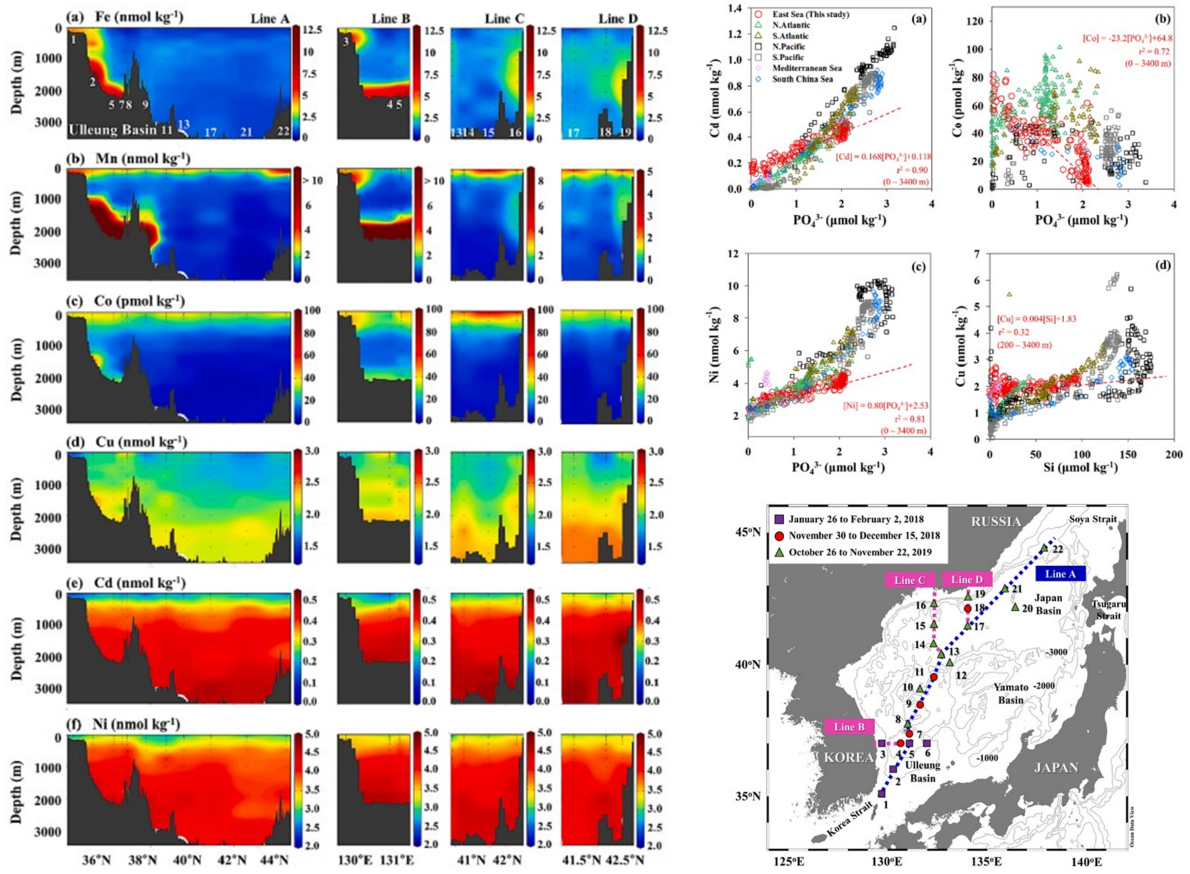
ANNUAL REPORT ON GEOTRACES ACTIVITIES IN SOUTH KOREA

May 1st, 2021 to April 30th, 2022

New GEOTRACES or GEOTRACES relevant scientific results



- Seo and his colleagues (2022, *Marine Chemistry*) reported the distributions of dissolved iron (Fe), manganese (Mn), cobalt (Co), copper (Cu), cadmium (Cd), and nickel (Ni) in the entire East Sea (Japan Sea). In this study, distinct atmospheric and shelf inputs of trace elements, except for Ni, were observed. In addition, unusually high concentrations of Fe and Mn (13 and 57 nmol kg^{-1}, respectively) are observed in the bottom layer of the Ulleung Basin (southwestern part of the East Sea), owing to large benthic inputs. These inputs might be related with the diffusion of dissolved organic matter (DOM) complexed Fe and Mn from the sediment to the overlying seawater. In contrast, the Co concentrations in the East Sea show the lowest value ever reported at similar depths in the oceans (2-8 pmol kg^{-1}), while the surface water concentrations of the same element are 2-5 fold higher than in the major oceans.
- Seo et al. (2022) examined the cycling of particulate organic carbon (POC) in continental shelf regions of the Yellow Sea (YS) and the East China Sea (ECS) was investigated by analyzing the ^{234}Th, POC and its isotopes ($\delta^{13}C$ and $\Delta^{14}C$), and particulate aluminum (pAl) over the period 10-20 August 2020. The continental shelf of YS and ECS is one of the largest continental shelves on the global ocean. This shelf receives and

extraordinarily large volume of terrestrial material from rivers, groundwater, and the atmosphere (below figure).

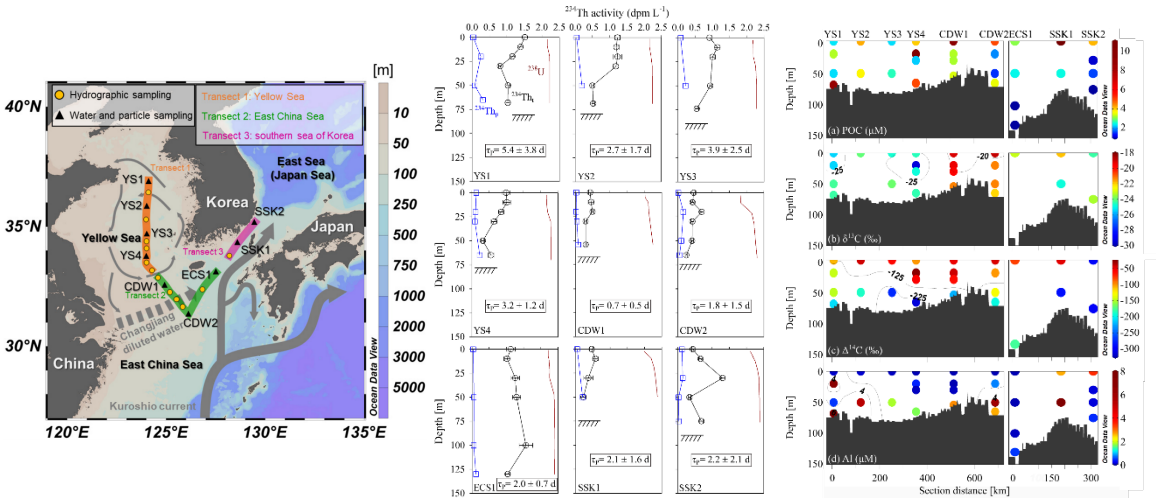


Figure Bathymetric map showing the locations of sampling stations in the study region (left figure). Vertical distributions of ^{234}Th in the Yellow Sea (YS), the East China Sea (ECS), and southern Sea of Korea (SSK) (center figure). Distributions of (a) POC concentration, (b) δ^{13}C, (c) Δ^{14}C, and (d) pAl in the study region (right).

The deficit of ^{234}Th relative to ^{238}U varied from 30% to 90%, indicating short residence times in the water column (2.6 ± 2.2 d). The POC flux to the seafloor were estimated to be 47 – 125 mmol m^{-2} d^{-1}. This POC settling flux was one to two orders of magnitude higher than the POC burial rates, suggesting effective oxidation (> 90%) via repeated resuspension/re-deposition cycle before burial. Based on the three-endmember mixing model for the dual carbon isotopes, the estimated contribution of resuspended sedimentary organic carbon to POC was 65% in the bottom layer (> 50 m). Overall, our study revealed the complex nature of POC cycling on this shelf, quantified the relative importance of each source of POC, and determined POC flux to the sediment.

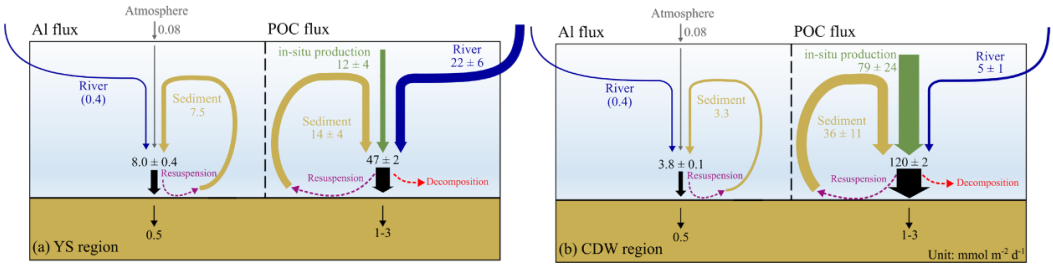
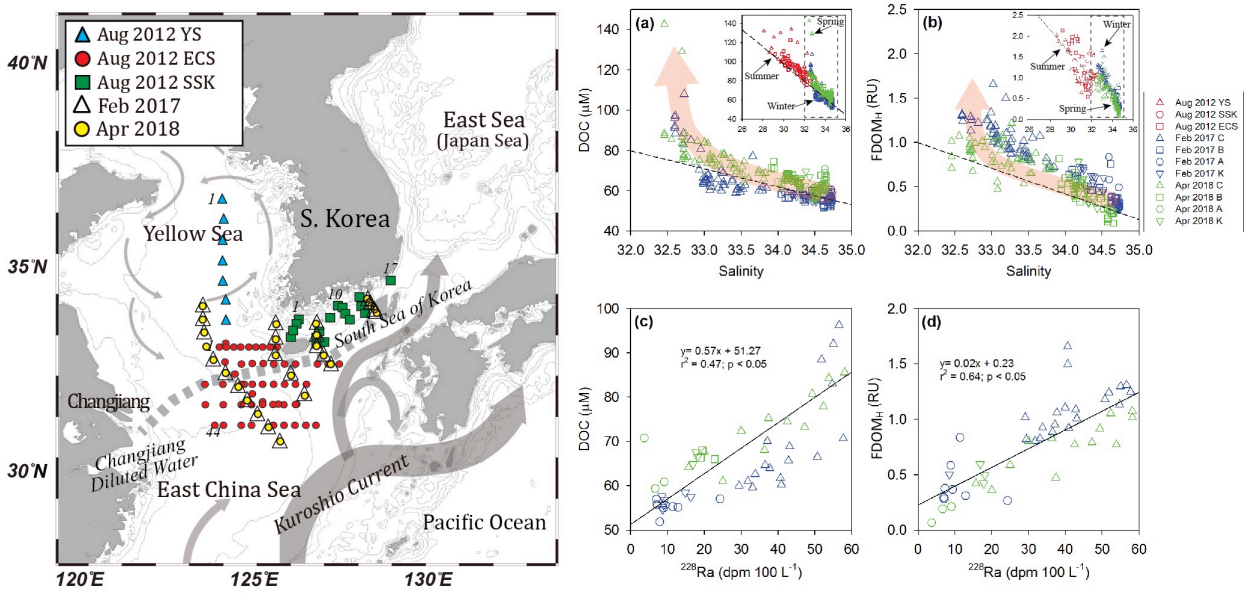


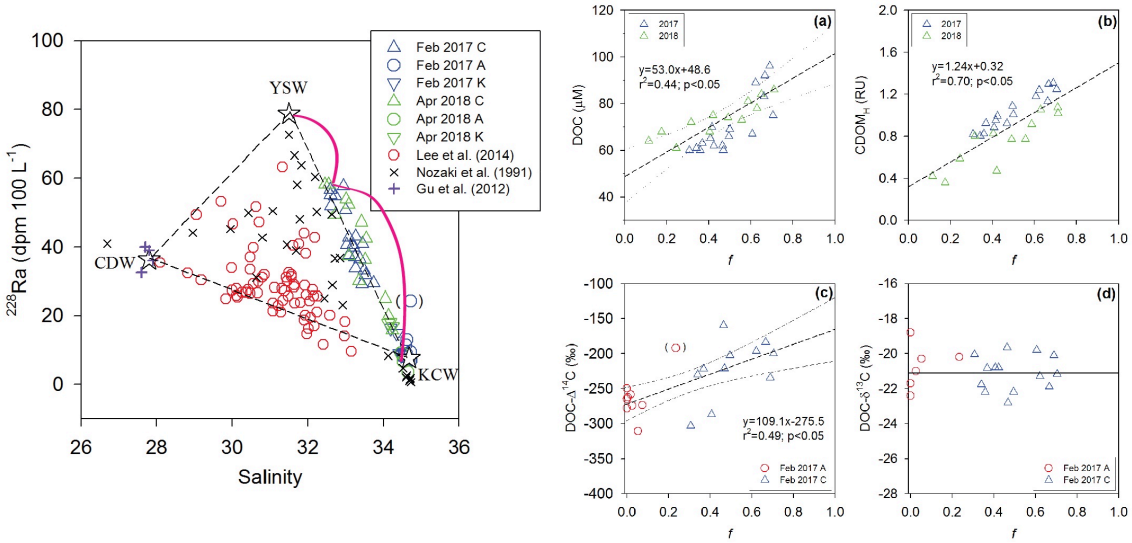
Figure Schematics of Al and POC fluxes in (a) the Yellow Sea (YS) and (b) the Changjiang Diluted Water (CDW) regions.

- The sources and fluxes of dissolved organic carbon (DOC) were estimated by using the multiple tracers including ^{228}Ra, fluorescent dissolved organic matter (FDOM), and dual carbon isotope (^{13}C and ^{14}C) analysis of DOC in the northwestern Pacific continental shelf. In this study, additional supplies of DOC (instead of riverine input) were found to be produced from the shelf-water based on a significant correlation between DOC and ^{228}Ra, which suggests that DOC is mainly from the shelf sediments and enriched in the shelf-water over the water residence time. Furthermore, the potential source of additional DOC was found to be produced in the shelf-water based on the marine δ^{13}C signature together

with the younger radiocarbon age of DOC than that of the Kuroshio Current water. The flux of the shelf-borne DOC was estimated to be ~1.9±0.8 Tg C yr^{-1}, which is almost comparable to that from the Changjiang discharge.



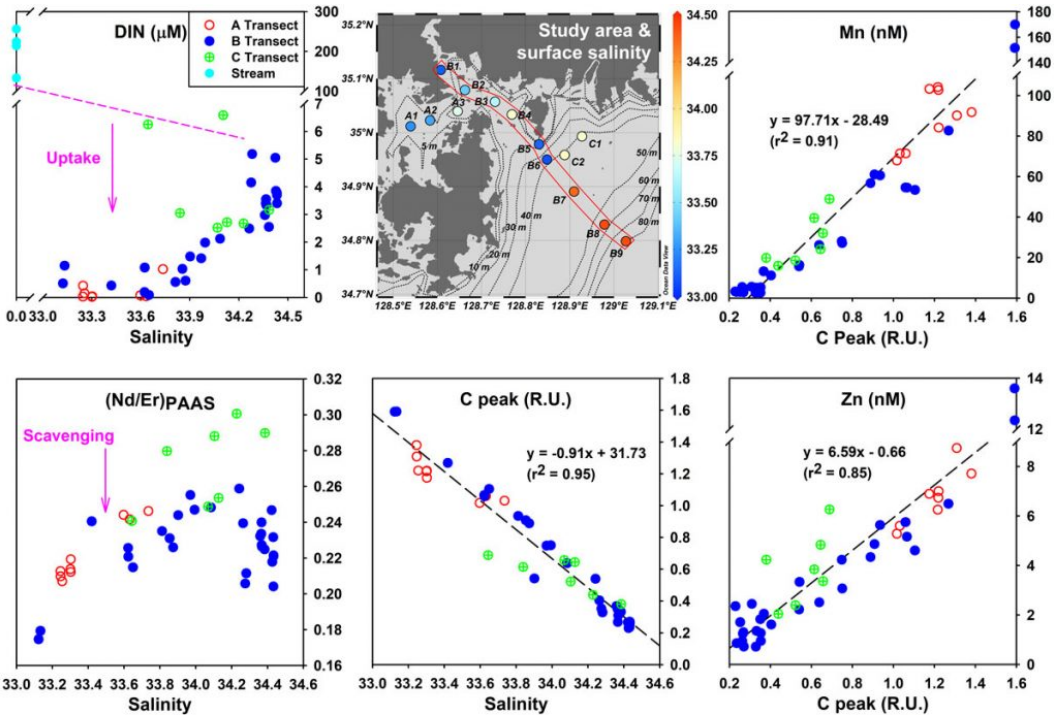
- Figure 1. Map of total sampling stations in the northwestern Pacific continental shelf in the East China Sea and the Yellow Sea (left) and correlations between the concentrations of (a) DOC and (b) $FDOM_H$ against the salinity and the concentration of (c) DOC and (d) $FDOM_H$ against the activities of ^{228}Ra in the continental shelf waters during the sampling periods. (right)



- Figure 2. A mixing diagram between ^{228}Ra and salinity. (YSW, Yellow Sea water; CDW, Changjiang diluted water; KCW, Kuroshio Current water.) (left) Correlations between the mixing fraction, f, (f=0 for KCW and f=1 for YSW) against (a) DOC, (b) $FDOM_H$, (c) DOC-$\Delta^{14}C$, and (d) DOC-$\delta^{13}C$ values. Dashed lines represent the end-member mixing lines. (right)

- Chen and co-workers (2021, see reference below) analyzed an array of trace metals (manganese, iron, nickel, copper and zinc) together with Rare Earth Elements (REE) in a

salinity gradient in the Jinhae Bay, the largest semi-enclosed bay in South Korea. Despite the occurrence of a significant scavenging activity revealed by the REE behaviors and intensive biological removal processes revealed by dissolved inorganic nutrients depletion, these trace elements showed higher concentrations in lower salinity waters and significant positive correlations with terrestrial humic substances. This thorough speciation study led the authors to hypothesize that when associated with terrestrial humic substances, these trace elements survive particle scavenging and biological consumption in the coastal mixing zone. This shuttling effect of terrestrial trace elements by humic substances in a coastal ocean is challenging the current paradigm assessing that trace elements are intensively removed in such salinity gradient.

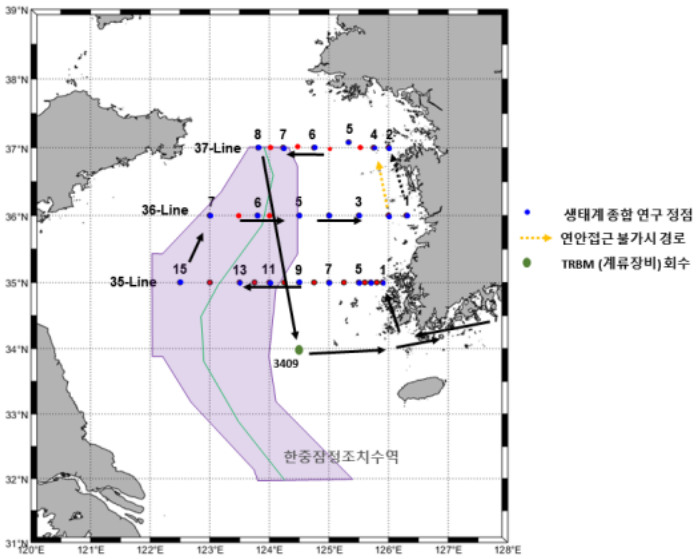


- The salinity plots for REE fractionation ((Nd/Er)PAAS) values and dissolved inorganic nitrogen (DIN) concentrations revealed significant particle scavenging of REE and biological removal of DIN in the inner Jinhae bay. However, trace elements (e.g. Mn and Zn) showed a good positive correlation with terrestrial humic substances (C peak), which behaved conservatively throughout the bay.

GEOTRACES or GEOTRACES relevant cruises

- There was research cruise of R/V Isabu (of the Korea Institute of Ocean Science and Technology (KIOST)) in the Yellow Sea, the marginal sea in the western part of the Korean Peninsula in the Feb. – Mar. in 2022 (Chief scientist Dr. Dong-Han Choi, the biologist in the KIOST) (see the below cruise track and sampling map). The researchers of KIOST (Dr. Intae Kim and Ms. Jaeeun Lee and Ms. Huisu Lee) conducted the trace metal-clean water sampling in this cruise (>10 stations) using PRISTINE Ultra Clean CTD (UCC) equipped in R/V Isabu. The measurements of dissolved-/and particulate trace elements were now in progress. The Korea-GEOTRACES relevant members expect the first trace element report in the water column of the Yellow Sea as outcome of this project.
-

- Sampling map in the Yellow Sea (2022. 02.~2022.03)



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)*

- Seo, H., Kim, G., Kim, T., Kim, I., Ra, K., & Jeong, H. (2022). Trace elements (Fe, Mn, Co, Cu, Cd, and Ni) in the East Sea (Japan Sea): Distributions, boundary inputs, and scavenging processes. *Marine Chemistry*, *239*, 104070. doi:10.1016/j.marchem.2021.104070
    - The authors, Seo, H. and Jeong.H, are the Ph.D. students
- Han, H., Na, T., Cho, H.-M., Kim, G., and Hwang, J. (2022) Large fluxes of continental-shelf-borne dissolved organic carbon in the East China Sea and the Yellow Sea. Marine Chemistry, 240, 104097.
    - The author, Han H. is post doc at the Seoul National University
- Seo, J., Kim, G., & Hwang, J. Sources and behaviors of particulate organic carbon in the Yellow Sea and the East China Sea based on 13C, 14C, and 234Th. *Frontiers in Marine Science*, 361.
    - The author, Seo J. is post doc at the Seoul National University
- Chen, X., Seo, H., Han, H., Seo, J., Kim, T., & Kim, G. (2021). Conservative behavior of terrestrial trace elements associated with humic substances in the coastal ocean. *Geochimica et Cosmochimica Acta*. https://doi.org/10.1016/J.GCA.2021.05.020
    - The authors, Chen X and Seo, H. are Ph.D students
    - Han, H and Seo, are the post doc at the Seoul National University

Submitted by **Dr. Intae Kim (ikim@kiost.ac.kr)**