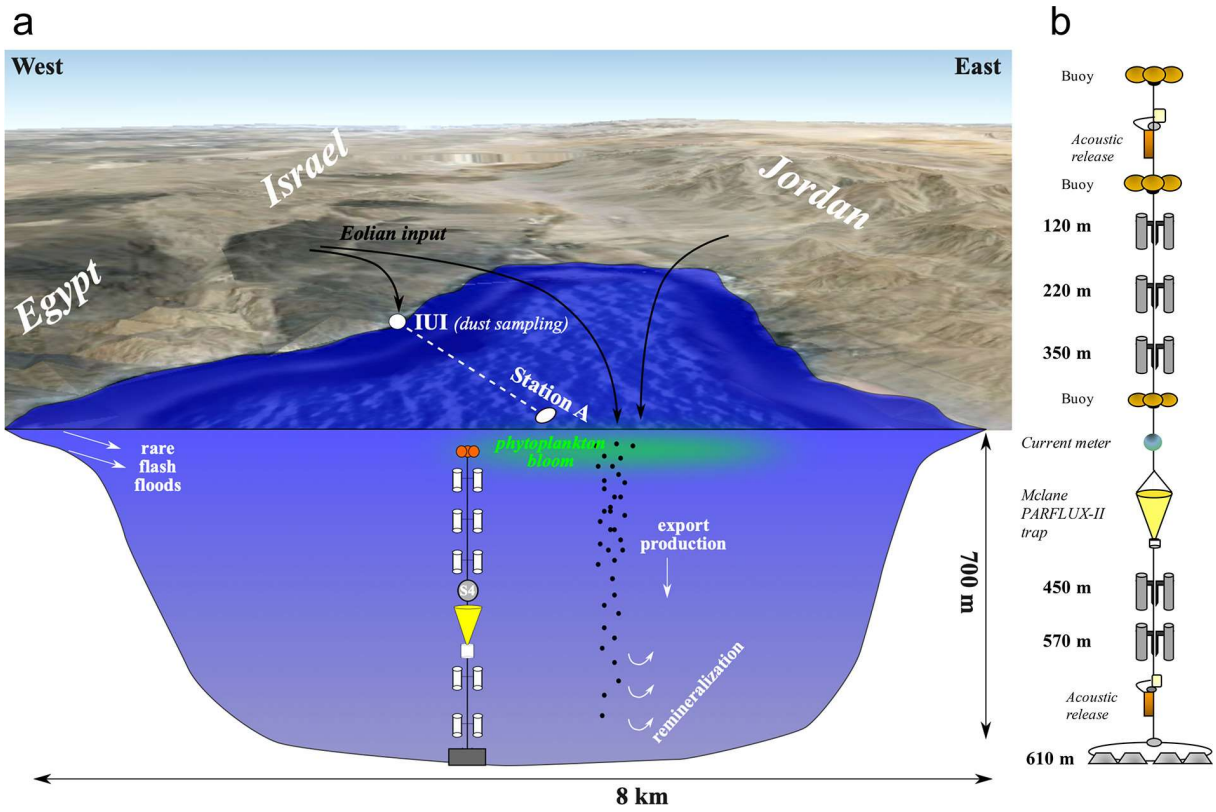
ANNUAL REPORT ON GEOTRACES ACTIVITIES IN ISRAEL

April 1st, 2020 to April 30th, 2021

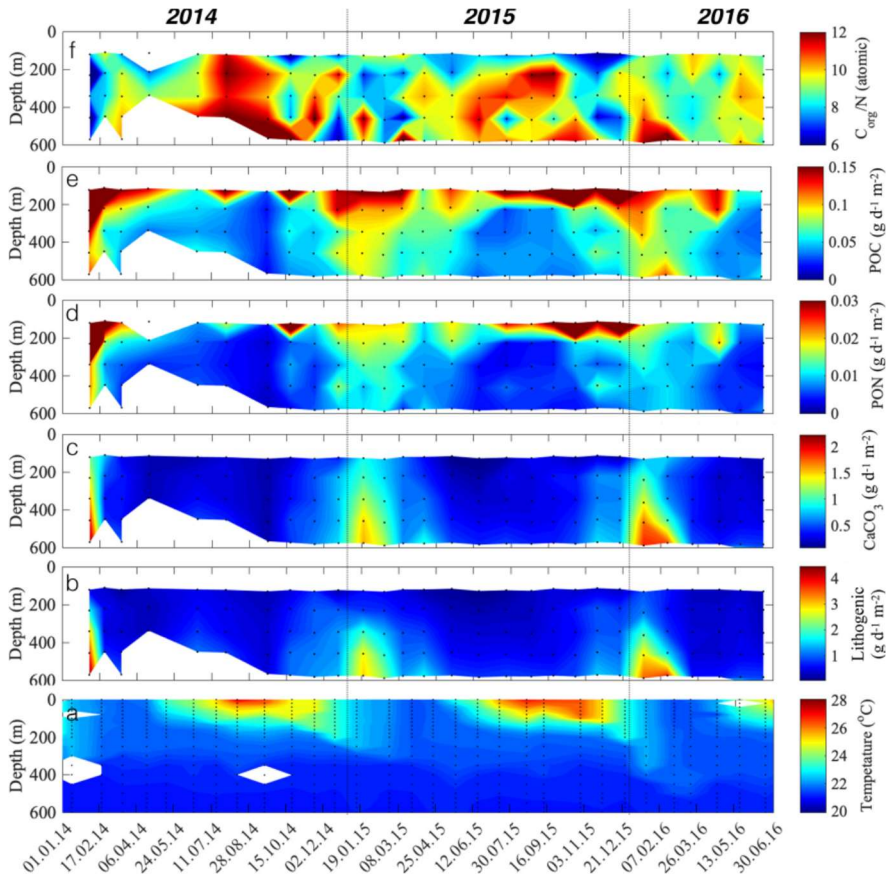
New GEOTRACES or GEOTRACES relevant scientific results

Marine particulate fluxes were studied between 2014 and 2017 in the oligotrophic Gulf of Aqaba (GOA), northern Red Sea. The results, described briefly below, were reported by Torfstein et al. (2020) in a special issue of *ACS Earth and Space Chemistry* devoted to "Marine Particle Chemistry: Influences on Biogeochemical Cycles and Particle Export". The study, which is part of the ***Red Sea Dust, Marine Particulates and Seawater Time Series*** (***REDMAST***, *GIpr09*), includes a monthly –rotated bottom tethered mooring mounted with 5 sediment trap stations (KC Denmark Inc.) at approximately equal depth intervals between 120 and 570 m (water depth of ~610 m).



Schematic diagram of the study site at the Gulf of Aqaba. The sediment trap mooring is bottom-tethered at ~610 m water depth. The mooring included KC Denmark cylinder sediment trap stations deployed at depths of 120, 220, 350, 450, and 570 m (the mooring further included a McLane time series PARFLUX-II trap at 410 m, the results of which will be discussed elsewhere). An S4 current meter system was deployed at 380 m and recorded current velocity and direction during part of the time of the study. In addition, the National Monitoring Program (NMP) carries out monthly measurements of physical and chemical conditions at Station A. Fine eolian particles (dust) are delivered year round to the GOA, and an atmospheric dust trap is operated routinely at IUI, the logistical base for this study, as well as additional dust monitoring stations deployed by the Israel Ministry of Environmental Protection (MEP) along the coast of Eilat. Flash floods deliver terrestrial particles a few times a year during brief (<1 day) well-defined events.

The bulk particulate fluxes were determined for the entire period, with organic C and N, $CaCO_3$, and lithogenic fluxes determined for the first two and half years of the deployment. The results are evaluated in the context of monthly resolved records of seawater temperature, chlorophyll-a concentrations, and macro-nutrient concentrations, as well as hourly to weekly dust load records and rare fluvial events. The results are further compared to core-tops collected from varying water depths and are combined to produce a basin source-to-sink mass balance of particulate fluxes. The GOA undergoes strong seasonal changes expressed by surface water temperatures and water column stratification and mixing, which control the vertical and temporal distribution of nutrients and primary and export production.



***Time series in the GOA during 2014–2016**. (a) temperature (°C), (b) lithogenic flux (g m^{-2} d^{-1}), (c) $CaCO_3$ flux (g m^{-2} d^{-1}), (d) particulate organic nitrogen (PON) flux (g m^{-2} d^{-1}), (e) particulate organic carbon (POC) flux (g m^{-2} d^{-1}), and (f) Corg/N atomic ratios. Black dots mark the depths and times of sampling.*

Accordingly, the seasonal variability in particulate fluxes varies over a wide range, typically displaying peak bulk fluxes in bottom waters during the winter (~5–7 g m^{-2} d^{-1}) and minimum values in shallow waters during summer (<0.5 g m^{-2} d^{-1}). Organic C and N fluxes are the highest in shallow waters and display strong vertical attenuation that varies seasonally, a-priori reflecting enhanced remineralization in the warm shallow waters during summer. In contrast, particulate organic carbon and nitrogen fluxes are enhanced in bottom waters during winter, due to the combined effect of the increased presence of mineral ballasts and vertical water column mixing. The quantification of particulate fluxes in the GOA suggests that, while most of the bulk particulates are introduced into the basin via episodic fluvial events, with direct dust inputs contributing approximately an order of magnitude less material, the internal cycling of terrigenous material is complex, with a lag between the initial deposition of influxing material along shallow margins and seasonal reworking and transport of sediments to the deep seafloor. Nevertheless, the fluxes of terrigenous and organic particulates are largely independent of each other, with export production fluxes driven by water column mixing and nutrient availability in the photic zone. On a wider scale, the findings reported here relate to the role of dust deposition and hemipelagic sedimentation in the oceans and their impact on export production and particle cycling in coastal regions. Combined, the findings illuminate the factors impacting marine habitats and ecosystems, the cycling and sequestration of trace elements and anthropogenic components in the oceans, and facilitate better understanding of the interplay between solid and

dissolved phases in the oceans and reconstructing past oceanographic and climatic conditions from marine sediment cores.

GEOTRACES or GEOTRACES relevant cruises

- The National Monitoring Program of Israel's Mediterranean waters –Hydrographic and sedimentological cruises on board R.V. Bat Galim along E-W transects across the Israeli Mediterranean EEZ (Water – bi-annual; Sediments – annual).
- DeepLev Observatory – deep-sea mooring station in the eastern Levantine basin at 1500 m water depth, ~50 km offshore Haifa, Israel, aimed at enhancing synchronized measurements of physical and biogeochemical dynamics. The station carries an array of sediment traps and sensors that measure physical, chemical, and biological attributes along the water column. Two cruises with R.V. Bat Galim; mooring operations. (Joint study – IOLR; BIU; UH; HUJI; TAU).
- Seafloor Hydrocarbon Seeps in the southeastern Mediterranean Sea – till recently 3 cruises at the Palmachim area including water column and sediment sampling. R.V. Bat Galim.
- The National Monitoring Program (NMP) for the Gulf of Eilat/Aqaba operates out of the IUI (http://www.iui-eilat.ac.il/Research/NMPAbout.aspx). Activities include monthly cruises across the north Gulf of Eilat/Aqaba, during which physical, chemical and biological measurements are performed in depth profiles (at a water depth of 700 meters) together with spatial-surface coverage. The main-relevant parameters monitored are: Temperature, salinity, dissolved oxygen, pH, alkalinity, POC, NO_2, NO_3, $Si(OH)_4$, PO_4, Chl-a. The samples are collected with the IUI Research Vessel, which has a powder coated aluminium Rosette (SeaBird) with 12 niskin bottles (12 liters each), and a CTD (SeaBird electronics). These measurements have been performed continuously since the year 2000. Analyses are performed at the IUI labs.

Outreach activities conducted

- Yeala Shaked became involved in i-scientists, zoom meetings with secondary and high school students to discuss research, ocean biogeochemistry in a changing world etc. https://davidson.weizmann.ac.il/en/programs/iscientist

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

- Benaltabet T., Lapid G. and Torfstein A. (2020) Seawater Pb concentration and isotopic composition response to daily time scale dust storms in the Gulf of Aqaba, Red Sea. *Marine Chemistry 227*, 103895.
- Chernihovsky N., Almogi-Labin A., Kienast S.S. and Torfstein A. (2020) The daily resolved temperature dependence and structure of planktonic foraminifera blooms. *Scientific Reports 10*(1), 1-12.
- Costa et al. (2020) ^{230}Th normalization: New insights on an essential tool for quantifying sedimentary fluxes in the modern and Quaternary ocean. *Paleoceanography and Paleoclimatology* 35, 1-36.
- Rahav E., Paytan A., Mescioglu E., Bar-Zeev E., Mart F., Xian P. and Herut B. (2020). Bio-aerosols negatively affect Prochlorococcus in oligotrophic aerosol-rich marine regions. *Atmosphere.* 11(5), 540.
- Rahav E., Raveh O., Yanuka-Golub K., Belkin N., Astrahan P., Maayani M., Tsumi N.,

Kiro Y., Herut B., Silverman J. and Angel D.L. (2020). Nitrate enrichment Structures Phytoplankton Communities in the Shallow Eastern Mediterranean Coastal Waters. Front. Mar. Sci. 7:611497. doi: 10.3389/fmars.2020.611497.

- Shaked Y, Buck KN, Mellett T, and Maldonado MT. (2020) Insights into the bioavailability of oceanic dissolved Fe from phytoplankton uptake kinetics. *The ISME Journal doi.org/10.1038/s41396-020-0597-3*.
- Sisma-Ventura G., Kress N., Silverman J., Gertner Y., Ozer T., Biton E., Lazar A., Gertman I., Rahav E. and Herut B. (2021) Post-eastern Mediterranean Transient Oxygen Decline in the Deep Waters of the Southeast Mediterranean Sea Supports Weakening of Ventilation Rates. *Front. Mar. Sci.* 7:598686.
- Sisma-Ventura G., Herut B., Silverman J., Katz T., Rubin-Blum M. and Rahav E. (2021). P fluxes and prokaryotic cycling at benthic boundary layer in the deep southeastern Mediterranean Sea. *Journal of Geophysical Research: Biogeosciences,* 126, e2020JG006110.
- Titelboim D., Sadekov A., Blumenfeld M., Almogi-Labin A., Herut B., Halicz L., Benaltabet T., Torfstein A., Kuceara M. and Abramovich S. (2021) Monitoring of heavy metals in seawater using single chamber foraminiferal sclerochronology. Ecological Indicators 120, 106931.
- Torfstein A., Kienast S.S., Rivlin A., Isaacs S., Yarden B. and Shaked Y. (2020) Bulk and export production fluxes in the Gulf of Aqaba, northern Red Sea. *ACS Earth and Space Chemistry* 4(8), 1461-1479.

Completed GEOTRACES PhD or Master theses

- Natalie Chernihovsky, "High-resolution temporal dynamics of planktonic foraminifera in the Gulf of Aqaba", HUJI. Advisors: Adi Torfstein (HUJI), Ahuva Almogi-Labin (GSI).

GEOTRACES presentations in international conferences

- Benaltabet T., Lapid G. and Torfstein A. (2020) Seasonal seawater Al dynamics and response to short-term perturbations in the Gulf of Aqaba, northern Red Sea. Goldschmidt meeting.
- Kienast S.S., Torfstein A. and Riehl L. (2019) Constraining Remineralization of Sinking Organic Carbon in the Oligotrophic Ocean: A Case Study from the Gulf of Aqaba, AGU fall meeting.
- Kienast S.S. and Torfstein A. (2020) Sinking organic carbon in the Gulf of Aqaba: Implications for a warming ocean. Goldschmidt meeting.
- Lapid G., Benaltabet T. and Torfstein A. (2020) Dissolved ^{230}Th and ^{232}Th as tracers of particle fluxes in the Gulf of Aqaba, Red Sea. Goldschmidt meeting.
- Rahav E. (2020) Nitrate-enrichment structures phytoplankton communities in the shallow eastern Mediterranean coastal waters. Aquacosm meeting, Crete.
- Rahav E and Herut B. (2021) The hitchhikes guide to bacterial transport: the role of viable dust-borne microbes deposition into marine environments. Micro2021 meeting.
- Torfstein A., Kienast S.S., Tirosh O. and Yarden B. (2020) Major and trace element settling and burial fluxes in the Gulf of Aqaba, northern Red Sea. Goldschmidt meeting.
- Torfstein A. (2021) Bulk and export production fluxes in the Gulf of Aqaba, northern Red Sea. Ocean Carbon and Biogeochemistry in Tropical Seas, KAUST, Saudi Arabia.

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