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Environmental history told by sludge: Global warming lets the dead zones in the Black Sea grow

Geoscientists from the Leibniz Institute for Baltic Sea Research Warnemünde (IOW), the universities of Oldenburg and Hannover as well as Rutgers University (USA) succeeded now in reconstructing the depositional environment of the last interglacial (Eemian, 128,000 years ago) in the Black Sea with unprecedented details. This enabled for the first time a direct comparison between the current oxygen-depleted conditions in the deep water with those during the Eemian when the water temperatures in summer were 3° higher. It shows that the dead zones of the Black Sea will most probably expand by a future global warming, leading to a significant shrinking of the productive zone in the surface water.

Oxygen deficiency together with the occurrence of toxic hydrogen sulphide below water depths of 100 – 150 m are the most prominent features of the Black Sea, the world's largest brackish basin. Today, up to 90 % of the Black Sea water body is a harsh and hostile oxygen-free environment where no higher life can survive. It is critical to understand how these dead zones will develop in response to the ongoing global warming and sea level rise. The detailed analyses of sediments from the last interglacial (Eemian) in the Black Sea, recently published in the international journal "Palaeogeography, Palaeoclimatology, Palaeoecology" offer insights into a potential future.

Oxygen depletion in the bottom waters of the Black Sea causes a decelerated decomposition of the organic matter sinking to the seafloor. These organic-rich muds form the so-called sapropels that are quite common among both recent and Eemian deposits. By means of detailed analyses of redox-sensitive chemical elements in these sapropels, the team succeeded in reconstructing a differentiated picture of the deep-water conditions during the Holocene and Eemian periods in the Black Sea. As environmental witnesses (so-called proxies) the geoscientists used, for example, the trace elements molybdenum and rhenium, which react differently and specifically on oxygen deficiency and the presence of sulphide. In total, the analysis of more than 10 of such proxies enabled the reconstruction of a complex picture.

IOW geologist Antje Wegwerth summarizes the results: "During the Eemian period the deep water of the Black Sea showed a significantly higher concentration of sulphide and, thus, was more toxic than today. The hostile conditions expanded over thousands of years and finally reached the so called photic zone, the highly productive surface water layer exposed to light."

In such a resolution and quality, no Eemian sediments have been investigated so far, because these deep lying deposits are normally accessible only by expensive deep-sea drillings. However, during a cruise on R/V METEOR sediments from both Holocene and Eemian periods could be retrieved by conventional gravity coring from a prominent bathymetric ridge structure. Thus, the direct comparison of both interglacials became possible.

Postglacial warming during the Eemian and the Holocene caused significant changes in the Black Sea. The large polar ice sheets disappeared, the global sea level rose, and once flooding the shallow Bosphorus sill, the salty and dense water masses of the Mediterranean Sea intruded the formerly Black Sea “Lake”. This led to a strong stratification with saline deep waters below the brackish surface waters. At the same time, elevated sea surface temperatures resulted in an increased productivity and flux of organic matter, ultimately exhausting oxygen in the basin during its decomposition. The interaction of these processes finally lead to the generation of enormous “dead zones” in the Black Sea.

References:

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