# Depositional processes, particulate organic carbon contents and origin across the Helgoland Mud Area, SE German Bight.

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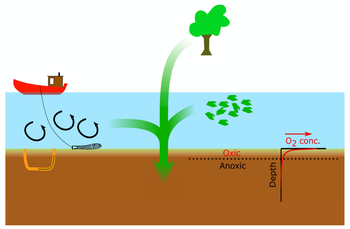
## Introduction

**Fine-grained coastal and marine sediments** are the **largest permanent carbon sink** on our planet. They harbor large stocks of particulate organic carbon (POC) derived from marine plankton, land plants and coastal vegetation that build POC via photosynthesis and in this way take up $CO_2$ from the atmosphere.

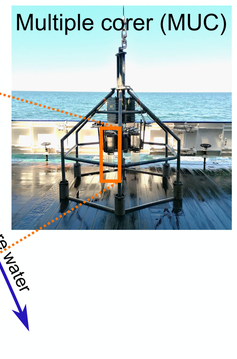



**Controlling factors** for the **preservation of POC** in sediments are (1) **grain size**, (2) **sedimentation rate**, (3) **oxygen exposure time** and (4) **organic matter composition**[1,2]. While a small grain size protects organic matter from degradation, sedimentation rates directly control the oxygen exposure time[2]. However, **resuspension** (e.g. bottom trawling, dredging, bioturbation/irrigation, storm events) can prolong the oxygen exposure time and thereby enhance POC degradation[2]. The POC composition controls the degradation potential and hence the conservation[2].

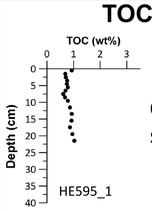
**Objectives**: (a) Provide insight into **sediment and POC dynamics** and long-term burial of POC by evaluating: (1) **sedimentation rates**, (2) **POC content** and its (3) **origin and reactivity**. (b) Assess the significance of fine-grained sediments as a **natural carbon sink**.

## Methods

**Two expeditions with RV Heincke:**
**HE575** in **2021** (3 MUC stations)
**HE595** in **2022** (17 MUC stations)

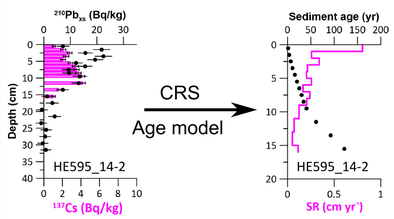



### TOC content



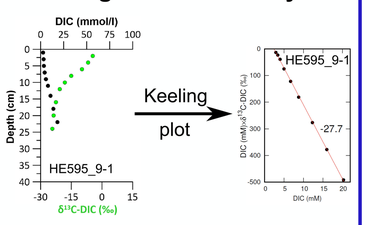

**Carbon** and sulfur **analyser**

### Sedimentation rates




**Gamma spectrometry** to determine $^{210}Pb_{XS}$ and $^{137}Cs$ activities

### Origin and reactivity




**DIC concentration** and its stable **carbon isotopic composition**

## Study area

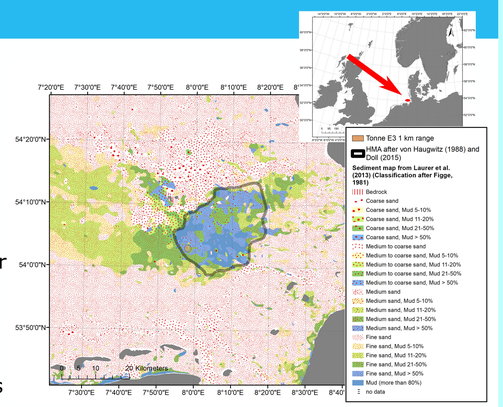
**German Bight, North Sea**

**Area**[3,4]: ~500 km²

**Water Depth**: 10 to 40 m

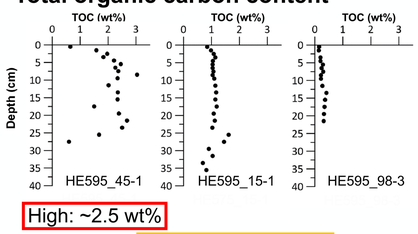
**Sediment input**: riverine, primary production, reworked sediments and dumped harbour sediment

**Regional features:** dumping site of harbour sludge, storm events, strong bed shear stress




## Results: controlling factors – POC preservation

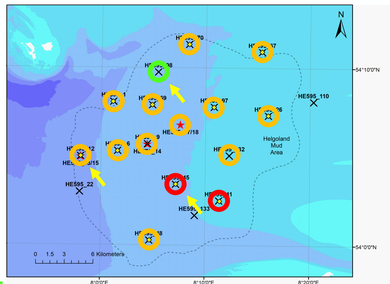
### Total organic carbon content



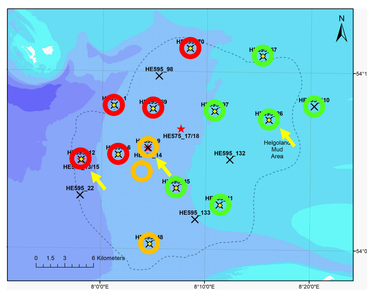

High: ~2.5 wt%

Intermediate: ~1 wt%

Low: <0.5 wt%




### Origin and reactivity

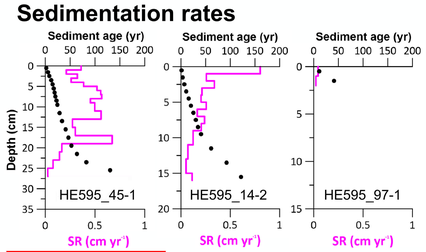



Marine[5] $\delta^{13}C$: -18 to -25 ‰

Terrestrial[5] $\delta^{13}C$: -25 to -33 ‰

Reworked

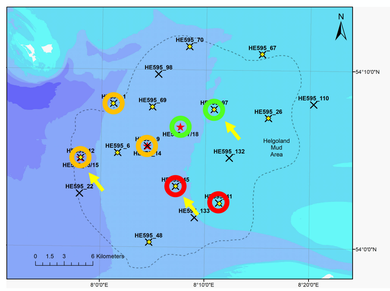
### Sedimentation rates




High: ~4 mm yr$^{-1}$

Intermediate: ~2 mm yr$^{-1}$

Low: <0.5 mm yr$^{-1}$




## Budget estimate

**Calculations were performed** assuming an average **TOC content** of **1 wt%**, an average **grain density** of **2.65 g cm$^{-3}$**, a **sediment porosity** of **0.6** and varying **sedimentation rates** between **0.2 and 5 mm yr$^{-1}$**.

| | |
|---|---|
| **POC budget - uppermost 10 cm HMA** | 0.27 < **0.53** < 1.06 **TgC** |
| Compared to the **North Sea**[6] | 0.12 < **0.23** < 0.46 **%** |
| **Annual POC accumulation** HMA | 0.001 < **0.011** < 0.027 **TgC yr$^{-1}$** |
| Compared to the North Sea[6] | 0.08 < **0.76** < 1.89 **%** |
| **HMA area** in **relation** to the **North Sea**[6] | **0.1 %** |

## Summary and outlook

- **TOC contents** are **~1 wt%** throughout the study area with **higher TOC contents of ~ 2.5 wt%** at the sites of **high sedimentation rates.**
- **Origin**, and therefore **availability,** of POC in the HMA shows different sources from **marine in the NW** to **terrestrial origin in the centre.**
- Although the **HMA covers** only **0.1 %** of the North Sea, it accounts for **0.23 %** of the **surface sediment POC** and, more important, has a **POC accumulation rate** of **0.76 %.**
- This highlights why not only the **TOC content** but also the **TOC burial rate** need to be considered **as factors** in assessing the **potential of a carbon sink.**
- Future estimates of **bioturbation rates** will help to further understand **sediment dynamics** and to discuss **changes in sedimentation rates.**
- **PCA** will be performed for defining **'geochemical provinces'.**

## References and affiliations

### References

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Feedback or comments?
Plese let us know!

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