

## ANNUAL REPORT ON GEOTRACES ACTIVITIES IN CHINA-TAIPEI

May 1st, 2023 to April 30th, 2024

### *New GEOTRACES or GEOTRACES relevant scientific results*

- Aerosol dissolvable metals, which influence marine phytoplankton growth and global elemental cycling, are challenging to measure in oceanic deposition due to complex pre- and post-deposition processes. Hsieh et al. (2023) collected lithogenic dust from Chinese deserts and aerosols from the East China Sea, analyzing their dissolvable metals using three leaching protocols (ultrapure water, buffer, and Berger leaches). They found that the solubilities of anthropogenic elements were extremely high, while those of lithogenic elements (Ti, Al, Fe) increased with particle size across all leaching methods. Without size-specific data on mass and solubility, deposition fluxes of lithogenic elements could be significantly overestimated. Notably, solubilities of desert dust in large aerosols were substantially enhanced, with Fe solubility increasing up to 68, 6, and 3 times for ultrapure water, buffer, and Berger treatments, respectively. These enhancements vary by region, suggesting regional specificity in the impact of transport processes. The study argues that buffer and Berger leaches provide more realistic solubility estimates for oceanic aerosols than ultrapure water. Conducting similar field studies in other regions is essential to refine global models of dissolvable aerosol metal fluxes in the ocean.
- Aerosol soluble metals, vital for marine phytoplankton growth and material cycling, dissolve in seawater through complex processes, notably interacting with organic ligands. Wu et al. (2023) have explored the dissolution kinetics of trace metals from fine and coarse aerosols over 30 days, with or without the organic ligand desferrioxamine B (DFB). Fine aerosols leached most metals quickly within an hour, while coarse aerosols with DFB saw a significant increase in Fe solubility from 0.1 to 10% and doubled solubility for other metals. Without DFB, soluble metals were still gradually released, except for Fe and Pb. Strong correlations between dissolved metals and silicate concentrations indicated that aluminosilicate-associated metals accounted for a significant portion of dissolved metals after 30 days. The findings emphasize the role of time-dependent interactions and organic ligands in seawater in determining the availability of dissolved metals to marine phytoplankton.
- The wind-driven meridional overturning circulation between tropical and subtropical oceans regulates decadal-scale temperature fluctuations in the Pacific and globally. An acceleration in this circulation reduces global surface temperatures by storing more heat in the ocean. The low-latitude western boundary current is crucial for this circulation, but long-term transport data is scarce. Chen et al. (2023) have reconstructed a 94-year  $^{15}\text{N}/^{14}\text{N}$  ratio record from *Porites* spp. corals in the Solomon Sea, which reveals that this ratio declined as global temperatures rose, suggesting the South Pacific western boundary current has strengthened over the past century. This record also indicates strong decadal variability linked to the Pacific Decadal Oscillation.

### *GEOTRACES or GEOTRACES relevant cruises*

- NORI cruise (NOR1-T030) in the Taiwan Strait, December 2023 (3 days) – Testing the new trace metal clean sampling system.
- NORI cruise (NOR1-068) in the North of South China Sea, the Luzon Strait, and the Western Philippine Sea, March 2023 (15 days).

### ***New projects and/or funding***

- Yu-Te Alan Hsieh, NSTC grant: Constraining the sources and sinks of barium isotopes in the ocean: implications for tracing the marine barium and carbon cycles, NSTC-113-2611-M-002-001. (2024-2025)
- 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-112-2611-M-006-006; NSTC-113-2611-M-006-001 (2023-2025)

### ***GEOTRACES workshops and meetings organized***

- Yu-Te Alan Hsieh, Taiwan trace metal clean sampling workshop, Institute of Oceanography, National Taiwan University; invited speaker: Greg Cutter (Old Dominion University, USA), December 2023.
- Tung-Yuan Ho, Haojia Abby Ren and Yu-Te Alan Hsieh, Taiwan GEOTRACES and BioGeoSCAPES session in 2024 Taiwan Ocean Science Conference, April 2024.

### ***Other GEOTRACES activities***

- A new GEOTRACES trace metal clean sampling system was completed in December 2023. The system features a class ISO-6 clean room container, an ultra-clean CTD winch designed by Kley France, an 8000 m Vectran conducting cable, and a Sea-Bird GEOTRACES frame equipped with 911 plus CTD, titanium-housed sensors, and 24 x 12-L OTE external-spring Niskin-style bottles. A 3-day test cruise on the R/V New Ocean Researcher 1 was conducted in the Taiwan Strait with marine scientists from Taiwan. Greg Cutter (Old Dominion University, USA) joined the cruise and provided advice on testing the system. This new system ensures trace metal clean sampling for ocean research in the marginal seas around Taiwan and the Pacific Ocean.

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

- Chen, W.-H., Ren, H., Chiang, J.C.H., Wang, Y.-L., Cai-Li, R.-Y., Chen, Y.-C., Shen, C.-C., Taylor, F.W., DeCarlo, T.M., Wu, C.-R., Mii, H.-S., Wang, X.T. (2023) Increased tropical South Pacific western boundary current transport over the past century. *Nature Geoscience*, 16, 590-596.
- Deng, L., Cheung, S., Xu, Z., Liu, K., Liu, H. (2023) Microzooplankton grazing exerts a strong top-down control on unicellular cyanobacterial diazotrophs. *Journal of Geophysical Research: Biogeosciences*, 128(12), e2023JG007824.
- Ekka, S.V., Y.-H. Liang, K.-F. Huang and D.-C. Lee (2023) Molybdenum isotopic fingerprints in Taiwan rivers: Natural versus anthropogenic sources, *WATER*, 15 (10) DOI:10.3390/w15101873.
- Hsieh, C.-C., C.-F. You, and T.-Y. Ho (2023) The solubility and deposition flux of East Asian aerosol metals in the East China Sea: The effects of aeolian transport processes. *Marine Chemistry* doi: 10.1016/j.marchem.2022.104268.

- Liang, Y.-T., P.-C. Wu, S. Ekka, K.-F. Huang and D.-C. Lee (2024) Iron and Molybdenum isotope application for tracing industrial contamination in a highly polluted river, *WATER*, 16 (2):199, DOI:10.3390/w16020199.
- Liao, W.-H., Planquette, H., Moriceau, B., Lambert, C., de Gesincourt, F.D., Laurenceau-Cornec, E., Sarthou, G., Gorgues, T. (2023) The effect of temperature on the release of silicon, iron and manganese into seawater from resuspended sediment particles. *Geochemica et Cosmochimica Acta*, 351, 1-13.
- Liu, Y.-W., Lin, K., Morgan, K., Wang X. (2024) Ocean acidification in the tropical Indian Ocean over the past 37 years: Insights from <sup>11</sup>B and B/Ca records in a Maldives coral. *Chemical Geology*, 662. 122243.
- Wu, H.-Y., C.-C. Hsieh, and T.-Y. Ho (2023) Trace metal dissolution kinetics of East Asian size-fractionated aerosols in seawater: The effect of a model siderophore. *Marine Chemistry* doi: 10.1016/j.marchem.2023.104277.
- You, C.-F., Liao, W.-L., Huang, K.-F., Chung, C.-H., Liu, Z. (2024) Sediment source variation using REEs, Sr, and Nd isotopic compositions: a case study in MD05-2901, northwestern South China Sea. *Frontiers in Marine Science*, 10, 1292802.

#### ***Completed GEOTRACES PhD or Master theses***

- Chih-Chiang Hsieh, Ph.D. thesis (July 2023), The Contribution of East Asian Aerosol Metals in the Ocean: Sources, Transformation Processes and Deposition Fluxes. National Taiwan University, URI: <https://tdr.lib.ntu.edu.tw/jspui/handle/123456789/88431>
- H.-Y. Chen, Master thesis (2023) Coral records of ocean acidification and marine lead pollution in the northern South China Sea. National Taiwan University, URI: <http://tdr.lib.ntu.edu.tw/jspui/handle/123456789/88209>

#### ***GEOTRACES presentations in international conferences***

- Hsieh, Y.-T., Chiu, J.-T., Huang, K.-F., Wu, P.-C., Chen, S.-T., Constraining riverine barium isotopes to the ocean: insights from river and seawater mixing experiments. Ocean Sciences Meeting 2024. New Orleans, USA. February 2024.
- Hsieh, Y.-T., Paver, R., Tanzil, J.T.I., Bridgestock, L., Lee, J.N., Henderson, G.M., Barium isotopes in Singapore seawater and shallow-water corals. 5<sup>th</sup> Asia-Pacific Coral Reef Symposium. Singapore, June 2023.

Submitted by Dr. Yu-Te Alan Hsieh ([alanhsieh@ntu.edu.tw](mailto:alanhsieh@ntu.edu.tw)).