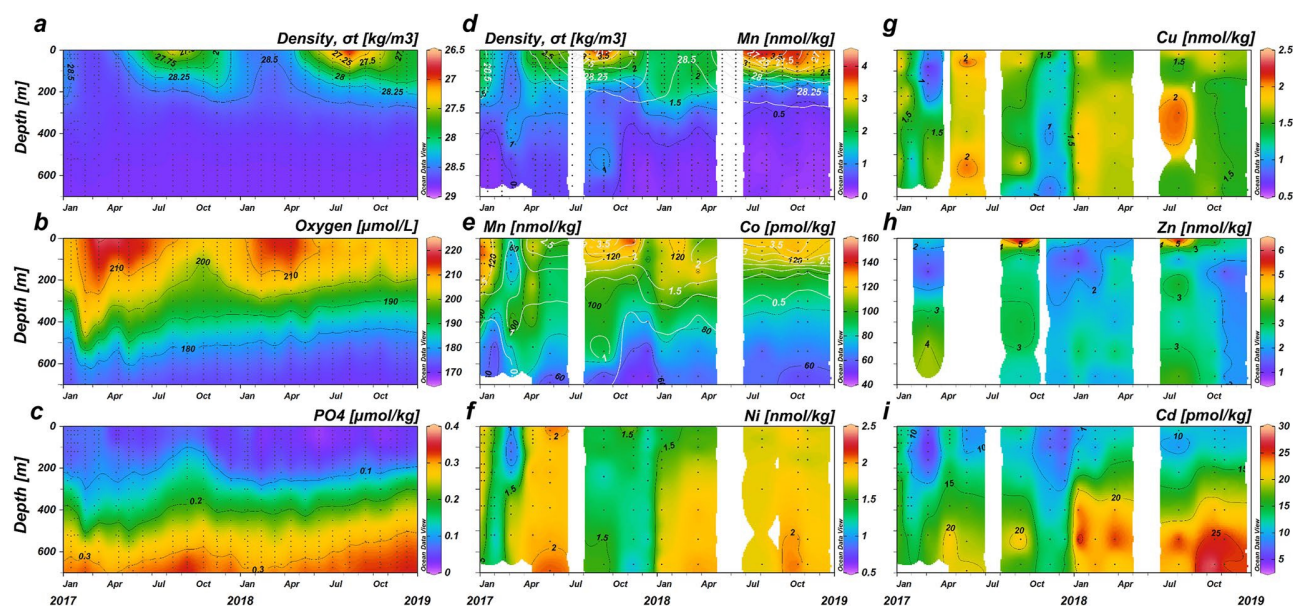


ANNUAL REPORT ON GEOTRACES ACTIVITIES IN ISRAEL

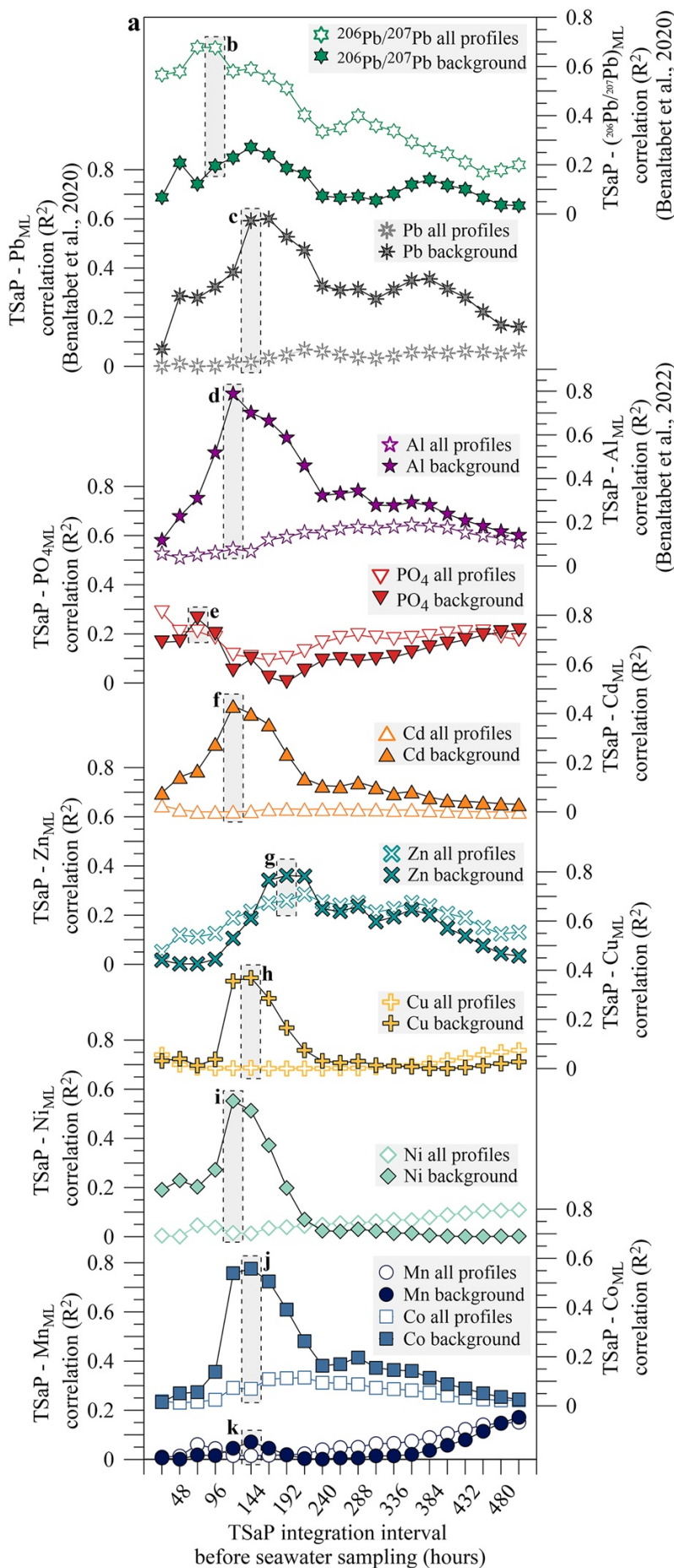
May 1st, 2023 to April 30th, 2024

New GEOTRACES or GEOTRACES relevant scientific results

- Response of Dissolved Trace Metals to Dust Storms, Sediment Resuspension, and Flash Floods in Oligotrophic Oceans (Benaltabet et al., 2023): Trace metals (TM) delivered by atmospheric dust play a key role in oceanic biogeochemical cycles. However, the impact of short-term environmental perturbations such as dust storms and sediment resuspension events on the oceanic water column is poorly constrained due to the low temporal sampling resolution and episodic nature of these events. Benaltabet et al. (2023) present a 2-year time series of dissolved manganese, cobalt, nickel, copper, zinc, cadmium, and phosphate concentration profiles sampled in the Gulf of Aqaba (GoA), Red Sea. The GOA is a highly accessible deep oligotrophic water body featuring exceptionally high atmospheric deposition fluxes that provide the main source of TMs to its surface waters. The study focuses on daily time scale dust storms and episodes of sediment resuspension to quantify the immediate impact of these events on dissolved TM cycling. Counter-intuitively, upper mixed layer TM inventories decrease with increasing aerosol loads, with the effects of aerosol-induced TM scavenging and dissolution peaking 5–6 days after aerosol deposition. Dust storms promote intense TM scavenging, with TM inventories decreasing by up to 44%, but seldom lead to TM enrichment. Similarly, sediment resuspension and flash flood events triggered significant TM scavenging. These findings highlight the potential dual role of atmospheric deposition in the oceans as a long-term source of dissolved TMs and a short-term sink. These in situ observations may be used to understand and quantify the global impact of abrupt environmental events on oceanic chemical compositions.



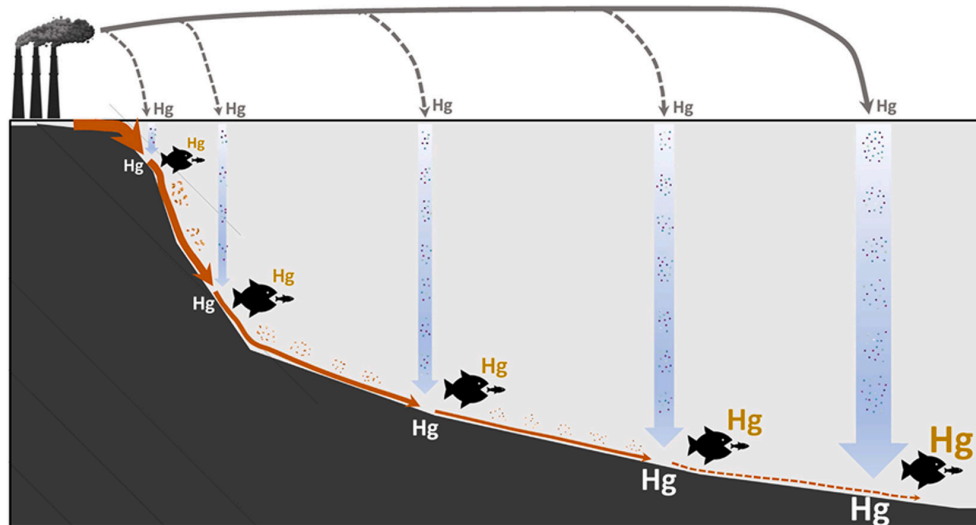
Seawater density, oxygen, PO₄ and dissolved trace metals concentrations at station A, Gulf of Aqaba during 2017-2018. Black dots denote the timing and depth of sampling.



Correlation values (R²) between dissolved trace metal mixed layer concentrations (TMML) and integrated dust (TSaP) loads at varying time intervals prior to seawater sampling. Background profiles (full symbols) display higher correlations to TSaP relative to the entire set of profiles (empty symbols). The highest correlations for Co_{ML}, Ni_{ML}, Cu_{ML}, Cd_{ML} and Al_{ML} were achieved for TSaP integration periods of 120-144 hours, whereas Mn_{ML} and PO_{4ML} R² values remained poor.

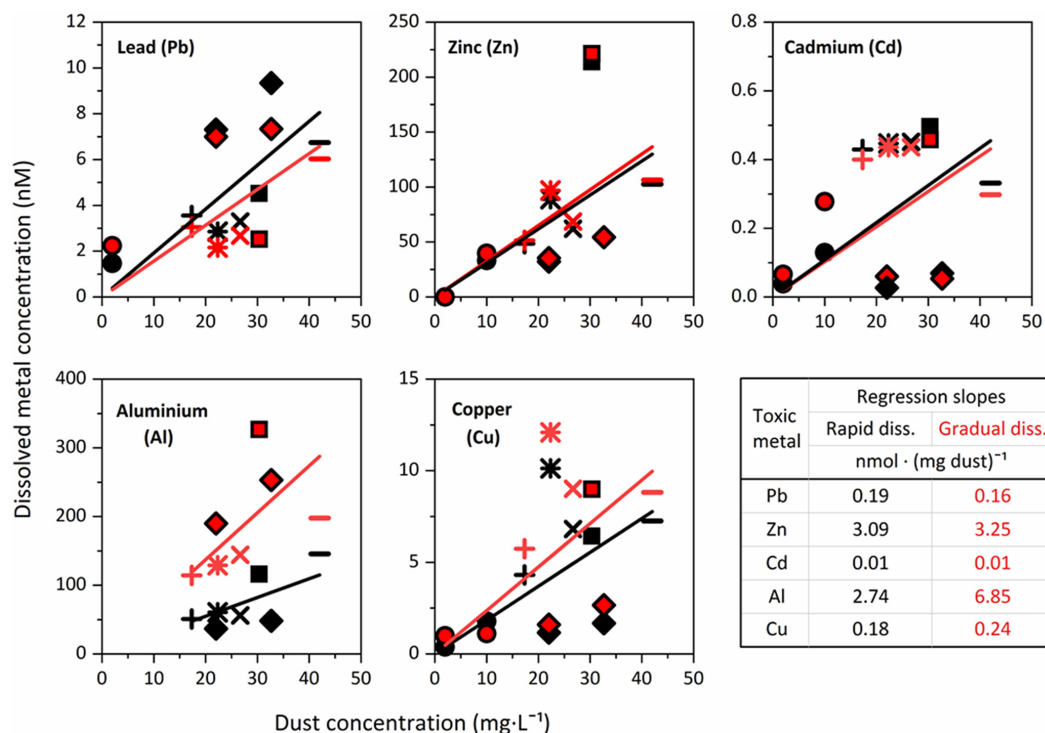
Reference: Benaltabet, T., Lapid, G. and Torfstein, A., 2023. Response of dissolved trace metals to dust storms, sediment resuspension, and flash floods in oligotrophic oceans. *Global Biogeochemical Cycles*, 37(10), p.e2023GB007858.

- Accumulation of total mercury in deep-sea sediments and biota across a bathymetric gradient in the Southeastern Mediterranean Sea (Sisma-Ventura et al., 2024): This study explores the accumulation of total mercury (THg) in deep-sea sediments and demersal megafauna of the ultra-oligotrophic Southeastern Mediterranean Sea (SEMS) across bathymetric gradients in the range 35–1900 m, sampled in seven cruises during 2013, 2017–2021, and 2023. Measurements of THg were conducted in surficial (0.0–0.5 cm) and subsurface (9.0–10 cm) sediments, demersal sharks, demersal teleost fish, and benthic crustaceans. Sedimentary organic carbon and biota $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values were determined to explore possible foraging habitats and dietary sources of THg. The results exhibit an increasing trend of THg in surficial sediments with increasing bottom depth, while in the subsurface, pre-industrial sediments, THg remains lower, slightly increasing with depth. Having no major terrestrial point sources in this area, this increasing trend of THg in surficial sediments across bathymetric gradients is controlled by atmospheric mercury deposition, scavenged by the biological pump, and by lateral transport of particulate Hg in winnowed fine particles from the shelf. Similarly, the THg in benthic crustaceans and demersal fish ranged between 0.02 and 2.71 $\mu\text{g g}^{-1}$ wet weight (0.06 and 10.8 $\mu\text{g g}^{-1}$ dry weight) and increased with muscle $\delta^{13}\text{C}$ as a function of distance offshore, while presenting a low THg- $\delta^{15}\text{N}$ bio-magnification power. Our results suggest that foraging habitats, longevity, and species-specific depth distribution control their muscle THg bioaccumulation. Despite this complexity, the pooling of THg in megafauna into specific deep zones reflected the trend of increasing anthropogenic THg across bathymetric gradients. Furthermore, many of the biota measurements exceeded safe consumption thresholds for Hg and therefore, should be considered carefully in the development and regulation of deep-sea trawling in this region.



Reference: Sisma-Ventura, G., Silverman, J., Guy-Haim, T., Stern, N., Shachnai, A., Mori, M.M., Khadra, M.A., Jacobson, Y., Segal, Y., Katz, T. and Herut, B., 2024. Accumulation of total mercury in deep-sea sediments and biota across a bathymetric gradient in the Southeastern Mediterranean Sea. *Chemosphere*, 351, p.141201.

- Costs of dust collection by *Trichodesmium*: effect on buoyancy and toxic metal release (Wang et al., 2024): The marine cyanobacterium *Trichodesmium* has the remarkable ability to interact with and utilize air-borne dust as a nutrient source. However, dust may adversely affect *Trichodesmium* through buoyancy loss and exposure to toxic metals. This study explored the effect of desert dust on buoyancy and mortality of natural Red Sea puff-shaped *Trichodesmium thiebautii*. Sinking velocities and ability of individual colonies to stay afloat with increasing dust loads were studied in sedimentation chambers. Low dust loads of up to ~400 ng per colony did not impact initial sinking velocity and colonies remained afloat in the chamber. Above this threshold, sinking velocity increased linearly with the colony dust load at a slope matching prediction based on Stoke's law. The potential toxicity of dust was assessed with regards to metal dissolution kinetics, differentiating between rapidly released metals, which may impact surface blooms, and gradually released metals that may impact dust-centering colonies. Incubations with increasing dust concentrations revealed colony death, but the observed lethal dose far exceeded dust concentrations measured in coastal and open ocean systems. Removal of toxic particles as a mechanism to reduce toxicity was explored using SEM-EDX imaging of colonies incubated with Cu-minerals, yet observations did not support this pathway. Combining our current and former experiments, we suggest that in natural settings the nutritional benefits gained by *Trichodesmium* via dust collection outweigh the risks of buoyancy loss and toxicity. Our data and concepts feed into the growing recognition of the significance of dust for *Trichodesmium*'s ecology and subsequently to ocean productivity.



Compilation of dust dissolution experiments conducted in seawater using different dust samples and concentrations. The data set combines new measurements (circles) and published data from Mackey et al. (2015) and includes seven dust samples plotted as different symbols. Metal release kinetics is presented by two categories - rapidly released metals (black, up to 6 hr) and gradually released metals (red, up to 7 days). Regression slopes linking dust and dissolved metal concentrations are plotted and summarized in the table next to the graph.

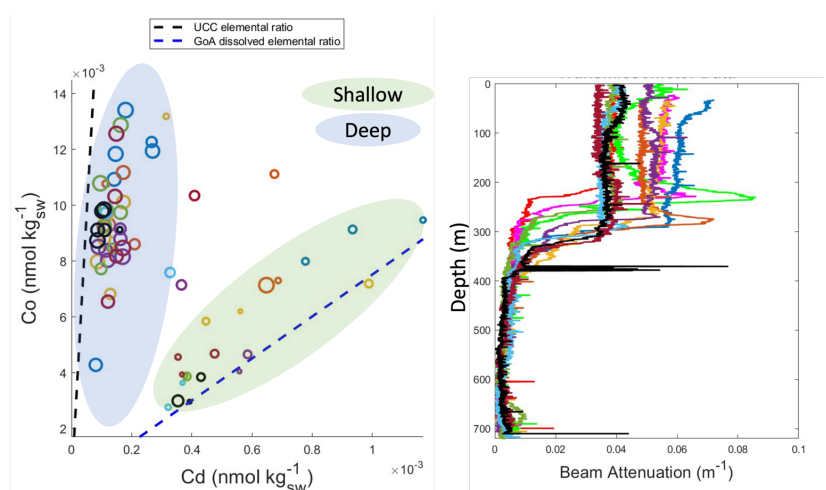
Reference: Wang, S., Zhang, F., Koedooder, C., Qafoku, O., Basu, S., Krisch, S., Visser, A.N., Eichner, M., Kessler, N., Boiteau, R.M. and Gledhill, M., 2024. Costs of dust collection by *Trichodesmium*: effect on buoyancy and toxic metal release. *Journal of Geophysical Research: Biogeosciences*, 129(4), p.e2023JG007954

GEOTRACES or GEOTRACES relevant cruises

- 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, NO₂, NO₃, Si(OH)₄, PO₄, 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.
- 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 (nutrients, alkalinity, pH, DO, Chl-a, pico-phytoplankton, PP, BP); Sediments – annual).
- Marine particulate fluxes, dust and dissolved seawater compositions are studied in the oligotrophic Gulf of Aqaba (GOA), northern Red Sea as part of the *Red Sea Dust, Marine Particulates and Seawater Time Series (REDMAST, GIp09)*. This includes a continuously deployed bottom tethered mooring mounted with sediment traps (e.g., Torfstein et al., 2020).
- Focused field campaigns:
 - *Research cruise M197 (RV METEOR)* sailed during January-February 2024 from Cyprus to Italy, with the aim of investigating the seawater and sediment biogeochemistry in the eastern Mediterranean Sea. The two specific foci of the research cruise were to (i) investigate the physical, chemical and biological factors regulating the productivity and sinking carbon flux in this region, and (ii) investigate natural and human induced changes in the region over the last few thousands of years. This cruise was led by GEMOAR scientists, with the University of Haifa and Israel Oceanography and Limnology Research institute as participating institutions.
 - *Eastern Mediterranean Sea transect. Quantification of dissolved and particulate fluxes* (²³⁴Th, POC, DNA, trace metal concentrations of particulate matter). January 2024, Yishai Weinstein (BIU) in collaboration with Adi Torfstein (HUJI).
 - *Daily timescale variability in particulate trace element concentrations in the Gulf of Aqaba, 2023*, Aden Clarfield (MSc student, advised by Adi Torfstein; HUJI). See figure below:

Particulate trace element concentrations in the Gulf of Aqaba, northern Red Sea, 2023 Clarfield & Torfstein, unpublished).

The left panel displays the particulate Co and Cd concentrations, where each color represents a different profile and corresponds to the transmissometer attenuation data in the right panel. Note the clear differences between shallow and deep waters, and the compositional range between upper crust and typical local seawater compositions. This project is in progress.



New projects and/or funding

- Eyal Rahav and Barak Herut (IOLR), *Assessing the survival and diversity of airborne bacteria in response to different anthropogenic and natural aerosols upon interaction with seawater*, Israel Science Foundation (2022-2026)
- Yeala Shaked and Dani Mandler (HUJI), *Iron Oxide Nanoparticles – Detection and Effect on Microorganisms*, Hebrew University Center for Sustainability (2023-2024)

GEOTRACES workshops and meetings organized

- The Israel Association of Aquatic Sciences (IAAS) annual meeting (2023) included GEOTRACES relevant talks on trace metal concentrations, fluxes and availability in open ocean and coastal environments. The IAAS president is Yeala Shaked.

Other GEOTRACES activities

- Yeala Shaked served as an active associate member of the SCOR working group: PRIMO - Physiology and Rates of Microbial Oceanography. This working group involves Geotraces (and biogeotraces) people and is part of the new program Biogeoscapes.
- Yeala Shaked served as an active associate member of the SCOR working group: RUSTED – Reducing Uncertainty in Soluble aerosol Trace Element Deposition. Joined meetings and special session in ASLO 2023 and online meetings

New GEOTRACES or GEOTRACES-relevant publications (published or in press) (If possible, please identify those publications acknowledging SCOR funding)

- Alkalay, R., Weinstein, Y., Herut, B., Ozer, T., Zlatkin, O., Bar, T., Berman-Frank, I. and Katz, T., 2024. Temporal pattern and profile of a coastal-deep sea conveyor at a marginal deep oligotrophic sea. *Journal of Geophysical Research: Oceans*, 129(6), p.e2023JC020441.
- Benaltabet, T., Lapid, G. and Torfstein, A., 2023. Response of dissolved trace metals to dust storms, sediment resuspension, and flash floods in oligotrophic oceans. *Global Biogeochemical Cycles*, 37(10), p.e2023GB007858.
- Eichner, M., Inomura, K., Karlusich, J.J.P. and Shaked, Y., 2023. Better together? Lessons on sociality from Trichodesmium. *Trends in Microbiology*, 31(10), pp.1072-1084.
- Sisma-Ventura, G., Silverman, J., Segal, Y., Hauzer, H., Khadra, M.A., Stern, N., Guy-Haim, T. and Herut, B., 2024. Exceptionally high levels of total mercury in deep-sea sharks of the Southeastern Mediterranean sea over the last~ 40 years. *Environment International*, 187, p.108661.
- Haim, N., Grigorieva, V., Soffer, R., Mayzel, B., Katz, T., Alkalay, R., Biton, E., Lazar, A., Gildor, H., Berman-Frank, I. and Weinstein, Y., 2024. Multiyear surface wave dataset from the subsurface “DeepLev” eastern Levantine moored station. *Earth System Science Data*, 16(6), pp.2659-2668.
- Herut, B., Goldman, R., Ozer, T., Lazar, A., Biton, E., Gertman, I., Silverman, J., Segal, Y., Sisma-Ventura, G., Gertner, Y. and Rubin-Blum, M., 2024. Tar pollution event (2021) at the Southeastern Levantine oligotrophic basin, short-term impacts and operational oceanography perspectives. *Marine Pollution Bulletin*, 198, p.115892.
- Herut, B., Guy-Haim, T., Almogi-Labin, A., Fischer, H.W., Ransby, D., Sandler, A., Katz, T. and Avnaim-Katav, S., 2023. Marine oligotrophication due to fine sediments and nutrient starvation caused by anthropogenic sediment and water retention in large rivers: the Nile damming case. *Frontiers in Marine Science*, 10, p.1226379.
- Katz, T., Bookman, R., Herut, B., Goodman-Tchernov, B. and Sisma-Ventura, G., 2024. Far-field effects of the Nile damming on the silica cycle in the Southeastern Mediterranean Sea. *Science of The Total Environment*, 921, p.171274.

- Levy, N., Torfstein, A., Schiebel, R., Chernihovsky, N., Jochum, K.P., Weis, U., Stoll, B. and Haug, G.H., 2023. Temperature calibration of elevated Mg/Ca in planktic Foraminifera shells from the hypersaline Gulf of Aqaba. *Geochemistry, Geophysics, Geosystems*, 24(7), p.e2022GC010742.
- Rahav, E., Herut, B. and Paytan, A., Blowing in the wind: The hitchhiker guide to microbial transport in the atmosphere. *Frontiers for Young Minds*. 11, p. 1172757.
- Rubin-Blum, M., Makovsky, Y., Rahav, E., Belkin, N., Antler, G., Sisma-Ventura, G. and Herut, B., 2024. Active microbial communities facilitate carbon turnover in brine pools found in the deep Southeastern Mediterranean Sea. *Marine Environmental Research*, 198, p.106497.
- Shaked, Y., de Beer, D., Wang, S., Zhang, F., Visser, A.N., Eichner, M. and Basu, S., 2023. Co-acquisition of mineral-bound iron and phosphorus by natural Trichodesmium colonies. *Limnology and Oceanography*, 68(5), pp.1064-1077.
- Sisma-Ventura, G., Silverman, J., Guy-Haim, T., Stern, N., Shachnai, A., Mori, M.M., Khadra, M.A., Jacobson, Y., Segal, Y., Katz, T. and Herut, B., 2024. Accumulation of total mercury in deep-sea sediments and biota across a bathymetric gradient in the Southeastern Mediterranean Sea. *Chemosphere*, 351, p.141201.
- Velasquez, X., Morov, A.R., Astrahan, P., Tchernov, D., Meron, D., Almeda, R., Rubin-Blum, M., Rahav, E. and Guy-Haim, T., 2024. Bioconcentration and lethal effects of gas-condensate and crude oil on nearshore copepod assemblages. *Marine Pollution Bulletin*, 203, p.116402.
- Wang, S., Zhang, F., Koedooder, C., Qafoku, O., Basu, S., Krisch, S., Visser, A.N., Eichner, M., Kessler, N., Boiteau, R.M. and Gledhill, M., 2024. Costs of dust collection by Trichodesmium: effect on buoyancy and toxic metal release. *Journal of Geophysical Research: Biogeosciences*, 129(4), p.e2023JG007954.
- Whitby, H., Park, J., Shaked, Y., Boiteau, R.M., Buck, K.N. and Bundy, R.M., 2024. New insights into the organic complexation of bioactive trace metals in the global ocean from the GEOTRACES era. *Oceanography*, 37(2), pp.142-155.

Completed GEOTRACES PhD or Master theses (please include the URL link to the pdf file of the thesis, if available)

- Tal Benaltabet, PhD, 2016 - 2023, "Dissolved trace metal and Pb isotope dynamics in response to dust storms in the Gulf of Aqaba, northern Red Sea", advisor: Adi Torfstein (HUJI)
- Siyuan Wang, PhD, 2023, "Iron and Phosphorus-utilization from Dust by Natural Trichodesmium Colonies in the Gulf of Aqaba", advisor: Yeala Shaked (HUJI)

GEOTRACES presentations in international conferences

- Benaltabet T., Lapid G., Alkalay R., Weinstein Y., Steffens T., Achterberg E.P. and Torfstein A. (2023) Dissolved trace metals, rare earth elements and Pb isotopes in the eastern Mediterranean Sea. Goldschmidt meeting, Lyon, France
- Edvardson G., Torfstein A., Subhas A., Wang A., Titmuss F.D., Morkeski K. and Wurgaft E. (2023) Heterogeneous reactions and their effect on dissolved inorganic carbon and total alkalinity. Gordon Research Conference on Chemical Oceanography, USA
- Edvardson G., Torfstein A., Wang A., Titmuss F.D., Lazar B., Churchill J., Morkeski K. and Wurgaft E. (2023) Heterogeneous reactions and their effect on dissolved inorganic carbon and total alkalinity. Israel Geological Society Annual Meeting
- Levy N., Torfstein A., Schiebel R., Chernihovsky N., Jochum K.P., Weis U., Stoll B., and Haug G.H. (2024) Inter-chamber elemental ratio variability in two planktic Foraminifera species from the Gulf of Eilat: Globigerinoides ruber albus and *Turborotalita clarkei*. Israel Geological Society Annual Meeting.
- Shaked Y., Koedooder C., Zhang F., Wang S., Gledhill M., Eichner M., de Beer D., Boiteau R., Visser A.N., Kessler N. and Basu S. (2023) Reclaiming the "Bio" Term for Aerosol Iron Bioavailability. ASLO meeting, Palma de Mallorca, Spain

- Shaked Y., Jacobson Y., de Beer D., Wang S., Zhang F., Visser A.N., Eichner M., Morag N., Angert A. and Basu S. (2023) Acquisition of Fe and P from Natural and Anthropogenic Aerosols by Marine Phytoplankton. Goldschmidt meeting, Lyon, France
- Torfstein A., Benalabet T. and Lapid G. (2023) Long- and short- term interplay between dissolved and particulate trace elements: insights from the Red Sea dust, marine particles and seawater timeseries (REDMAST). Goldschmidt meeting, Lyon, France (*Invited talk*)

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