Changes in bottom water redox and productivity in the Bothnian Sea and Baltic Proper over the Holocene

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Introduction

During the early Holocene, the deeper waters in the Bothian Sea and Baltic Proper were connected and were more saline[1] than today. Here, we present evidence that bottom waters in both basins were euxinic, i.e. contained free sulfide during this time. This is deduced from sediment molybdenum records for two sites in the Bothnian Sea and Baltic Proper. *n*-Alkane based proxies suggest that the euxinia in both basins was associated with enhanced marine productivity. Post-glacial rebound and eustatic sealevel rise led to a separation of the basins and contrasting trends in productivity and redox conditions over the past millennia.

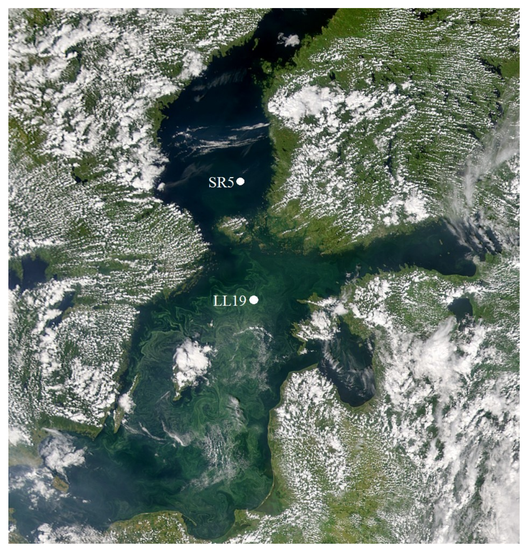

Figure 1. Satellite image of the Baltic Proper showing a present day cyanobacterial bloom and the location of the two coring sites studied in this project. SR5 is situated in the Bothnian Sea and LL19 in the Baltic Proper.

The sediment molybdenum and bulk organic carbon record

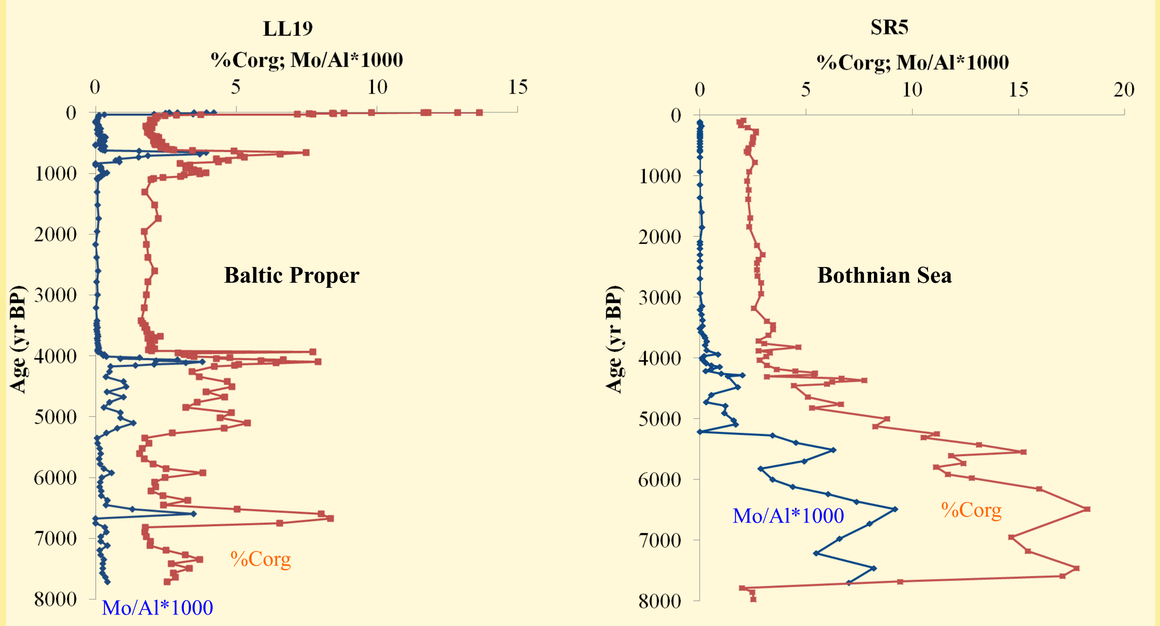

Figure 2. Mo/Al and organic carbon content for LL19 (Baltic Proper; left) and SR5 (Bothnian Sea; right) versus age.

While euxinia in the Baltic Proper was recorded in the molybdenum record during the early Holocene and the Medieval interval (Fig. 2), the Bothnian Sea only experienced a long period of euxinia during the early Holocene. The sediment bulk organic carbon content for both sites follows the same trends as the molybdenum records.

n-Alkane fractions

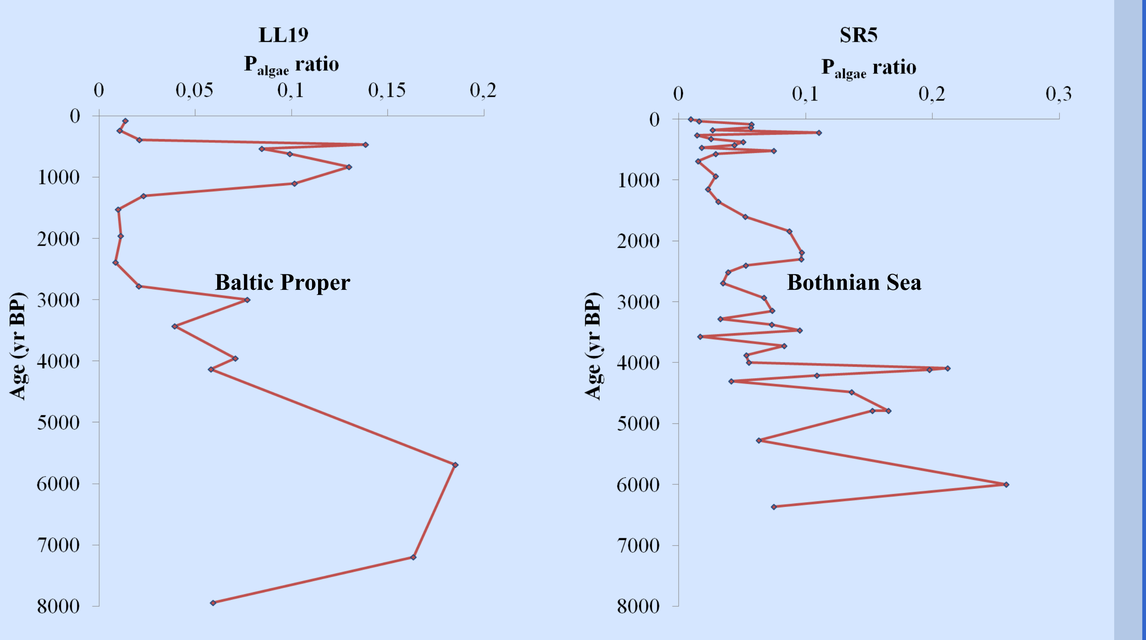

Figure 3. P_{algae} fractions for LL19 (Baltic Proper; left) and SR5 (Bothnian Sea; right) derived from the fraction of n-alkanes with a marine origin.

The *n*-alkane fractions for the Baltic Proper (Fig. 3) show two peaks in the marine-derived fraction (P_{algae} is based on the organic solvent extractable fraction of C_{17} *n*-alkane calculated as $P_{algae}=(C_{17}+C_{19})/(C_{17\text{-}31})$ where C_x is the *n*-alkane with an odd numbered chain length x) at times of high molybdenum content during the early Holocene and the Medieval interval. A higher P_{algae} implies higher marine productivity. In the Bothnian Sea high P_{algae} values are found during the early Holocene, during the Medieval some variability is found but the values are generally lower.

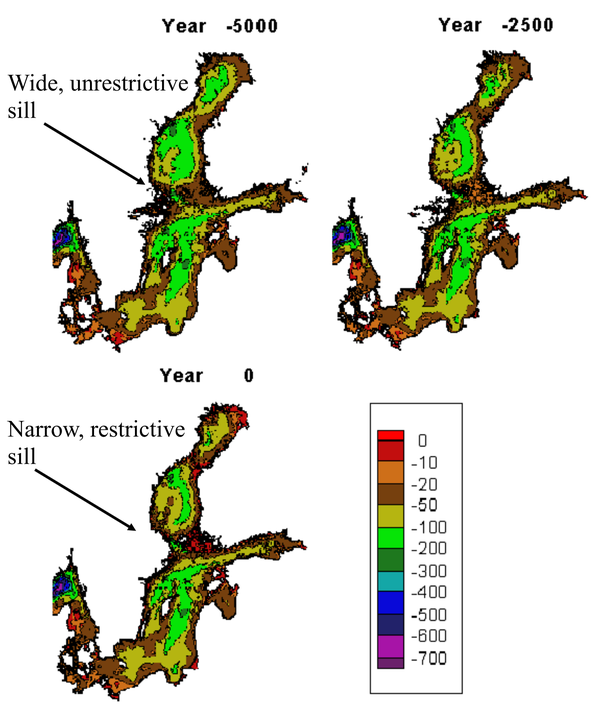

Figure 4. Changes in Baltic Sea Bathymetry, the ages are given in cal yr. BP and elevation is in meters[2].

Due to organic matter remineralisation, the dissolved oxygen in the Baltic Proper and Bothnian Sea was depleted to the point of euxinia during several periods of the Holocene. While the Baltic proper shows the occurence of several periods of high marine productivity and euxinia occuring together, the Bothnian Sea only had conditions like these during the early Holocene.

The role of basin configuration

These findings indicate that the restricted water circulation between the Baltic Proper and the Bothnian Sea (as the result of the rising sill between the basins due to post-glacial rebound, Fig. 4) led to a freshening of the Bothnian Sea. The lack of salinity stratification in the Bothnian Sea prevented it from becoming euxinic again. Thus, while the Baltic Proper developed bottom water euxinia again in Medieval times and over the past decades, the Bothnian Sea remained fully oxygenated. This highlights the role of basin configuration in determining deep water circulation and oxygenation in coastal nearshore areas.

References

1. Gustafsson, B.G.,Westman, P., 2002. On the causes of salinity variations in the Baltic Sea during the last 8500 years. Paleoceanography 17, 1–14
2. Courtesy of Bo Gustafsson.

Acknowledgements

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