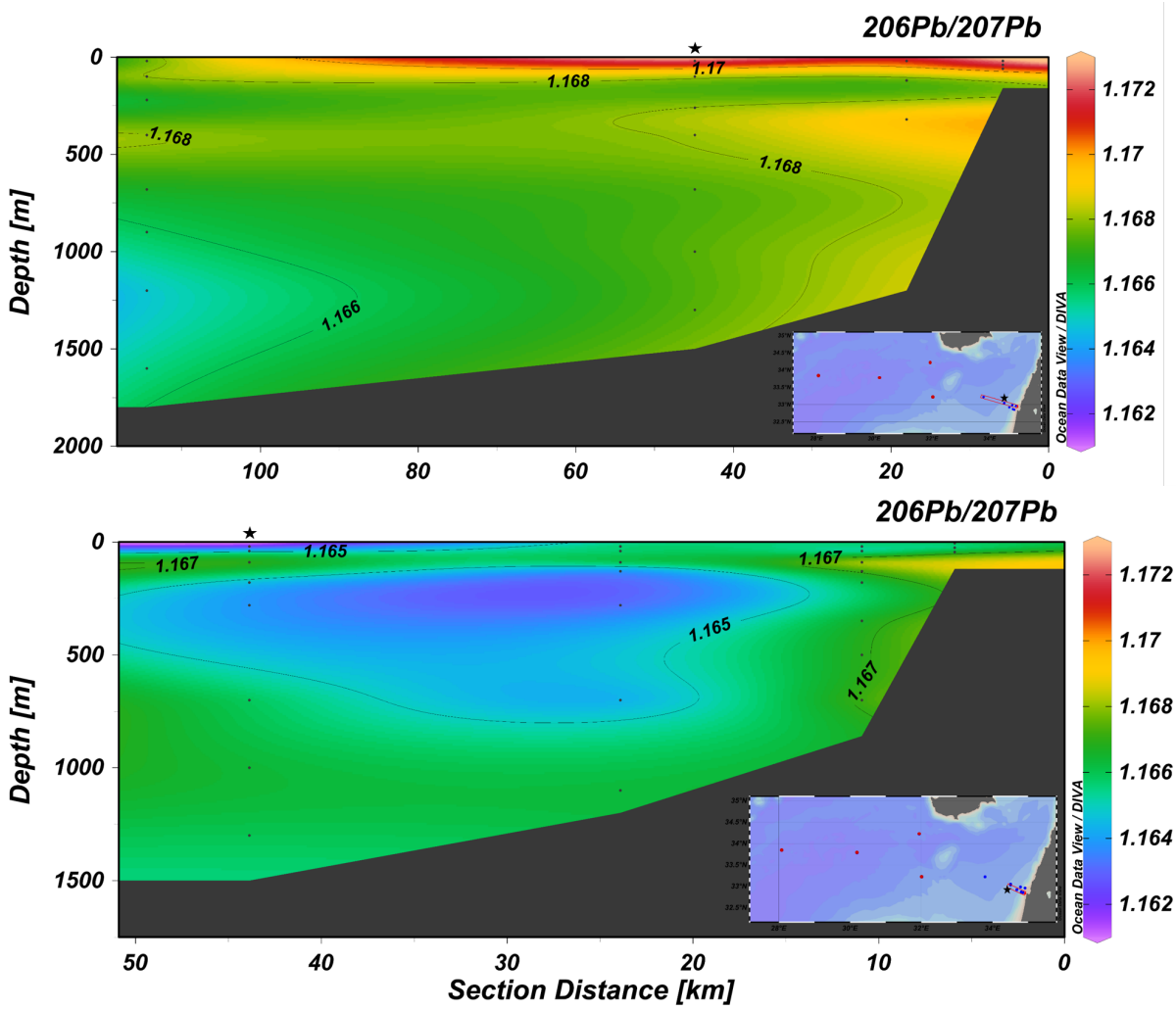
ANNUAL REPORT ON GEOTRACES ACTIVITIES IN ISRAEL

May 1st, 2021 to April 30th, 2022

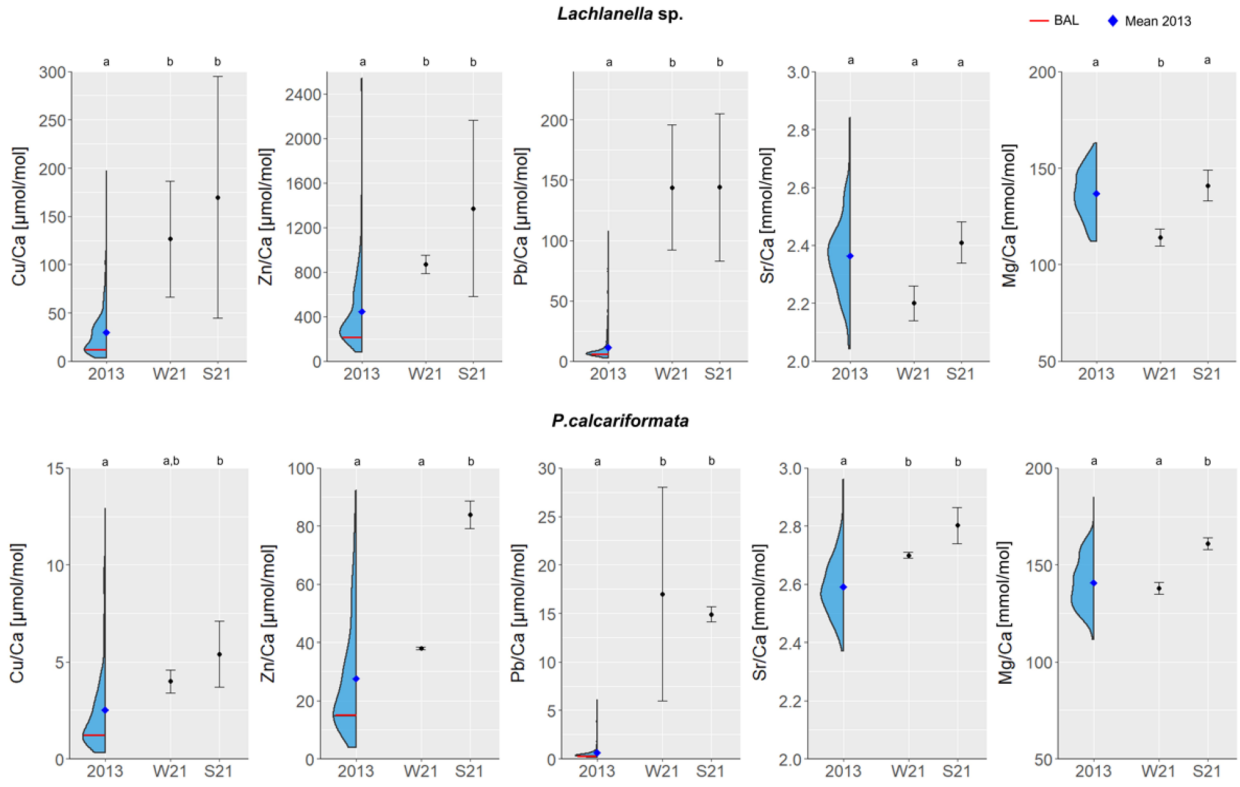
New GEOTRACES or GEOTRACES relevant scientific results

- Eastern Mediterranean transects: Inputs from continental margins and anthropogenic activities exert strong controls over trace metal biogeochemical cycles with oceanic Pb being a primary tracer of anthropogenic inputs to the marine environment, and its isotopic composition widely used to distinguish and quantify its different sources. Although the Mediterranean Sea was extensively sampled for trace metals, observations regarding its eastern margins remain scarce. During June 2021, we performed a transect between Haifa and the central Levant Basin (120 km offshore) on board the *R.V. Bat Galim*. Sampling included surface water (short lived U-nuclides) and vertical profiles (dissolved trace element concentrations, Pb isotopes (^{208,207,206,204}Pb), ^{230}Th and ^{232}Th). These data are coupled with a similar transect performed during 2018, to constrain shelf to depth fluxes of particulates, nutrients and trace elements (PIs: Weinstein and Torfstein).



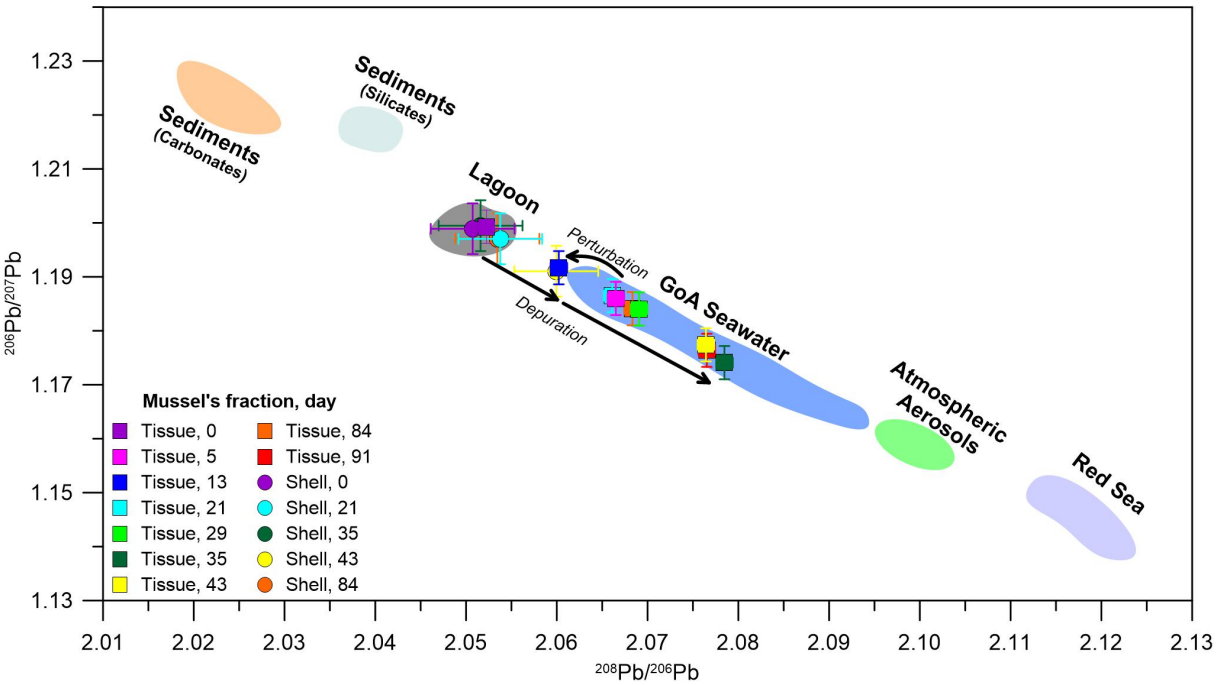
Pb isotopic composition of seawater across two transects in the eastern Mediterranean

- Monitoring of marine heavy metals 1: One of the challenges in monitoring the marine coastal environments is quantifying the magnitude and duration of pollution events. Hoober et al. (2022) introduce a new concept of defining heavy metal (HM) baseline assessment levels (BALs) in coastal environments using foraminiferal shells. We demonstrated the potential of this approach by examining a nature reserve along the Mediterranean coast of Israel. Our previous investigation of this site in 2013–2014 using foraminiferal single-chamber LA-ICPMS created a large dataset consisting of HM measurements of two species, *Lachlanella* and *Pararotalia calcariformata*. This database was used to establish the BAL of Zn, Cu and Pb, associated with anthropogenic sources. In February 2021, a significant tar pollution event affected the entire Mediterranean coast of Israel, derived from an offshore oil spill. This event provided a unique opportunity to test the applicability of the foraminiferal BAL by comparing it to whole-shell ICPMS measurements of the two species collected in winter and summer 2021. Results reveal a significant increase (2–34 -fold) in the three HMs between 2013–2014 and 2021, with Pb/Ca displaying the most prominent increase in both species. This suggests a possible linkage between the oil spill event and the significantly elevated metal/Ca ratios in 2021.



Violin plots of metal/Ca ratios in benthic foraminifera (from: Hoober et al., 2022). Single-chamber 2013–2014 LA-ICPMS records are compared with mean whole-shell winter (W21) and summer (S21) 2021 ICPMS ratios. Red horizontal lines mark the BAL ratio for each anthropogenic metal, Cu, Zn and Pb. The blue diamond indicates the average metal/Ca of all single-chamber 2013–2014 LA-ICPMS analyses. Error bars represent 1 SD. Letters represent the results of the groups' comparison test. Note the different concentration scales (y axes) of the HMs between the two species.

- Monitoring of marine heavy metals 2: Mussels are considered highly efficient marine biomonitors, tracing anthropogenic and natural variations in heavy metals and various organic compounds. While heavy metals depuration processes in biomonitors are of growing interest, less knowledge is available regarding their Pb isotopes and rare earth elements (REEs) accumulation- release dynamics, and their response to short-term anthropogenic and terrigenous perturbations. Benaltabet et al. (2021) report the results of a relocation experiment where a group of mussels (*Brachidontes pharaonis*) were extracted from a contaminated lagoon in the Gulf of Aqaba, northern Red Sea, and placed in water tanks that were flushed continuously with fresh, uncontaminated seawater. Specimens were removed periodically from the water table over a period of 13 weeks and trace and REEs and Pb isotopic compositions were determined separately for mussel's shells and soft tissues. The results display a clear decrease over time in the concentrations of various heavy metals and REEs in the soft tissue, in concert with a similar shift in the Pb isotopic compositions toward seawater values. By contrast, the elemental and Pb isotopic composition of the shell presents little change over time. Coupling between the Pb isotopic composition of corresponding soft tissue and shell samples allows back-calculation of the timing and magnitude of abrupt pollution events and presents a novel approach for monitoring short-term pollution events. Given the coastal setting of the studied samples, it is important to consider the effects of terrigenous material on the results. Accordingly, Al-normalized element concentrations, Pb isotopes and calculated Ce anomalies, are used to identify two distinct terrigenous end members controlling the contaminated lagoon and the pristine site. The study demonstrates the potential of using mussels as robust biomonitors of natural and anthropogenic environmental perturbations through the combination between elemental concentrations and the isotopic composition of Pb.



The isotopic composition of $^{208}Pb/^{206}Pb$ versus $^{206}Pb/^{207}Pb$ in soft tissue (squares) and shells (circles) (from Benaltabet et al., 2021). Colored markers represent the different samples through the length of the experiment. Shaded areas represent the regional end members: GoA seawater (blue field; Benaltabet et al., 2020, *Mar. Chem.*), atmospheric aerosols (Chien et al., 2019, *Env.Sci. Tech.*), GoA leached and residual sediment fractions (Benaltabet et al., 2020, *Mar. Chem.*), which represent the carbonate (orange field) and silicate (light blue field) fractions of bottom sediments, respectively. Red Sea seawater compositions (purple field) are assumed to correspond with Arabian Sea compositions (after Lee et al., 2015, *GCA*). For more information regarding the suggested end members the reader is referred to Chien et al. (2019, *Env.Sci. Tech.*) and Benaltabet et al. (2020, *Mar. Chem.*). The day 0 shell and soft tissue composition represents the lagoon end member (gray field).

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, 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.
- 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-phytoplancton, PP, BP); Sediments – annual).
- Marine particulate fluxes are studied in the oligotrophic Gulf of Aqaba (GOA), northern Red Sea as part of the ***Red*** *Sea* ***Dust,*** ***M****arine Particulates and* ***S****eawater* ***T****ime Series* (***REDMAST,*** *GIpr09*). This 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).

New projects and/or funding

- Yeala Shaked: Israel Science Foundation (ISF) research grant. Dust as a source of Phosphorus to Trichodesmium - a globally important marine N2-fixer.
- Yeala Shaked: United States – Israel Binational Science Foundation (BSF) research grant (with Rene Boiteau). Ocean Fertilization by Dust – Studying how marine microorganisms 'mine' nutrients from dust.

GEOTRACES workshops and meetings organized *(Please include the number of early career researchers involved in each event, when possible)*

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Outreach activities conducted (please list any outreach/educational material available that could be shared through the GEOTRACES web site) *(We are particularly interested in recordings from webinars from GEOTRACES research)*

- Public talk (Adi Torfstein): "Climate change and global warming: where we came from and where we are heading", Yeruham, 2021

Other GEOTRACES activities

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New GEOTRACES or GEOTRACES-relevant publications (published or in press) *(Please identify those publications acknowledging SCOR funding and for these publications include the number of PhD or postdoc students involved, if possible)*

- Banc-Prandi G., Baharier N., Benaltabet T., Torfstein A., Antler G. and Fine M. (2022) Elevated temperatures reduce the resilience of the Red Sea branching coral *styllophora pistillata* to copper pollution. *Aquatic Toxicology 244, 106096.*
- Benaltabet T., Gunter-Hoch E. and Torfstein A. (2021) Heavy metal, rare earth element and Pb isotope dynamics in mussels during a depuration experiment in the Gulf of Aqaba, northern Red Sea. *Frontiers in Marine Science 8, 669329*
- Hoober L., Titelboim D., Abramovich S., Herut B., Teutsch N., Benaltabet T. and Torfstein A. (2022) Establishing baseline assessment levels for monitoring coastal heavy metals using foraminiferal shells: A case study from the Southeastern Mediterranean. *Water 14, 1352*
- Kolker, D., Bookman, R., Herut, B., David, N., Silverman, J. (2021). An Initial Assessment of the Contribution of Fresh Submarine Ground Water Discharge to the Alkalinity Budget of the Mediterranean Sea. Journal of Geophysical Research: Oceans, 126(8):p.e2020JC017085. https://doi.org/10.1029/2020JC017085
- Ozer, T., Gertman, I., Gildor, H., Herut, B. (2022). Thermohaline temporal variability of the SE Mediterranean coastal waters (Israel) -long-term trends, seasonality, and connectivity. Frontiers in Marine Sciences, 8:799457.
- Shaked Y, Twining B , Tagliabue A , and Maldonado MT. 2021. Probing the bioavailability of dissolved iron to ocean phytoplankton using *in situ* single cell iron quotas. Global Biogeochemical Cycles. e2021GB006979. https://doi.org/10.1029/2021GB006979
- Guy Sisma-Ventura, Or M. Bialik, Yizhaq Makovsky, Eyal Rahav, Tal Ozer, Mor Kanari, Sophi Marmen, Natalia Blekin, Tamar Guy-Haim, Gilad Antler, Barak Herut, Maxim Rubin-Blum (2022). Cold seeps alter the near-bottom biogeochemistry in the ultraoligotrophic Southeastern Mediterranean Sea. Deep–Sea Research I 183: 103744. ttps://doi.org/10.1016/j.dsr.2022.103744
- 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. https://doi.org/10.3389/fmars.2020.598686

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

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GEOTRACES presentations in international conferences

- Yeala Shaked: Invited and funded speaker at SOLAS/SCOR Workshop: "Iron at the Air-Sea Interface". Ashville, US. (July, Remote).
- Yeala Shaked: Invited keynote speaker at: American Society for Limnology and Oceanography, Palma de Mallorca, Spain. Session chair (June, virtual meeting).
- Adi Torfstein: Co-convener of session in the Goldschmidt Meeting, Lyon, 2021: "Marine biogeochemistry: Particle fluxes and dissolved trace element cycling from source to sink"

Presentations:

- Lapid G., Torfstein A., Teutsch N. and Erel Y. (2021) Constraints on the provenance and weathering rates of atmospheric dust from the U and Nd isotopic compositions of carbonate and silicate phases. Goldschmidt meeting.
- Benaltabet T., Lapid G. and Torfstein A. (2021) Seawater aluminium seasonal dynamics and response to short-term perturbations in the Gulf of Aqaba, northern Red Sea. Goldschmidt meeting.
- Levy N., Torfstein A., Schiebel R., Chernihovsky N., Jochum K.P., Weis U., Stoll B., and Haug G.H. (2021) Time series of trace element distributions in planktonic foraminifer shells from the oligotrophic Gulf of Aqaba, northern Red Sea. Goldschmidt meeting.
- Kienast S.S. and Torfstein A. (2022) First estimate of biological carbon pump efficiency in the subtropical Gulf of Aqaba. Ocean Sciences meeting

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