Poster #7609

Benthic hypoxia and early diagenesis in the Black Sea shelf sediments

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Context

Between 1970 and 1990, the coastal benthic compartment of the Black Sea underwent modifications due to the occurrence of increasing hypoxia, leading to a deterioration of the structure and functioning of the ecosystems [1]. Nowadays, the Northwestern shelf is still affected seasonally by hypoxic events [2].

Within the framework of the BENTHOX project, a biogeochemical study focusing on the study of early diagenesis was conducted on the Ukrainian shelf (Figs 1 & 2).

The project aims :

- To contribute to a new dataset of biogeochemical measurements in the sediments including porewaters.
- To obtain a better understanding of the impact of benthic hypoxia on the diagenetic pathways.
- To reconstruct the long-term hypoxia history using a multi-paleoproxy approach.

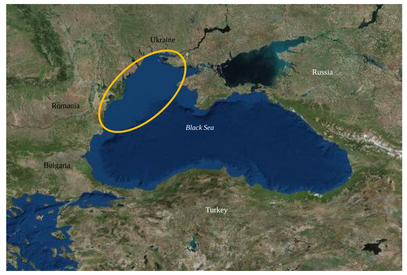


Fig. 1: Northwestern shelf of the Black Sea.

Fig. 2: Transect of the EMBLAS-II cruise. Locations of the 4 stations sampled by the BENTHOX are indicated.

Methods

Our investigation took place on board the R/V *Mare Nigrum* during 6 days in late May 2016. The campaign was conducted in collaboration with the EMBLAS-II project whose aim was to improve the environmental monitoring of the Black Sea.

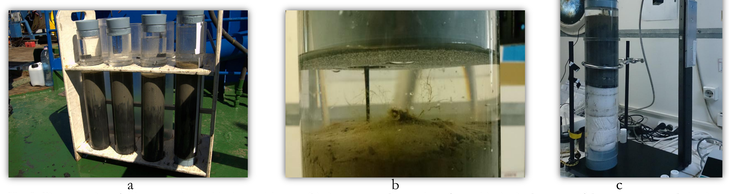
Sampling

4 cores were sampled per station with a multicorer (Fig. 3a).
1 long core was taken per station with a gravity corer.

Analytical

Microprofiling of geochemical gradients of dissolved oxygen, hydrogen sulfide and pH were conducted with *UNISENSE* sensors on cores taken with the multicorer (Fig. 3 b&c) [3].

Sediments of the long cores were sliced at every 1.5 cm intervals and dried at 105°C. They were analysed for contents of total organic matter, total carbonate and mineral clasts, using a sequential weight Loss Of Ignition (LOI) technique, first ashed at 550°C and then at 950°C [4].



a b c

Fig. 3: Photographs of (a) cores taken with the multicorer, (b) the water-sediment interface with the hydrogen sulfide sensor inserted, (c) the setup of the microprofiler.

Results - Microprofiling

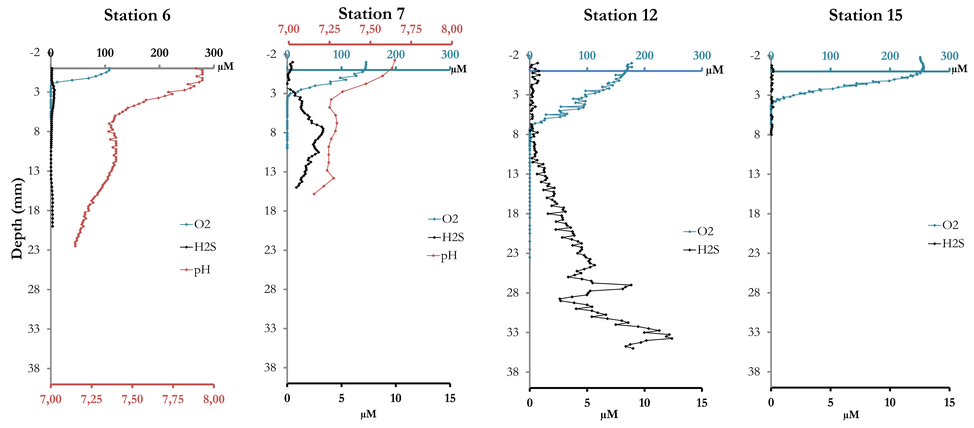


Fig. 4: Vertical profiles of dissolved oxygen, hydrogen sulfide and pH in the sediments at stations 6 and 7 as well as those of dissolved oxygen and hydrogen sulfide at stations 12 and 15.

Vertical profiles of dissolved oxygen, hydrogen sulfide and pH in the sediments are shown in Fig. 4:

- At the sediment-water interface, dissolved oxygen concentrations are higher than the hypoxic limit (63 µM).
- Dissolved oxygen concentration decreases rapidly with depth at each station.
  In all the cores examined, sediments are depleted in dissolved oxygen at a depth of less than 10 mm.
  Oxygen consumption in the benthic layer and the depth at which sediments become anoxic are related to the loading of detrital organic matter at the interface, thus to the primary production in the photic zone as well as to the riverine inputs of organic matter [5].

$$\textbf{Oxic respiration: } CH_2O + O_2 \rightarrow CO_2 + H_2O$$

- The occurrence of dissolved sulfides in deeper sediments at stations 6, 7 and 12 results from :

$$\textbf{Sulfate reduction: } 2\,CH_2O + SO_4^{2-} \rightarrow H_2S + 2\,HCO_3^-$$

- pH decreases with depth at stations 6 and 7.
  These variations suggest the degradation of organic matter in the upper layers of the sediments, releasing CO_2 (as confirmed by the oxic respiration) and acidifying the porewaters.

Results - Sedimentology

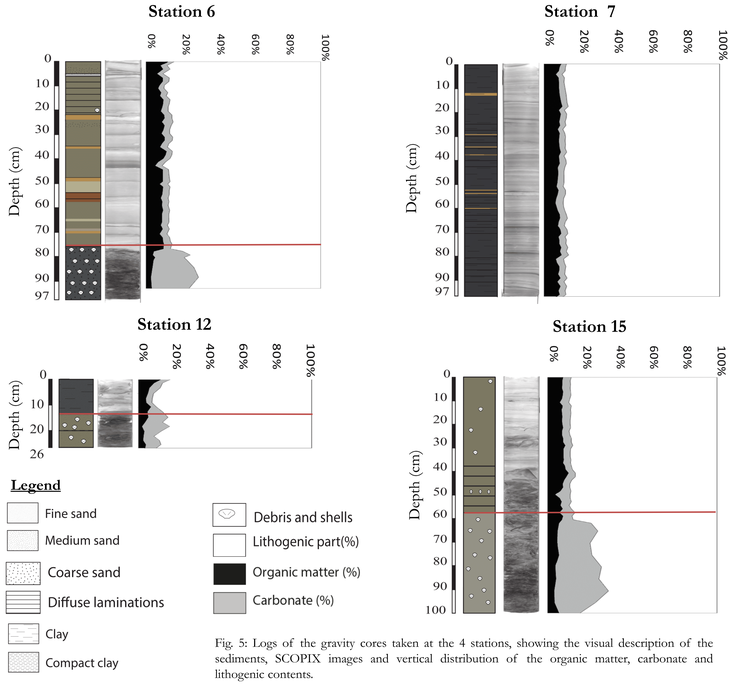


Fig. 5: Logs of the gravity cores taken at the 4 stations, showing the visual description of the sediments, SCOPIX images and vertical distribution of the organic matter, carbonate and lithogenic contents.

- Sediments from stations 6, 12 and 15 are made of 2 main lithologies (Fig. 5): 1) mm to cm laminated silty clays with some fine to coarse sandy layers and sparse shells; 2) cm to dm massive shell-rich layers. The laminated units most probably represent the background sedimentation on the Ukrainian continental plateau, under variable hydrodynamic conditions recorded by the observed grain size variations. The bioclastic units rather reflect punctual deposits related to storm-like events. As an exception, station 7 is only made of laminated sediments.
- The sediments are essentially composed of mineral clasts. Organic matter and carbonate contents are uniform at the station 7. The small increase in carbonate content (below the red line) at stations 6, 12 and 15 might be linked to an in-situ biogenic accumulation [6].

Conclusions & Perspectives

- According to our results, no hypoxia in bottom waters on the Ukrainian shelf was observed in May.
- The depth at which the anoxic sediments appear is characteristic of coastal systems (less than 10 mm).
- These first results reveal certain diagenetic reactions.
- LOI method could be used as a proxy for the lithological composition study of the recent Northwestern Black Sea shelf sediments.
- The study of other parameters (proxies), biological (foraminifera) and geochemical (reactive Fe, trace element compounds), could help to identify and reconstruct the hypoxic history.
- The next sampling cruise is planned in late August 2017. The occurrence of an hypoxic event can be expected. Comparison of the results obtained from the two contrasting situations can then be made.
- Station 7 is probably the most interesting one to study in terms of changes in hypoxia, considering the continuous laminated sedimentation.

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