

ANNUAL REPORT ON GEOTRACES ACTIVITIES IN SLOVENIA

April 1st, 2021 to April 30th, 2022

New GEOTRACES or GEOTRACES relevant scientific results

The results of two relevant topics can be considered:

- Study of the fate and processes of Hg and its speciation in marine ecosystems. The published Critical Review updates current knowledge on the sources, biogeochemical cycling, and mass balance of Hg in the Mediterranean and identifies perspectives for future research especially in the context of global change. Concentrations of Hg in the Western Mediterranean average $0.86 \pm 0.27 \text{ pmol L}^{-1}$ in the upper water layer and $1.02 \pm 0.12 \text{ pmol L}^{-1}$ in intermediate and deep waters. In the Eastern Mediterranean, Hg measurements are in the same range but are too few to determine any consistent oceanographical pattern. The Mediterranean waters have a high methylation capacity, with MeHg representing up to 86% of the total Hg, and constitute a source of MeHg for the adjacent North Atlantic Ocean. The highest MeHg concentrations are associated with low oxygen water masses, suggesting a microbiological control on Hg methylation, consistent with the identification of *hgcA*-like genes in Mediterranean waters. MeHg concentrations are twice as high in the waters of the Western Basin compared to the ultra-oligotrophic Eastern Basin waters. This difference appears to be transferred through the food webs and the Hg content in predators to be ultimately controlled by MeHg concentrations of the waters of their foraging zones. Many Mediterranean top-predatory fish still exceed European Union regulatory Hg thresholds. The review also points out other insufficiencies of knowledge of Hg cycling in the Mediterranean Sea, including temporal variations in air–sea exchange, hydrothermal and cold seep inputs, point sources, submarine groundwater discharge, and exchanges between margins and the open sea. Future assessment of global change impacts under the Minamata Convention Hg policy requires long-term observations and dedicated high-resolution Earth System Models for the Mediterranean region.

The second research is subject to interconversions via (photo)chemical and (micro)biological processes that determine the extent of dissolved gaseous mercury (DGM) (re)emission and the production of monomethylmercury in seawater. We investigated Hg speciation in the South Atlantic Ocean on a GEOTRACES cruise along a 40°S section between December 2011 and January 2012. Using statistical analysis, concentrations of methylated mercury (MeHg, geometric mean 35.4 fmol L^{-1}) were related to seawater temperature, salinity and fluorescence. DGM concentrations (geometric mean 0.17 pmol L^{-1}) were related to water column depth, concentrations of macronutrients and dissolved inorganic carbon (DIC). The first-ever observed linear correlation between DGM and DIC obtained from high-resolution data indicates possible DGM production by organic matter remineralization via biological or dark abiotic reactions. DGM concentrations projected from literature DIC data using the newly discovered DGM–DIC relationship agreed with published DGM observations.

- Distribution, mobility and fate of trace elements in an estuarine and lagoonal systems. The accumulation of contaminants and their potential mobility represent two of the main environmental issues facing coastal environments. Sediments often act as “reservoirs” of contaminants, including potentially toxic trace elements, but they can also be considered a secondary source of contamination due to remobilisation processes at the sediment-water interface which may affect the quality of the coastal water and aquatic biota. Our research provide a geochemical characterisation of the estuarine system of the Timavo/Reka River, focusing on the occurrence of trace elements in different environmental matrices with the purpose of highlighting potential critical conditions in terms of environmental quality. The surface sediments were found to be enriched in several trace elements especially in the innermost sector of the area. There, sulphate-reductive conditions in the bottom saltwater testify to potential anoxia at the sediment-water interface, driving trace element accumulation in the

residual fraction of the sediments. However, Fe and Mn redox behaviour appears to play a crucial role in the recycling of dissolved trace elements in the water column. With the lone exception of the saltwater in the innermost sector, trace elements were found to be mainly associated with suspended particles due to oxidation and precipitation processes, whereas a common lithogenic origin was identified for Cr, Ni, and Co, which are significantly correlated both in the surface sediments and in the suspended particles.

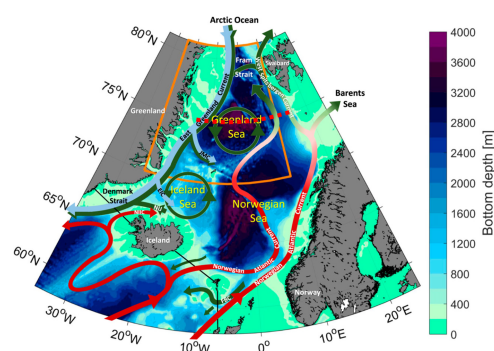
The cycling of metal(loid)s at the sediment–water interface (SWI) was evaluated at two selected sites (VN1 and VN3) in an active fish farm in the Grado Lagoon (Northern Adriatic, Italy). Despite sediments at two sites exhibiting high total metal(loid) concentrations and moderate effluxes at the SWI, the results suggest that they are hardly remobilized from the sediments. Recycling of metal(loid)s from the SWI would not constitute a threat for the aquatic trophic chain in the fish farm.

GEOTRACES or GEOTRACES relevant cruises

CASSANDRA project: Advancing knowledge on the present Arctic Ocean by chemical-physical, biogeochemical and biological observations to predict the future changes

Period of the cruise: 29/08/2021, Longyearbyen (NO) – 14/09/2021, Bergen (NO)

The project was financially supported by the Italian Program of Research In Arctic. The measurements and results are in progress.



New projects and/or funding

- The new MSCA IT project GMOS-Train started already in 2020, but should be mentioned in this report. The GMOS-Train: Global Mercury Observation and Training network in support to the Minamata Convention started in 2020 and is coordinated by M. Horvat (JSI). With the purpose to better understand the global exchange of Hg between atmosphere, hydrosphere, lithosphere, and biosphere, the next generation of young researchers will gain expertise through a network-based, highly interdisciplinary research training programme including atmospheric chemistry and physics, aquatic chemistry, ecology, analytical chemistry, multimedia modelling, and the use of science results for policy making.
- A new national project IsoCont - Innovative Isotopic Techniques for Identifying Sources and Biogeochemical Cycles of Mercury on Contaminated Areas started in October 2010.

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

COSSA, Daniel, HORVAT, Milena, et al. Mediterranean mercury assessment 2022 : An Updated budget, health consequences, and research perspectives. Environmental science & technology. [Print ed.]. [in press] 2022, 23 str. ISSN 0013-936X. DOI: [10.1021/acs.est.1c03044](https://doi.org/10.1021/acs.est.1c03044).

ŽIVKOVIĆ, Igor, GAČNIK, Jan, JOZIĆ, Slaven, KOTNIK, Jože, ŠOLIĆ, Mladen, HORVAT, Milena. A simplified approach to modeling the dispersion of mercury from precipitation to surface waters—The Bay of Kaštela case study. Journal of marine science and engineering. 2022, vol. 10, no. 4, str. 539-1-539-13. ISSN 2077-1312. DOI: [10.3390/jmse10040539](https://doi.org/10.3390/jmse10040539).

KOTNIK, Jože, ŽAGAR, Dušan, NOVAK, Gorazd, LIČER, Matjaž, HORVAT, Milena. Dissolved gaseous mercury (DGM) in the gulf of Trieste, Northern Adriatic Sea. Journal of marine science and

engineering. 2022, vol. 10, no. 5, str. 587-1-587-18, ilustr. ISSN 2077-1312.
DOI: [10.3390/jmse10050587](https://doi.org/10.3390/jmse10050587).

ŽIVKOVIĆ, Igor, KOTNIK, Jože, BEGU, Ermira, FAJON, Vesna, HORVAT, Milena, et al.
Enhanced mercury reduction in the South Atlantic Ocean during carbon remineralization. Marine pollution bulletin. 2022, vol. 178, str. 1-113644-10-113664. ISSN 0025-326X.
DOI: [10.1016/j.marpolbul.2022.113644](https://doi.org/10.1016/j.marpolbul.2022.113644).

PETRANICH, Elisa, CROSER, Matteo, PAVONI, Elena, FAGANELI, Jadran, COVELLI, Stefano.
Behaviour of metal(loid)s at the sediment-water interface in an aquaculture lagoon environment (Grado Lagoon, Northern Adriatic Sea, Italy). Applied sciences. 2021, iss. 5, [article] 2350, str. 1-16. ISSN 2076-3417. <https://www.mdpi.com/2076-3417/11/5/2350>, DOI: [10.3390/app11052350](https://doi.org/10.3390/app11052350).

PAVONI, Elena, CROSER, Matteo, PETRANICH, Elisa, FAGANELI, Jadran, KLUN, Katja, OLIVERI, Paolo, COVELLI, Stefano, ADAMI, Gianpiero. Distribution, mobility and fate of trace elements in an estuarine system under anthropogenic pressure : the case of the karstic Timavo River (Northern Adriatic Sea, Italy). Estuaries and coasts. 2021, vol. 44, str. 1831-1847. ISSN 1559-2723. <https://link.springer.com/article/10.1007/s12237-021-00910-9>, DOI: [10.1007/s12237-021-00910-9](https://doi.org/10.1007/s12237-021-00910-9).

FAGANELI, Jadran, OGRINC, Nives, TAMŠE, Samo, KRANJC, Bor, TURK, Valentina, MALEJ, Alenka, KOVAČ, Nives. "Kisanje" severnega Jadrana. Acta chimica slovenica. [Spletna izd.]. 2021, vol. 68, no. 3, str. s87-s93, ilustr. ISSN 1580-3155. DOI: [10.17344/acsi.2021.7002](https://doi.org/10.17344/acsi.2021.7002).

GEOTRACES presentations in international conferences

HORVAT, Milena. Towards a better understanding of mercury dynamics within a between land, atmosphere, and ocean systems to support the effectiveness evaluation of the Minamata Convention. V: Goldschmidt Virtual Conference 2021, 4-9 July, 2021.

<https://2021.goldschmidt.info/goldschmidt/2021/meetingapp.cgi>.

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