

ANNUAL REPORT ON GEOTRACES ACTIVITIES IN CHINA-TAIPEI

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New scientific results

Taiwanese scientists have been continuing their efforts to understand regional biogeochemical dynamics in the marginal seas and the open western Pacific, applying various geochemical tools. In particular, progress has been made to address climatic and human impact on the biogeochemical cycles in these environments. Some major findings over the last year are summarized below.

- Dr. Tung-Yuan Ho's group in Academia Sinica has published several papers on trace metal cycling in the surface water of the Northwestern Pacific Ocean (NWPO) and trace metal phytoplankton interaction. Wang and Ho (2020) investigated the transformation processes of aerosol Fe in the surface water of the NWPO. With one order of magnitude higher aerosol Fe contributed to the surface ocean in the spring season, the elevated deposition of aerosols was not reflected in the dissolved pool but the suspended pool. The results indicate that the surface precipitated or aggregated Fe on small biotic particles would possess longer residence time and higher bioavailability than the large and dense lithogenic particles in the euphotic zone. Through Zn elemental and isotopic composition in seawater, Liao et al. (2020) showed that anthropogenic aerosol deposition may play an important role in causing the variations of Zn elemental and isotopic composition in oceanic surface water globally. Tuo et al. (2020) found that Ni limitation results in one order of magnitude higher H₂ accumulation rates in the low Ni than high Ni treatments for some marine diazotrophic cyanobacteria.
- Dr. Chin-Chang Hung's group in National Sun Yat-sen University made progress in understanding biogeochemical responses to typhoons in the open South China Sea. They report on nitrate + nitrite (N), Chl and POC fluxes in the northern South China Sea (NSCS) before and shortly after the passage of typhoons and storms, between September 2012 and June 2014. They find elevated POC fluxes after the passage of typhoons Tembin and Soulik, but the changes in POC fluxes are not coupled with changes in nutrient or chlorophyll concentrations. Overall, their analysis of this 2-year dataset highlights the spatial and temporal variability of the factors controlling POC exports to the deep NSCS.
- Dr. Chen-Tung Arthur Chen's group in National Sun Yat-sen University made the first discovery of the presence of PM₁ in 21 of the 22 sea anemones collected from Taiwan and Southeast China, with a depth of intertidal zone to 1000 m. Based on radioisotope ¹⁴C results, the contribution of fossil fuel source PM₁ was 8–24%. Regardless of PM₁'s color, S and Fe were commonly detected by scanning electron microscopy and energy-dispersive spectrometry (SEM-EDS), suggesting anthropogenic sources. Furthermore, a maternal transfer of materials was suggested based on the existence of PM₁ in sea anemone eggs and in brooding and released juveniles. The significance of PM₁ accumulation by biota in aquatic ecosystems and the potential risk to living organisms via food webs warrant further investigation.
- Dr. Chun-Mao Tseng's group in National Taiwan University reports spatiotemporal distribution of dissolved elemental mercury (DEM) in the East China Sea (ECS) from six seasonal cruises between 2003 and 2010. Their findings show that the seasonal distributions of DEM were primarily governed by SST and solar radiation-related in-situ

production rates; therefore, concentrations of DEM were significantly higher in the summer. They also report higher DEM concentrations in the near-shore Changjiang Diluted Water than in the Shelf-Mixing Water. In a global perspective, annual Hg evasion flux from the ECS is about three times higher than that of global ocean average. This study has successively elucidated our knowing about the distribution and controlling factors of DEM in the ECS and highlighted the importance of marginal seas in global Hg cycling.

- Dr. Abby Ren's group at National Taiwan University have been involved in evaluating nutrient dynamics across the southern extension of the East Australian Current. The cruise IN2018_04 was led by Dr. Michael Ellwood in Australian National University, and is part of a project to constrain external iron inputs and cycling in the southern extension of the East Australian Current. Dr. Ren's group analyzed seawater samples for the concentrations and nitrogen and oxygen isotopic composition on nitrate in the water column across this transect. The data shows nitrate uptake from the euphotic zone as surface water moves from Subantarctic zone to the Subtropics, and addition of new nitrogen to the subtropical surface waters through N fixation.

New research vessels in testing and operation

- Constructions of three new research vessels have all been complete. The New Ocean Researcher II and III (818 ton), operated by National Taiwan Ocean University and National Sun Yat-sen University respectively, have completed tests and are now in operation. The New Ocean Researcher I is currently being tested and expected to be in operation in 2020.

New projects and/or funding

- Dr. Tung-Yuan Ho's research project on "Marine biogeochemical cycling of anthropogenic aerosol Fe" is funded by Ministry of Science and Technology from 2019/08-2022/07.
- Dr. Ho has submitted a sub-project to a Taiwan MOST (Ministry of Science and Technology) thematic proposal titled 'Expedition to the Pacific Ocean', a pending project led by Dr. Ban-Yuan Kuo, Institute of Earth Sciences, Academia Sinica. The sub-project requests GEOTRACES cruises from Taiwan to Guam in 2021 and 2022 by using our new *R/V ORI* or *R/V Legend*.

Outreach activities

- "Application of stable isotope in Earth Science" & "Understanding aerosol", October 26, 2019, Academia Sinica Open house, <https://openhouse.sinica.edu.tw>

New publications

- Reich*, H. G., I. B. Rodriguez, T. C. LaJeunesse, and T.-Y. Ho* (2020) Endosymbiotic dinoflagellates pump iron: differences in iron and other trace metal needs among the Symbiodiniaceae. *Coral Reefs* doi: 10.1007/s00338-020-01911-z.
- Wang, B.-S. and T.-Y. Ho* (2020) Aerosol Fe cycling in the surface water of the Northwestern Pacific Ocean. *Progress in Oceanography* doi: 10.1016/j.pocean.2020.102291.

- Liao, W.-H., S. Takano, S.-C. Yang, K.-F. Huang, Y. Sohrin, and T.-Y. Ho* (2020) Zn isotopic composition in the water column of the Northwestern Pacific Ocean: the importance of external sources. *Global Biogeochemical Cycles* doi: 10.1029/2019GB006379.
- Li, T., X. Lin, L. Yu, S. Lin, I. B. Rodriguez, and T.-Y. Ho (2020) RNA-seq profiling of *Fugacium kawagutii* reveals strong responses in metabolic processes and symbiosis potential to deficiencies of iron and other trace metals. *Science of The Total Environment* doi: 10.1016/j.scitotenv.2019.135767.
- Tuo, S., I. B. Rodriguez, and T.-Y. Ho* (2020) H₂ accumulation and N₂ fixation variation by Ni limitation in *Cyanothece*. *Limnology and Oceanography*. doi: 10.1002/lno.11305
- Chen, Y.S., C.M. Tseng*, J.R. Reinfelder (2020) Spatiotemporal Variations in Dissolved Elemental Mercury in the River-Dominated and Monsoon-Influenced East China Sea: Drivers, Budgets, and Implications. *Environ. Sci. Technol.* 2020, 54, 7, 3988-3995, <https://dx.doi.org/10.1021/acs.est.9b06092>
- Shih Y-Y, Hung C-C*, Huang S-Y, Muller FLL and Chen Y-H (2020) Biogeochemical Variability of the Upper Ocean Response to Typhoons and Storms in the Northern South China Sea. *Front. Mar. Sci.* 7:151. doi: 10.3389/fmars.2020.00151
- Chen, N., Yang, T.F., Hong, W. et al. (2020) Discharge of deeply rooted fluids from submarine mud volcanism in the Taiwan accretionary prism. *Sci Rep* 10, 381. <https://doi.org/10.1038/s41598-019-57250-9>
- M.-T. Chung, Kuo-Fang Huang, C.-F. You, C.-C. Chiao & C.-H. Wang* (2020) Elemental Ratios in Cuttlebone Indicate Growth Rates in the Cuttlefish *Sepia pharaonis*, *Frontiers in Marine Science*. 6:796, doi: 10.3389/fmars.2019.00796
- Tu, Y. J., You, C. F., & Kuo, T. Y. (2020). Source identification of Zn in Erren River, Taiwan: An application of Zn isotopes. *Chemosphere*, 248. <https://doi.org/10.1016/j.chemosphere.2020.126044>
- Wang, T. H., You, C. F., Chung, C. H., Liu, H. C., & Lin, Y. P. (2020). Macro-sublimation: Purification of boron in low-concentration geological samples for isotopic determination by MC-ICPMS. *Microchemical Journal*, 152. <https://doi.org/10.1016/j.microc.2019.104424>
- Chen, C. C., Gong, G. C., Chou, W. C., & Shiah, F. K. (2020). Hypoxia in autumn of the East China Sea. *Marine Pollution Bulletin*, 152. <https://doi.org/10.1016/j.marpolbul.2019.110875>

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