ANNUAL REPORT ON GEOTRACES ACTIVITIES IN SOUTH KOREA

May 1st, 2023 to April 30th, 2024

New GEOTRACES or GEOTRACES relevant scientific results

- Lee H.S et al (2024) reported the atmospheric deposition flux of ^{210}Pb in the equatorial western Indian Ocean, In addition, they calculated the atmosphere-derived dissolvable Pb in seawater using the budget of ^{210}Pb. Based on the mass balance of the total ^{210}Pb budget in the water column, they estimated the atmospheric deposition flux of 210Pb and the residence time of Pb for the first time in this region. The atmospheric deposition flux of ^{210}Pb was estimated to be 0.1–0.5 dpm cm^{-2} yr^{-1}, and these values agreed with the general global estimations for the major oceans (0.1–0.7 dpm cm^{-2} yr^{-1}). Considering the residence time of 210Pb (29–41 years) in the water column (estimated from the ^{210}Pb inventory and ^{234}Th-based Pb scavenging rate), the atmospheric input of seawater-dissolvable Pb was quantified to be 0.08–0.1 nmol cm^{-2} yr^{-1}, which is about eight times higher than the estimated input in the early 1990s in the region. Therefore, these results imply that radioactive ^{210}Pb could be a useful tracer for quantifying Pb flux in seawater.

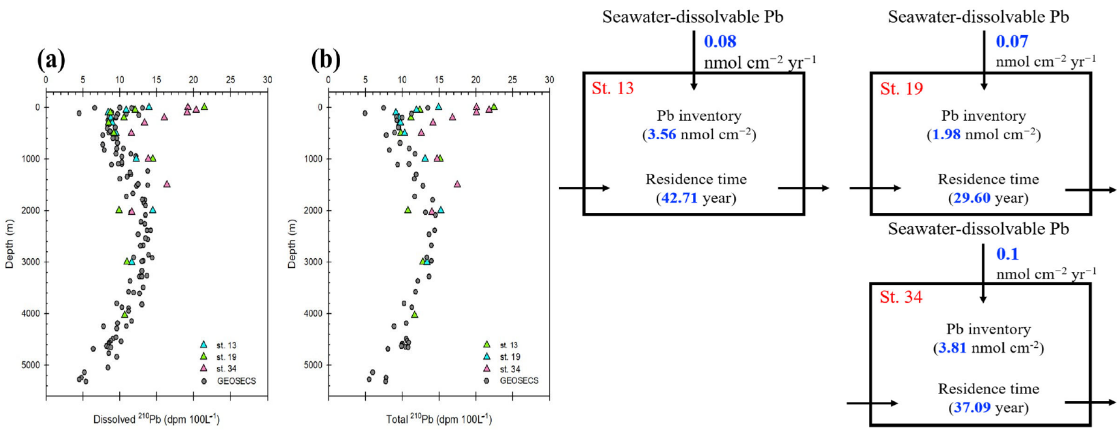


Figure 1. Vertical profiles of (a) dissolved ^{210}Pb and (b) total ^{210}Pb in the Indian Ocean. The GEOSECS data from the 1970s obtained from nearby stations in our study area are shown for comparison (Left figure) and A schematic box model accounting for residence time of dissolved Pb, Pb inventory, and atmospheric flux of seawater-dissolved Pb (nmol cm^{-2} yr^{-1}) in the equatorial western Indian Ocean.

- Actinium-227 (^{227}Ac) has been used as a powerful tracer of diapycnal mixing in the ocean, assuming that it is conservative and originates mainly from deep-sea sediments. However, here Dr. Seo H.J. et al. show an unexpectedly large source (continental margin) and sink (scavenging) of ^{227}Ac in the ocean, based on high-resolution ^{227}Ac distributions obtained for the first time by mooring Mn-fibers in the East Sea (Japan Sea). Although we expected a decrease in radium-228 (^{228}Ra) to ^{227}Ac ratios with depth owing to their different half-lives, the ratios increased with depth in the upper layer, indicating efficient removal of ^{227}Ac by particle scavenging. In addition, unusually high ^{227}Ac activities (～15 dpm m −3) were observed in the surface layer, likely due to the horizontal transport of ^{227}Ac-enriched shelf water. Thus, our results suggest refining our understanding of the geochemical cycle and application of ^{227}Ac in the ocean.

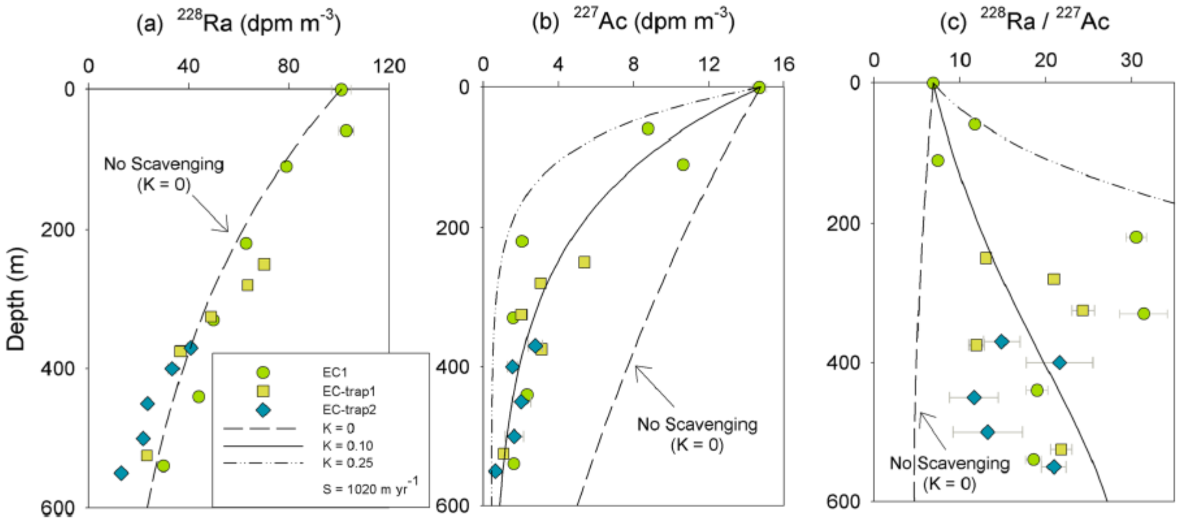
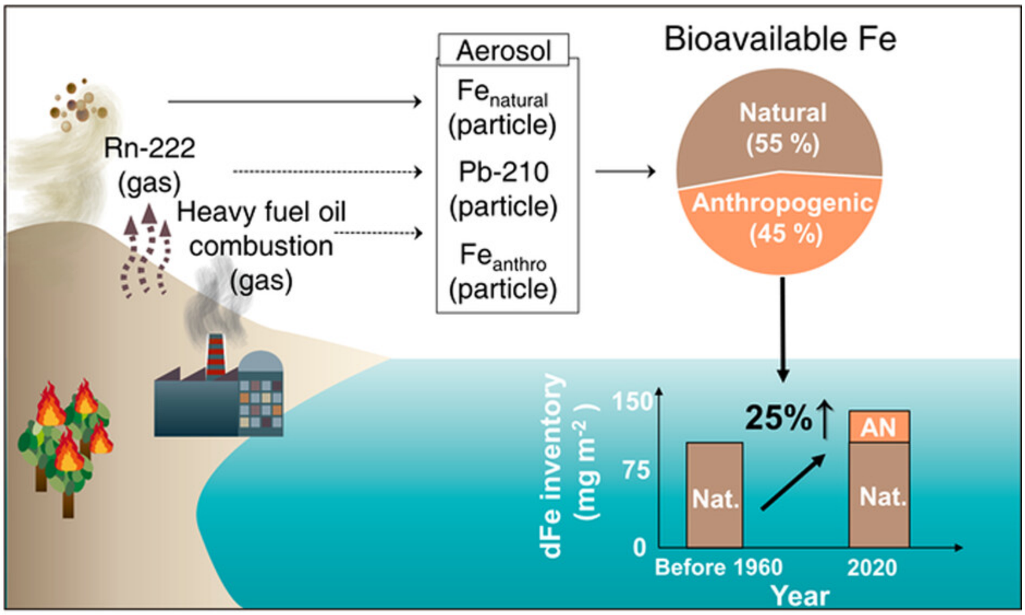


Figure 2. Vertical profiles of (a) ^{228}Ra (dpm m^{-3}), (b) ^{227}Ac (dpm m^{-3}), and (c) the activity ratios of ^{228}Ra to ^{227}Ac in the upper layer of the East Sea by fitting to different ratios of particulate to dissolved ^{227}Ac (K) using a reversible scavenging model.



- Iron (Fe) is an essential micronutrient for phytoplankton growth, and its availability limits primary production in half of the global ocean. Traditionally, atmospheric input of natural mineral dust has been considered as a main source of Fe in the surface ocean. However, here Dr. Seo H.J. et al. show that about 45% of the water-soluble Fe in aerosols collected over the East Sea (Japan Sea) is anthropogenic, which originates mainly from heavy fuel oil combustion, based on the analyses of various chemical tracers (Al, K, V, Ni, Pb, and ^{210}Pb). It is striking that a tiny quantity of oil, less than 1% of the aerosols in mass, can constitute the majority of water-soluble Fe in aerosols due to its high Fe solubility. Furthermore, they show that a quarter of dissolved Fe in the East Sea is anthropogenic using a ^{210}Pb-based scavenging model. Since this sea is almost fully enclosed (200–3,000 m) and located at the forefront of the Asian human footprint, these results provide an insight that the marine Fe cycle may be already perturbed by human activities.

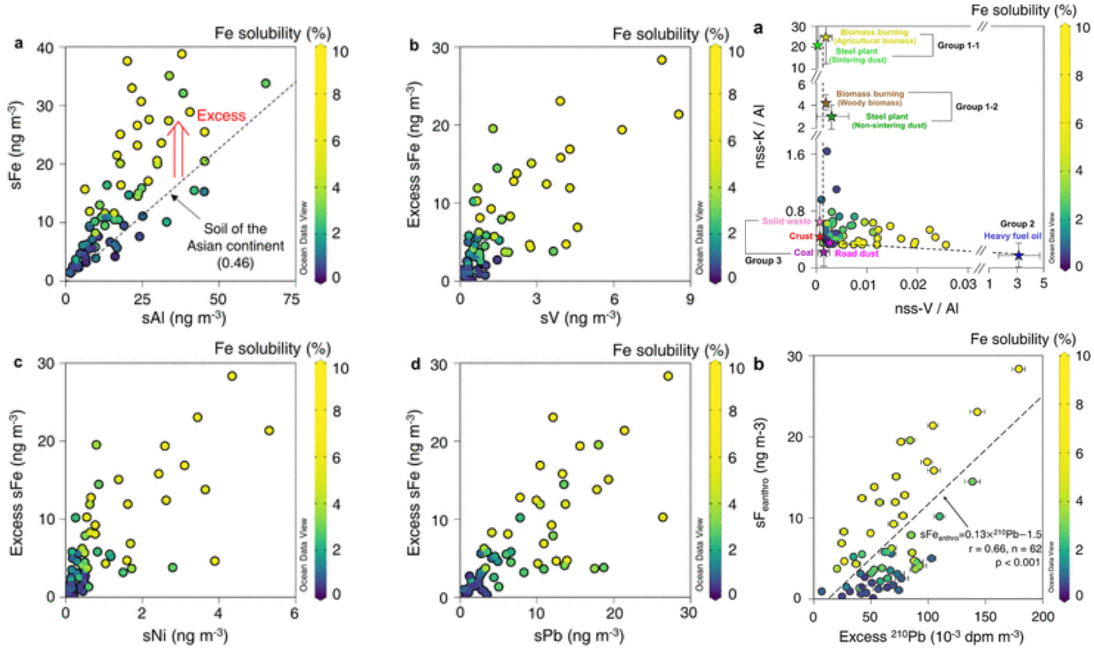


Figure 3. Relationship between Fe and other elements. (a) Water-soluble Fe (sFe) versus water-soluble Al (sAl). The dashed line represents the Fe-to-Al ratio from soils of the Asian continent. (b) Excess sFe versus water-soluble vanadium (sV). (c) Excess sFe versus water-soluble nickel (sNi). (d) Excess sFe versus water-soluble lead (sPb). The color gradient indicates Fe solubility. Sources of anthropogenic Fe and its relationship with ^{210}Pb in aerosols. (a) Plot between non-sea-salt potassium-to-aluminum ratios (nss-K/Al) and non-sea-salt vanadium-to-aluminum ratios (nss-V/Al). The error bars for each end-member represent a 1-standard deviation from average values. The color gradient indicates Fe solubility. (b) Anthropogenic Fe in water-soluble fraction versus excess ^{210}Pb. The dashed line represents the slope and intercept of a linear regression of data ($r = 0.66$ and $p < 0.001$). The error bars for excess ^{210}Pb are based on 1-standard deviation counting statistics.

GEOTRACES or GEOTRACES relevant cruises

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New projects and/or funding

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GEOTRACES workshops and meetings organized

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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)*

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Other GEOTRACES activities

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

- 1. Seo, H., & Kim, G. (2023). Anthropogenic iron invasion into the ocean: Results from the East Sea (Japan Sea). Environmental Science & Technology, 57(29), 10745-10753.
- 2. Seo, H., Lee, H., & Kim, G. (2024). New insight into the source and sink of 227Ac in the ocean. Geophysical Research Letters, 51(2), e2023GL105853.
- 3. Seo, J., Kim, G., Seo, H., Na, T., Noh, S., & Hwang, J. (2023). Sources and behaviors of particulate organic carbon, iron, and manganese in the bottom nepheloid layer of the southwestern East Sea (Japan Sea). Marine Chemistry, 257, 104323.
- 4. Seo, J., Kim, I., Kang, D. J., Lee, H., Choi, J. Y., Ra, K., ... & Kim, S. H. (2024). Particulate organic carbon export fluxes across the Seychelles-Chagos thermocline ridge in the western Indian Ocean using 234Th as a tracer. Frontiers in Marine Science, 10, 1288422.
- 5. Lee, H., Lee, J., Lee, H., & Kim, I. (2023). The Atmospheric Input of Dissolvable Pb Based on the Radioactive 210Pb Budget in the Equatorial Western Indian Ocean. Journal of Marine Science and Engineering, 11(6), 1120.

Please indicate if there is any forthcoming or planned GEOTRACES special issue publication

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

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GEOTRACES presentations in international conferences

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