ANNUAL REPORT ON GEOTRACES ACTIVITIES IN CHINA-TAIPEI

May 1st, 2024 to April 30th, 2025

New GEOTRACES or GEOTRACES relevant scientific results

- **Tracing anthropogenic and lithogenic aerosol iron inputs in the East China Sea**

  A recent study by Hsieh and Ho (2024) investigated the contributions of anthropogenic and lithogenic iron (Fe) in aerosols over the East China Sea (ECS), a key region receiving continental aerosol input during the East Asian monsoon. Using Fe isotopes (δ^{56}Fe) and trace metal ratios (notably Cd/Ti), the researchers distinguished high-temperature combustion-derived anthropogenic aerosols from lithogenic dust. Despite anthropogenic aerosols showing very low δ^{56}Fe (down to −4.5‰) and accounting for a significant portion of dissolved Fe in fine particles, coarse lithogenic aerosols remained the dominant contributor to total and dissolved Fe fluxes to the ECS surface waters. The study highlights Cd/Ti as a reliable proxy to quantify anthropogenic Fe in coarse aerosols and confirms that lithogenic inputs are still the primary Fe source, even in regions with intense anthropogenic influence. (https://doi.org/10.1029/2024JC021113)

- **Coral records reveal long-term ocean acidification in the tropical Indian Ocean**

  New research by Liu et al. (2024) from Taiwan utilized boron isotopes (δ^{11}B) and B/Ca ratios from a Porites coral core in the Maldives to reconstruct ocean acidification trends over the past 37 years in the tropical Indian Ocean. Their findings demonstrate a clear long-term decline in coral calcification fluid pH, indicative of increasing ocean acidification. The study highlights the complexity of coral responses to changing seawater chemistry, emphasizing the importance of geographically diverse proxy records for better understanding global ocean acidification. This work provides valuable insights into coral biomineralization processes and supports GEOTRACES goals by improving paleoceanographic reconstructions of seawater carbonate chemistry. (https://doi.org/10.1016/j.chemgeo.2024.122243)

- **Diatom experiments illuminate biological controls on barium isotope fractionation**

  Diatom culturing experiments by Hsieh et al. (2025) provide the first direct constraints on biological uptake of barium (Ba) and associated isotope fractionation in marine diatoms, using culture experiments with the model diatom *Thalassiosira weissflogii*. Results show diatoms preferentially take up isotopically lighter Ba, with isotope fractionation factors (Δ^{138}Ba_bio-sw) ranging from −0.14‰ to −0.47‰. This biologically driven fractionation partly explains why natural pelagic barite has more negative Ba isotope signatures than barite precipitated abiotically in the laboratory. However, the study also highlights that biological Ba uptake alone cannot fully account for pelagic barite formation, emphasizing the need to explore additional Ba sources such as microbial processes. This work significantly advances our understanding of Ba isotope systematics, supporting GEOTRACES objectives to decipher marine biogeochemical cycles and element fluxes in the ocean. (https://doi.org/10.1016/j.gca.2025.03.006)

- **Direct pathway for dietary nitrogen incorporation in planktonic foraminifera**

  A recent study from Hojia Ren's group (Fang et al., 2025) provides critical new insights into nitrogen isotope incorporation in planktonic foraminifera, a proxy widely used to reconstruct past ocean nutrient cycles. Using controlled laboratory experiments with the dinoflagellate-bearing species *Trilobatus sacculifer*, researchers demonstrated that dietary nitrogen (N) is directly and rapidly incorporated into the foraminiferal calcite shell without

significant isotopic fractionation or trophic enrichment. This work highlights a previously unrecognized direct pathway of dietary nitrogen to shell-bound organics, supporting the reliability of foraminifera-bound $\delta^{15}N$ as a paleoceanographic proxy for surface ocean nutrient conditions. These findings significantly enhance our understanding of nitrogen cycling processes, aligning closely with GEOTRACES research themes. (https://doi.org/10.1016/j.epsl.2025.119231)

GEOTRACES or GEOTRACES relevant cruises

- **LGD-2415** cruise (*R/V Legend*) in the North of South China Sea, the Luzon Strait, and the Western Philippian Sea, 25 August – 04 September 2024 (11 days).
- **NOR1-0086** cruise (*R/V New Ocean Researcher 1*) in the Kaoping Canyon, the southwest offshore region of Taiwan, 25 – 31 August 2025 (7 days).

New projects and/or funding

- Yu-Te Alan Hsieh, NSTC grant: Using barium isotopes to trace riverine inputs to the oceans, NSTC 113-2611-M-002-021 (2024/08/01-2025/07/31)
- Wen-Hsuan Liao, NSTC grant: Using laboratory experiment and field observation to study the important and underestimated sedimentary trace metal inputs to the ocean, NSTC-113-2611-M-006-001 (2024/08/01-2025/07/31)
- Yi-Wei Liu, NSTC grant: Impacts of climate changes on seasonal calcifying carbonate chemistry variations of coral Porites, NSTC-113-2116-M-001-020 (2024/08/01-2025/07/31)
- Tung-Yuan Ho, NSTC thematic project: Taiwan BioGeoSCAPES: Ocean metabolism and nutrient cycles on a changing planet (I) (2025/08/01-2028/07/31)

Other GEOTRACES activities

- Dr. Shotaro Takano (Kyoto University, Japan) and Dr. Yoshiko Kondo (Nagasaki University, Japan) visited National Taiwan University in December 2025. During their visit, they gave talks on marine trace elements and isotope studies, as well as the importance of vitamin B12 limitation in the ocean.

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

- Buck, C. S., Fietz, S., Hamilton, D.S., Ho, T.-Y., Perron, M. M.G., and Shelley, R. U. (2024) GEOTRACES: Fifteen Years of Progress in Marine Aerosol Research. *Oceanography* doi.org/10.5670/oceanog.2024.409
- Cai-Li, R.-Y., Ren, H., Fang, W.-N., Yang, E.-W., Chen, W.-H., LeKieffre, C., Branson, O., Fehrenbacher, J., Vetter, L., Jeng, M.-S., and Spero, H.J. (2025), Symbiont regulation of nitrogen metabolism and excretion in tropical planktonic foraminifera, *Geochimica et Cosmochimica Acta 396*, 135-145. doi.org/10.1016/j.gca.2025.03.009

- Coale, T. H., Loconte, V., Turk-Kubo, K. A., Vanslembrouck, B., Mak, W. K. E., Cheung, S., ... & Zehr, J. P. (2024) Nitrogen-fixing organelle in a marine alga. Science, 384(6692): 217-222. DOI: 10.1126/science.adk1075
- Fang, W.-N., Branson, O., Yang, E.-W., Chen, W.-H., Cai-Li, R.-Y., Spero, H.J., Fehrenbacher, J., Vetter, L., LeKieffre, C., and Ren, H. (2025), Direct Pathway of Incorporating Dietary Nitrogen in Shell-bound Matrix of the Planktic Foraminifera Trilobatus sacculifer, *Earth and Planetary Science Letters* 654, 119231, doi.org/10.1016/j.epsl.2025.119231.
- Hsieh, C.-C. and Ho, T.-Y. (2025) Determination of dissolved trace metals in seawater with EDTA: Reassessment and Optimization. *Environmental Technology and Innovation* doi.org/10.1016/j.eti.2025.104235
- Hsieh, C.-C. and Ho, T.-Y. (2024) Contribution of Anthropogenic and Lithogenic Aerosol Fe in the East China Sea. *Journal of Geophysical Research: oceans* doi.10.1029/2024JC021113.
- Hsieh, Y.-T., Yang, P.-K., and Ho, T.-Y. (2025), Barium uptake and isotope fractionation by a marine diatom: Implications for oceanic barium cycle. *Geochimica et Cosmochimica Acta* 395, 238-247. doi.org/10.1016/j.gca.2025.03.006
- Liu, Y.-W., Lin, K., Wang, X., and Morgan, K. (2024), Ocean acidification in the tropical Indian Ocean over the past 37 years: Insights from $\delta^{11}B$ and B/Ca records in a Maldives coral. *Chemical Geology* 662, 122243, doi.org/10.1016/j.chemgeo.2024.122243

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

- Po-Kai Yang, Master thesis (2024) Barium uptake and isotope fractionation in some marine phytoplankton. National Taiwan University, URI: http://tdr.lib.ntu.edu.tw/jspui/handle/123456789/93255

GEOTRACES presentations in international conferences

- Chien, C.-T., Pahlow, M., Schartau, M., Somes, C., and Oschlies, A.: Simulating marine biogeochemistry and atmospheric pCO2 for the Last Glacial Maximum using an ensemble of calibrated parameter sets, EGU General Assembly 2025, Vienna, Austria, 27 Apr–2 May 2025, EGU25-17858, https://doi.org/10.5194/egusphere-egu25-17858, 2025.
- Liao, W.-H., Probing potential sedimentary trace metal inputs to the ocean: laboratory experiments and field observations. 2025 Japan Kochi core school training course.

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