The impact on sedimentation in case the Adriatic Sea becomes meromictic due to global climate change

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Introduction: Stratification without mixing of sea layers is known as the meromictic state. This condition currently prevails in the Black Sea. The fact that the Adriatic Sea is prone to meromictic conditions is evident from the periodically increased organic carbon content in Holocene sediments. The Adriatic Sea exhibited many periods of benthic anoxic/hypoxic conditions. The last one occurred only 1650 ±100 years B.P. as determined by ^{14}C AMS dating of sediment cores [1]. The organic-rich sediment layers are associated with periods of warm climate and elevated sea levels. Mangini and Schlosser [2] have shown that the Adriatic Sea is very sensitive to small increases in water temperature (0.7 °C) or small decreases in salinity (0.2) that could cause stratification of Adriatic water masses. The ^{18}O stratigraphy has shown that the anoxic conditions in the Adriatic Deep-Sea Water (AdDW) cannot be attributed solely to increased freshwater input from the Adriatic rivers, nor to increased primary production [2].

The stratification of the water column requires more energy to break the thermohaline and mix the water layers. This could make it increasingly difficult to ventilate the lower layer. If the Adriatic Sea drastically changes its properties and becomes meromictic, the lower layer will become increasingly hypoxic, hindering the decomposition of organic matter and restoring the organic-rich sedimentation.

In the last decade, and especially in the last five years, the increase in temperature and salinity in the Adriatic Sea has accelerated along the entire water column. This could be both a sign of the inflow of warmer and less oxygen-rich deep waters from the Aegean Sea into the Adriatic Sea or a consequence of the ongoing warming and salinization of the entire Mediterranean Sea. Progressive warming of the upper layer combined with an increase in salinity in the lower layer of the Adriatic Sea will result in more stable thermohaline. This event will trigger a chain reaction on the Mediterranean Sea. One of the expected consequences will be destabilization and release of methane hydrates (MH) in the Mediterranean Sea, which will further exacerbate global climate change [3].

Methods: Trends in the Adriatic thermohaline formation will be assessed by evaluating existing data on vertical profiles of temperature, salinity, and oxygen over the last two decades throughout the water column of the Adriatic and Ionian Seas. Existing vertical current meter profiles will be analysed to determine trends in the water flux. Sediment cores will be analysed to identify reduced oxygen content events in Holocene sediments. A hydrodynamic model will be created to estimate the downward flux of water during winter and in events of strong bora winds in the northern Adriatic. MH stability estimates compared to temperature and salinity trends will also be evaluated.

Results and Discussion: Over the past two decades we have observed an abrupt increase in the average temperature and salinity of the AdDW. The temperature increased from 12.6 °C (until the 2000s) to 13.9 °C (currently), while the salinity increased from 38.6 to 38.9. The AdDW is formed by the contribution of dense water from the northern and southern Adriatic, formed due to cooling by the intense bora wind during the winter months. The AdDW, which is denser and more oxygenated than the adjacent Mediterranean water, overflows into the Ionian Sea and then into the Eastern Mediterranean Sea, filling and ventilating the deep layers and promoting the existence of the benthic ecosystem. The modification of the AdDW characteristics in the late 1980s and early 1990s [4], dramatically changed the hydrodynamic situation of the entire Mediterranean basin. If the trend of warming continues and leads to oxygen depletion, most bottom-dwelling marine fish will disappear, with direct economic consequences for fisheries. In addition, MH could become unstable in the surface sediments of the Mediterranean Sea, further contributing to global warming.

References: [1] Fontugne MR et al. (1989) *Paleoceanography* **4**(2):199–206; [2] Mangini A and Schlosser P (1986) *Mar Geol* **72**:115-124; [3] Obhodas J et al. (2020) *J Soils Sediments* **611**(20):2724-2732; Cardin et al. (2015) *Ocean Sci* **11**:53-665.