ANNUAL REPORT ON GEOTRACES ACTIVITIES IN TURKEY

April 1st, 2019 to March 31st, 2020

New GEOTRACES or GEOTRACES relevant scientific results

GEOTRACES-relevant activities in Turkey include basin-wide biogeochemical surveys in the Mediterranean, Marmara and Black Seas funded mainly through national projects won by the Institute of Marine Sciences of the Middle East Technical University. As a part of these larger initiatives, the Deep Sea research group of METU regularly performs trace-metal and redox-related specific research activities. Main activities in this context can be listed as follows:

- The new Black Sea and Marmara Sea Redox Cruise held winter and summer of 2019

The Black Sea is the one of the unique representative of global ocean with oxic shelf to permanent anoxic deep seawater. Although the surface waters of the Black Sea (80-100 m) contain oxygen, the rest of the basin (2200 m depth) contains the world's largest body of anoxic and sulfidic waters. Since the benthic region in the Black Sea is located under both oxygenated, sub-oxic and sulfidic waters, it offers an ideal oceanographic study site to understand the shelf to deep sea biogeochemical processes, trace metal burial and transport.

The Sea of Marmara connects the Mediterranean and the Black Seas, hosting over 20 million people in its catchment. Recently, the Sea of Marmara has dramatic decrease in oxygen revealed by over 20 years of dissolved oxygen time series held by METU-IMS. The deoxygenation of the Sea of Marmara results the hypoxic, or oxygen minimum zone (OMZ) extending nearly 1000 m in depth. This makes the Sea of Marmara as one of the world's OMZ zones under high human impact. Thus, there is an urgent need to understand the rate, causes, and key nutrient cycles related with the redox-dependent metal cycles such as Fe and P release under anoxic conditions.

For understand the key biogeochemical sysles, in the winter and summer period of 2019, sea water and sediment core samples obtained from the 19 stations in the Marmara Sea and the Black Sea. A newly acquired deep-sea multicorer (Figure) was utilized to collected undisturbed sediment column samples of about 50-60 cm in height. The core was sectioned, and each slice was separated to its porewater and solid phase, for subsequent analyses of trace metals, carbon and others. The stations located close to the main driver of the oceanographic processes such as Bosporus plume, pollution point source, basins and shelf to open ocean system (Fig. 2). Total and reactive Fe by spectrophotometric method, hydrogen sulfide and dissolved oxygen in porewater measured on board. Collected seawater and sediment core samples analysed for trace metals, nutrients, and major elements (Cl, SO4, Li, Na, K, Mg, Ca) on the campus.

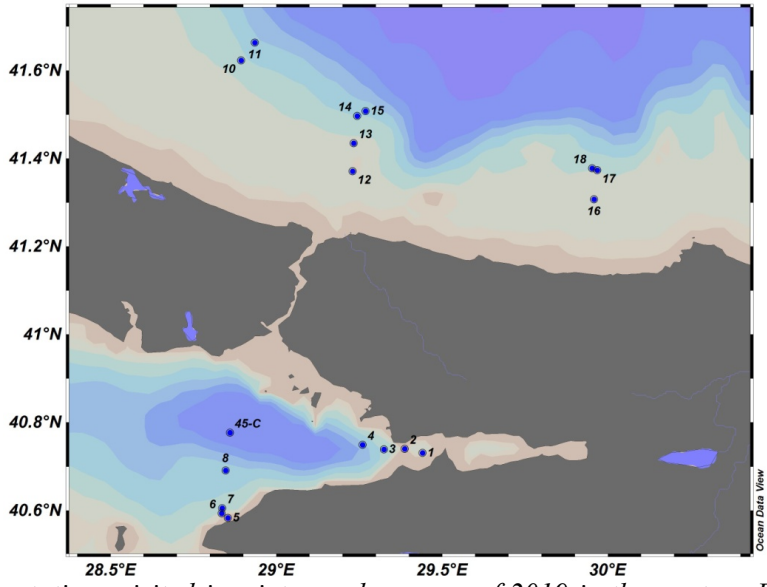

Figure: *The stations visited in winter and summer of 2019 in the western Black Sea and the Sea of Marmara.*

The main findings of this study are the dramatic deoxygenation of deep waters in the Sea of Marmara, dissolved oxygen concentrations in the deep waters (>900 m) decreased from 70.7 µM in 1995 to 7.3 µM in 2019. This is possibly resulted from the excessive nutrient fluxes from the boundaries. We confirm the decrease of oxygen trends in winter compared to our previous studies. We observed hydrogen sulfide accumulation at levels of 2.6-2.9 µM in Marmara's Eastern basin of the previous study and we could not detect hydrogen sulfide accumulation in summer 2019. The transition of the accumulation implies the redox gradient in the deep water that could mostly depend on nutrient inputs. The porewater ammonia and dissolved phosphate were at high concentration whereas dissolved iron increased under low-oxygen conditions in the sediment column. Hence, the high phosphate and organic matter accumulation, hence eutrophication in the water column can create the Fe and phosphate release in the sediment that could also increase the production.

- The Erdemli Time Series, Northeastern Mediterranean is a long-term oceanographic study based at Middle East Technical University, Institute of Marine Sciences (METU IMS) since 1997. The monthly cruises covers the high resolution of spatial distribution of shelf to deep-sea up to 500 m water depth including physical, chemical and biological properties. The 12 Niskin bottles General Oceanics rosette sampler coupled with a Sea-Bird Model 9 conductivity-depth-temperature (CTD) sensor is operated for seawater sampling. Temperature, salinity, nutrients, dissolved oxygen, pH, phytoplankton, zooplankton and pigment and pelagic and benthic macrofauna of are the main topics of the time series study.
- The seasonal (winter and summer)/annual monitoring of the Black Sea, the Sea of Marmara, the Aegean Sea, and the Mediterranean Sea is a long-term oceanographic program that recently funded by DEKOSIM grant BAP-08-11-DPT.2012K120220, financed by the Ministry of Development of Turkey. In these cruises, the oceanographic properties of the all seas are investigated for seasonal/annual change and the historical change of its oceanography and ecosystems. The map of sampling stations is given in the Figure 3. The Eastern Mediterranean also investigated for its oceanography, climate change and ocean acidification studies with sensitive pH and oxygen sensors (ISFET, Aandrea optodes for oxygen) with the synchronous monitoring program with French PERLE program.

GEOTRACES or GEOTRACES relevant cruises

- Black Sea and Marmara Sea Redox Cruise held winter and summer of 2019 with *R/V Bilim-2*. Fe in the sediment core was measured on board with the Ferrozine assay.

New projects and/or funding

- "Deep-sea metal and nutrient cycling in the Marmara and the Black Sea Improving the detection of redox processes and nanoparticle formation (DEEPREDOX)" Research Project is accepted and funded by European Research Council(ERC) Support Program, the Scientific and Technological Research Council of Turkey (TUBITAK).(PI:Assoc. Prof. Dr. Mustafa Yücel, Host: Middle East Technical University, Institute of Marine Sciences).

Outreach activities conducted

- Summary report of the Black Sea and Marmara Sea Redox Cruise.

Other GEOTRACES activities

- Mustafa Yucel participated as a member of SCOR International Working Group 151, Iron Model Intercomparison Project (FeMIP) meeting, 16 February 2020, San Diego, California, USA.

New GEOTRACES or GEOTRACES-relevant publications (published or in press)

- Findlay, A. J., Estes, E. R., Gartman, A., Yücel, M., Kamyshny, A., & Luther, G. W. (2019). Iron and sulfide nanoparticle formation and transport in nascent hydrothermal vent plumes. Nature communications, 10(1), 1-7.

GEOTRACES presentations in international conferences

- Estes, E.R., Berti, D., Findlay, A., Hochella, M.F., Yucel, M., Luther, G.W., (2020). Differential behavior of metal sulfides in hydrothermal plumes and diffuse flows. In Ocean Sciences Meeting 2020. AGU.
- Yücel, M., Sevgen, S., and Le Bris, N., (2019). Dissolved, colloidal and particulate iron in hydrothermal vent fluids and rising plumes from Broken Spur and Rainbow, Mid-Atlantic Ridge. In Goldschmidt Conference 2019, Barcelona, Spain.
- Akçay İ., Yücel M., (2019). Deoxygenation and coastal eutrophication drive distinct benthic nutrient dynamics in the hypoxic Marmara Sea and oxic northeastern Mediterranean Sea. In Goldschmidt Conference 2019, Barcelona, Spain.
- Alımlı, N., Sevgen, S., Yucel, M., (2019). Black Sea: Biogeochemical bridge between A-ancient earth and ocean-worlds. In 3rd Astrobiology Conference of Turkey, METU, Ankara, Turkey.

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