

Division of Environmental Chemistry

– Hydrospheric Environment Analytical Chemistry –

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Prof
SOHRIN, Yoshiki
(D Sc)



Assist Prof
TAKANO, Shotaro
(D Sc)



Assist Prof
ZHENG, Linjie
(D Sc)



Techn Staff
IWASE, Misato

Students

UEKI, Ryuta (D1)

CHAN, Cheuk-Yin (D1)

NAGAE, Ayumi (M2)

TATSUYAMA, Tomomichi (M2)

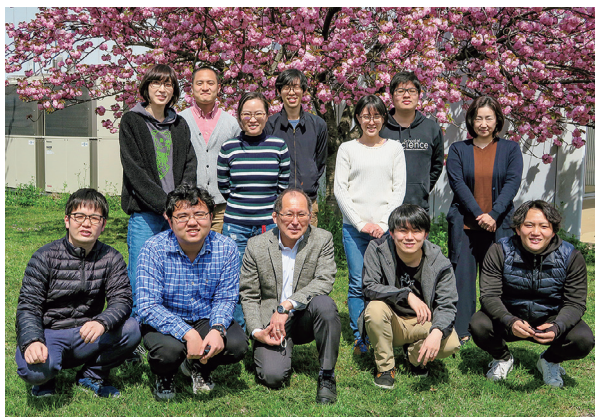
ISOBE, Kota (M1)

KANAMURA, Hideo (M1)

MATSUOKA, Kohei (M1)

Scope of Research

(i) Biogeochemistry of trace elements in the hydrosphere: Novel analytical methods are developed for trace metals and their isotopes. Distribution of trace elements in the hydrosphere and their effects on the ecosystem are investigated. The study also covers hydrothermal activity, deep biosphere, and paleocean. (ii) Ion recognition: Novel ligands and ion recognition system are designed, synthesized, and characterized.



KEYWORDS

Marine Chemistry

Analytical Chemistry

Trace Elements

Stable Isotopes

Metal Ion Recognition

Recent Selected Publications

Liao, W.-H.; Takano, S.; Tian, H.-A.; Chen, H.-Y.; Sohrin, Y.; Ho, T.-Y., Zn Elemental and Isotopic Features in Sinking Particles of the South China Sea: Implications for Its Sources and Sinks, *Geochim. Cosmochim. Acta.*, **314**, 68-84 (2021).

Sakata, K.; Takahashi, Y.; Takano, S.; Matsuki, A.; Sakaguchi, A.; Tanimoto, H., First X-ray Spectroscopic Observations of Atmospheric Titanium Species: Size Dependence and the Emission Source, *Environ. Sci. Technol.*, **55**, 10975-10986 (2021).

Zheng, L.; Minami, T.; Takano, S.; Ho, T.-Y.; Sohrin, Y., Sectional Distribution Patterns of Cd, Ni, Zn, and Cu in the North Pacific Ocean: Relationships to Nutrients and Importance of Scavenging, *Glob. biogeochem. Cycles.*, **35**, e2020GB006558 (2021).

Takano, S.; Tsuchiya, M.; Imai, S.; Yamamoto, Y.; Fukami, Y.; Suzuki, K.; Sohrin, Y., Isotopic Analysis of Nickel, Copper, and Zinc in Various Freshwater Samples for Source Identification, *Geochem. J.*, **55(3)**, 171-183 (2021).

Nakaguchi, Y.; Ikeda, Y.; Sakamoto, A.; Zheng, L.; Minami, T.; Sohrin, Y., Distribution and Stoichiometry of Al, Mn, Fe, Co, Ni, Cu, Zn, Cd, and Pb in the East China Sea, *Journal of Oceanography*, **77**, 463-485 (2021).

Sectional Distribution Patterns of Cd, Ni, Zn, and Cu in the North Pacific Ocean: Relationships to Nutrients and Importance of Scavenging

The North Pacific Ocean is located at the end of the thermohaline circulation of deep water. This study reports on basin-scale full-depth sectional distributions of total dissolvable (td), dissolved (d), and labile particulate (lp) Cd, Ni, Zn, and Cu along three transects: the GEOTRACES transects GP18 (165°E) and GP02 (47°N), and along 160°W. We find that scavenging is an important factor that significantly affects the distributions of dZn, dNi, and dCu, of which the magnitude of influence increases in the order of Cd < Ni, Zn < Cu. The relationships between the four dissolved metals with Si(OH)₄ and PO₄ differed considerably from those in other oceans. The spot concentration ratio of dCd/PO₄ was 0.34 ± 0.02 nmol/μmol ($n = 296$) in waters >800 m deep, which is in the range of the phytoplankton Cd/P ratio. This is indicative of the dominant effect of water circulation and biological processes on dCd distribution. The dissolved metals (dMs) to PO₄ ratios of other examined metals were either partially or completely outside the range of typical biomass ratios. They generally increased with depth in waters >800 m deep; the magnitude of increase was the highest for Cu and moderate for Ni and Zn. Below 800 m, an increase in the apparent oxygen utilization from 150 to 300 μmol/kg was concurrent with a decrease in the dMs/PO₄ ratios: 4 ± 3 % for Cd, 21 ± 4 % for Zn, 21 ± 3 % for Ni, and 69 ± 7 % for Cu.

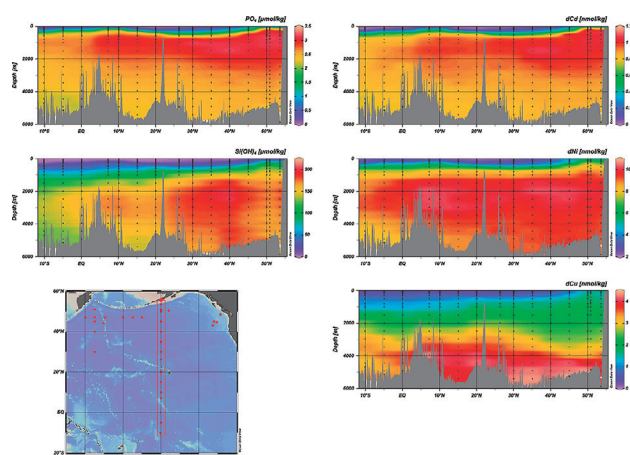


Figure 1. Full-depth sectional distributions of PO₄, Si(OH)₄, dCd, dNi, and dCu along 160°W.

Constraints on Redox Conditions in the Japan Sea in the Last 47,000 Years Based on Mo and W as Palaeoceanographic Proxies

Both molybdenum (Mo) and tungsten (W) form soluble oxyanions in oxic seawater, whereas Mo forms insoluble thiomolybdate and W forms soluble thiotungstate in sulfidic seawater. Thus, concentrations and stable isotope ratios of Mo and W in sediments may fluctuate due to changes in redox conditions and can be used to estimate paleoenvironmental changes. The modern Japan Sea is oxic from the surface to the bottom, whereas deep water became anoxic several times from the late Pleistocene to the Holocene. Detailed information on redox conditions is still lacking. In this study, we analyzed a sediment core that was collected from offshore Iwanai, Hokkaido (43°22'36" N, 140°04'10" E, water depth 900 m). To the best of our knowledge, our study is the first to report stable isotope data of Mo and W in sediments of the Japan Sea. We observed maxima in the Mo concentration of up to 29 ppm in the sediment layers of 11–10 ka, 17–14 ka (the last glacial maximum), 31 ka, and 45 ka in accordance with the maxima of total sulfur, thereby indicating the deposition of thiomolybdate MoO₃S_{4-x}²⁻ ($0 \leq x \leq 3$). δ⁹⁸Mo, however, was between -0.19 and 0.69‰ at these ages, suggesting that the H₂S concentration in bottom water never exceeded 11 μmol kg⁻¹. The concentration and isotopic ratio of W were relatively constant throughout the core; W = 1.2 ± 0.2 ppm and δ¹⁸⁶W = 0.03 ± 0.03 ‰ (ave ± sd). The authigenic Mo and W ratio, Mo_{auth}/W_{auth} (mol/mol), was 10.5 ± 7.3 except for the above four ages, supporting the control of Mn and Fe(oxyhydr)oxides on Mo_{auth} and W_{auth} under oxic conditions.

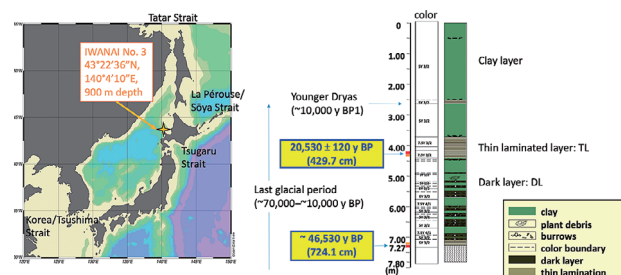


Figure 2. Sampling site and appearance of the sediment core.