Side Scan Sonar data (MSc thesis, Jensen (2021))

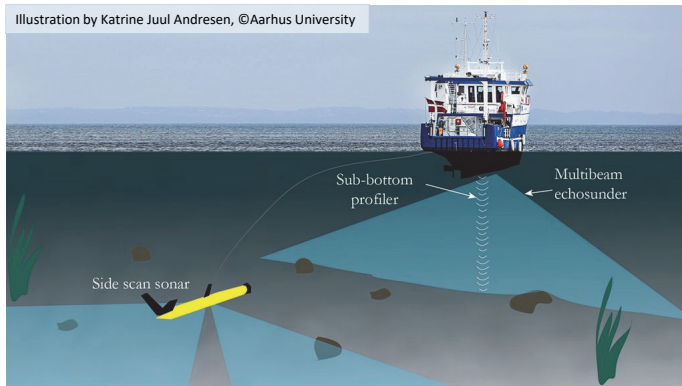
Point cloud from multibeam echosounder

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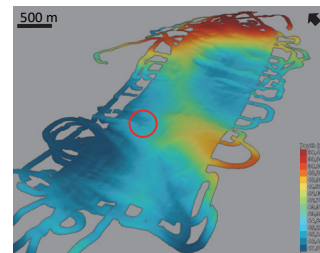
## SMS ELBING

Illustration by Katrine Juul Andresen, ©Aarhus University



Data acquired during research cruise in May-Jun 2020

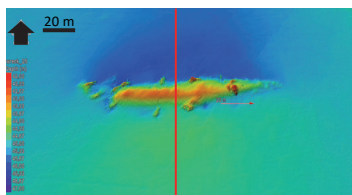
- Multibeam bathymetry
- Side scan sonar
- Subbottom profiler
- Sediment samples



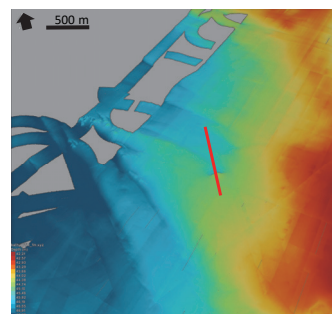
DTM from multibeam echosounder data  
(MSc thesis, Jensen (2021))

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## SMS ELBING



Wreck DTM from multibeam echosounder data  
(MSc thesis, Jensen (2021))



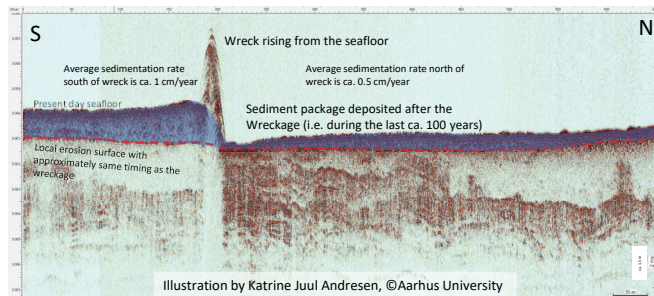
DTM from multibeam echosounder data  
(MSc thesis, Jensen (2021))



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# SMS ELBING

Sub-bottom profile from the SMS Elbing wreck showing the **present and past** sediment dynamics around the wreck



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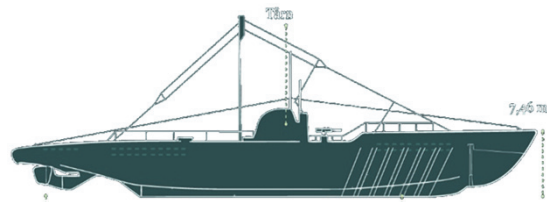
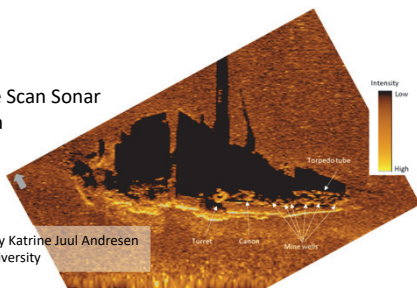
# SM UC 30



Photo from Deutsches U-Boot-Museum, Cuxhaven-Altenuhr

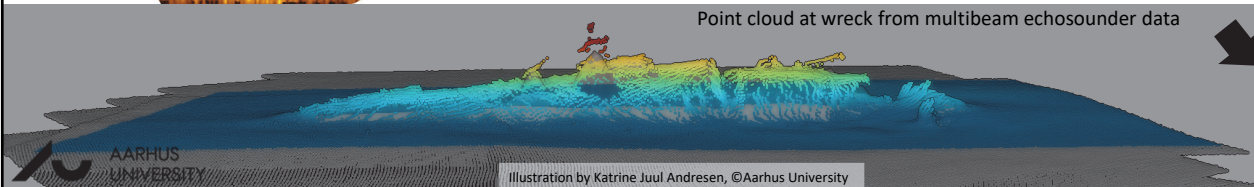
- German WWI submarine, 27 crew, 51 m long
- Sunk in 1917 after coming across a British mine field
- Located at 23 m water depth
- 18 mines (type: UC 200) in 6 mine wells (100 cm diameter)
- Three 50 cm diameter torpedo tubes (2 bow above water, 1 stern under water) (torpedo types G6 or G7)
- One Quickfiring Gun with Torpedo Boat mounting (8.8 cm)
- One machine gun (8 mm)

Side Scan Sonar data



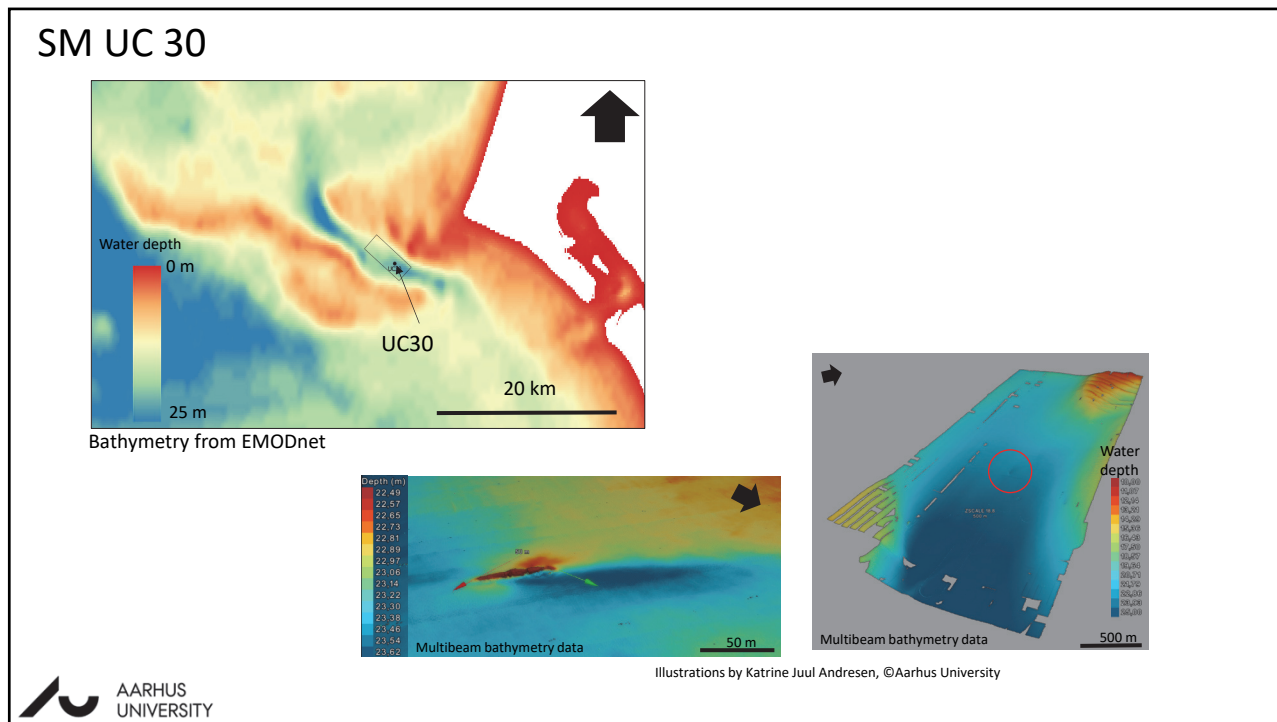
Wreck sketch model from dr.dk

Point cloud at wreck from multibeam echosounder data

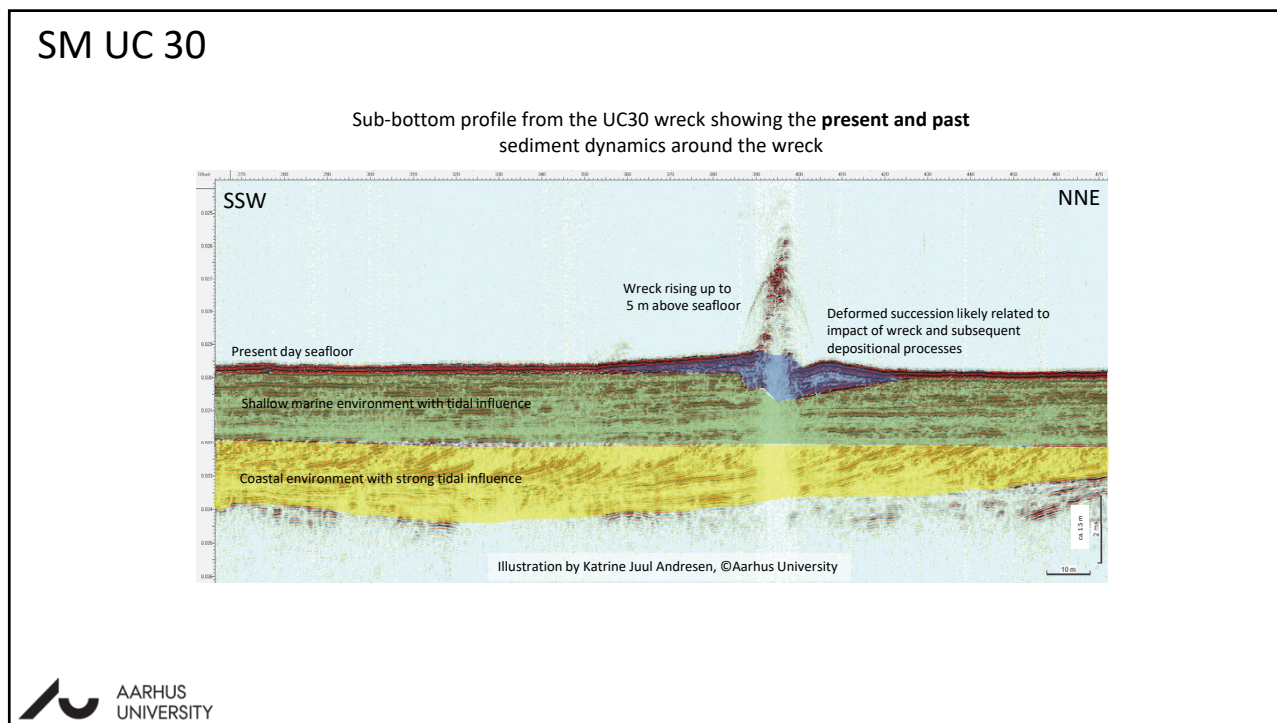


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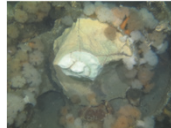
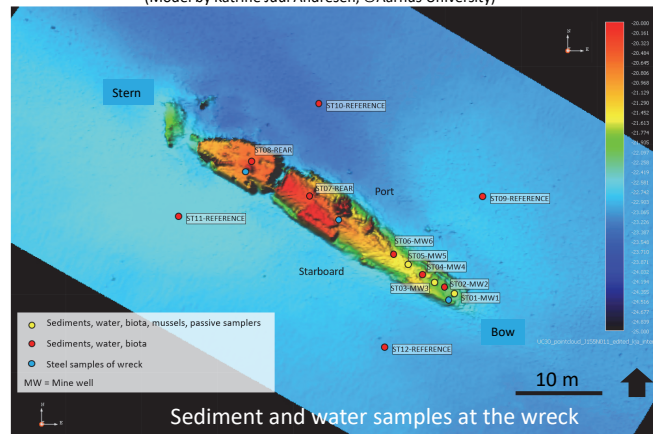
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## SM UC 30



Photos from the Royal Danish Navy

Wreck DTM from multibeam bathymetry data  
(Model by Katrine Juul Andresen, ©Aarhus University)

Sediment and water samples at the wreck

## Conclusions

- Geological processes can work for and against the risk from wrecks
- Seafloor instability generally increases risks from wrecks due to rupture and potential further exposure
- Sediment dynamics around wrecks can lead to both burial and exposure of wrecks
- Buried wrecks generally pose a lower risk because munitions are not exposed to the seafloor
- Erosion exposes the wreck to further corrosion and direct erosion of explosives
- At SMS Elbing, the wreck influences the seafloor sedimentation to a distance of ca. 300 m
- At SMS Elbing maximum deposition is about 1 m in 100 years
- At SM UC 30 the sedimentation processes only have a local and short distance effect (<50 m).
- Samples indicate that energetic chemicals are spread around the wreck according to the sedimentation processes
- Geology and seafloor sediment processes thus potentially have a strong control on the effect-distance for pollution from wrecks

# Acknowledgements

Captain and crew of RV Aurora, Aarhus University  
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