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When the unexpected reaches the methanogenic zone: coupled CH_4-Fe-N cycling

ORIT SIVAN[1], ALICE BOSCO SANTOS[2], ADI RIVLIN[1], AMIT WAISMAN[1], BARAK HERUT[3], RON SHAAR[4] AND MAXIM RUBIN-BLUM[3]

[1]Ben Gurion University of the Negev

[2]University of Lausanne

[3]Israel Oceanographic and Limnological Research

[4]Hebrew University

Presenting Author: oritsi@bgu.ac.il

In diagenetic anoxic sediments, the reduction of highly reactive iron and manganese oxides are not expected to take place in the methanogenic zone, being reduced before microbially or chemically by acid-volatile sulfides. However, conditions with rapid sediment burial and/or a combined higher flux of these oxides than sulfate could promote their preservation in the methanic sediments. In the Southeastern Eastern Mediterranean Sea continental shelf series of observations support Fe(oxyhydr)oxides reduction (up to 100 μM Fe^{2+}) in the methanic sediments, even few meters below the sulfate-methane transition zone. Contrary to the expected, anaerobic oxidation of methane coupled to iron reduction could not explain the Fe^{2+} increase. The iron reduction was accompanied by high levels of ammonium (3 and 7 mM), and surprisingly also the oxidized nitrogen species nitrate (1.07 to 9.8 μM) and nitrite (1.3 to 2.2 μM). This is together with increased magnetite concentrations in the sediments and enhanced magnetic proprieties. The microbial community in the methanic sediments provides hint for the complex couplings. There was a high distribution of Planctomycetes (17-32%) bacteria phylum, including two species of Brocadiaceae family capable of anammox. Furthermore, a strong positive correlation between the increased abundance of Elusimicrobia, recently proposed as a novel group of magnetotactic bacteria, and Fe^{2+} (> 0.83, $p<0.05$) was shown. As Elusimicrobia could be also related to the methane cycling, we are investigating closely if anammox can explain the source of Fe^{2+} and magnetotactic bacteria can explain its fate and contribute to methanogenesis in the Mediterranean Sea methanic sediments.