ANNUAL REPORT ON GEOTRACES ACTIVITIES IN CROATIA

May 1st, 2024 to April 30th, 2025

New GEOTRACES or GEOTRACES relevant scientific results

The Croatian GEOTRACES activities were related to:

- processes governing copper chemistry and toxicity in natural waters;
- interaction of trace metals with marine microplastics;
- study of geochemistry of redox proxies and redox transformations in seawater under a range of critical environmental conditions (Cu, V, Re, Mo and U);
- study of geochemistry of technology critical elements in seawater (REE and Pt) and in sediments (Li, Nb, REE, Ga, Sb, Ge, Te and W);
- mercury speciation and determination by CV-AAS in natural waters, including monitoring of the coastal and open waters of the Adriatic Sea;
- ecological drivers of carbon cycling in the ocean;
- study of interactions between surface water chemistry, phytoplankton, atmospheric chemistry, and climate;
- application of improved electrochemical methods (in combination with ICPMS) for determination of number of trace metals, their speciation, fractionation and interaction with organic matter and sulphur species in natural waters, including monitoring of the coastal and open waters of the Adriatic Sea;
- geochemical research and biological response in different environmental systems (coastal and open sea, marine lakes, anchialine caves, submarine groundwater discharge);
- development of new methods for ex- and in-situ determination of natural and anthropogenic radionuclides (focus is on $^{86/87}$Sr, ^{89,90}Sr and ^{210}Pb);
- measurements of activity concentration of ^{7}Be and ^{210}Pb in atmospheric precipitation (rain, aerosols - PM2.5) in order to monitor dynamics of particle transport, metrological information, origin of air mass transfer and seasonal variation of aerosol deposition;
- work on advanced technologies for water quality control/monitoring and prediction purposes.

GEOTRACES or GEOTRACES relevant cruises

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New projects and/or funding

Current projects supported by the Croatian Ministry of Science, Education and Sport and Croatian Science Foundation (CSF):

- 2020-2025, CSF and Swiss National Science Foundation: Understanding copper speciation and redox transformations in seawater (SeCuTrans) (PI: E. Bura-Nakić)
- 2020-2024, CSF project: Marine (micro)plastic litter and pollutant metals interaction: a possible pathway from marine environment to human (METALPATH) (PI Vlado Cuculić)

- 2024-2027, CSF project: The ocean of the future: Will changed phytoplankton composition positively impact the biological carbon pump? (FUTURE OCEAN) (PI: B. Gašparović)
- 2024-2027, CSF project: Interactions in the coccolithophorid phycosphere and implications for ocean carbon cycling (Cocco-Channel) (PI: J. Godrijan)
- 2023-2027, CSF project: Pollen in the Adriatic Sea: input dynamics, chemical characterization and impact on primary production (POLLMAR) (PI: S. Strmečki Kos)

GEOTRACES workshops and meetings organized

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Outreach activities conducted

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Other GEOTRACES activities

- D. Omanović (Ruđer Bošković Institute, Zagreb) is a member of the GESAMP working group 45 - Climate Change and Greenhouse Gas Related Impacts on Contaminants in the Ocean
- I. Ciglenečki (Ruđer Bošković Institute, Zagreb) is a member of EMB working group on Ocean Oxygen

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

- Crmarić, D., Marcinek, S., Cindrić, A. M., Omanović, D., & Bura-Nakić, E. (2025). Redox speciation of copper in the estuarine environment: Towards better understanding of copper water chemistry. *Marine Chemistry*, *268*, 104471.
- Bura-Nakić, E., Crmarić, D., Cukrov, N., & Mlakar, M. (2025). Voltammetric study of bathocuproine disulphonate/copper system. *Electroanalysis*, *37*(1), e202400090.
- Marcinek, S., Cindrić, A. M., & Omanović, D. (2025). Influence of seasonal changes in organic matter pool on copper bioavailability in a stratified estuary. *Marine Chemistry*, *270*, 104513.
- Zitoun, R.[&], Marcinek, S.[&], Hatje, V., Sander, S. G., Völker, C., Sarin, M., & Omanović, D. (2024). Climate change driven effects on transport, fate and biogeochemistry of trace element contaminants in coastal marine ecosystems. *Communications earth & environment*, *5*(1), 560.
- Hollister, A.[&], Marcinek, S.[&], Schmidt, K., Omanović, D., Schulte, M. B., & Koschinsky, A. (2024). First indication of platinum input into the southern North Sea via German Rivers. *Marine chemistry*, *265*, 104439.
- Amorim, K., Grover, R., Omanović, D., Sauzéat, L., Do Noscimiento, M. M., Fine, M., & Ferrier-Pagès, C. (2024). Desert dust improves the photophysiology of heat-stressed corals beyond iron. *Scientific Reports*, *14*(1), 26509.

- Posarić, L., Palinkaš, S. S., Hilmo, J., Fiket, Ž., Čobić, A., & Fajković, H. (2025). Lithology as a factor for the distribution of metals in stream sediments associated with sediment-hosted Cu deposits: a case study from the Alta-Kvænangen tectonic window, northern Norway. *Environmental geochemistry and health*, *47*(4), 97.
- Alempijević, S. B., Vidović, K., Vukosav, P., Frka, S., Kroflič, A., Mihaljević, I., ... & Strmečki, S. (2025). Integrating voltammetry in ecotoxicology: Cu (II)-nitrocatechol complexes formation as a driver of Cu (II) and nitrocatechol toxicity in aquatic systems. *Electrochimica acta*, *522*, 145938.
- Strmečki, S., Dešpoja, I., Penezić, A., Milinković, A., Alempijević, S. B., Kiss, G., ... & Frka, S. (2024). How do certain atmospheric aerosols affect Cu-binding organic ligands in the oligotrophic coastal sea surface microlayer?. *Environmental Science: Processes & Impacts*, *26*(1), 119-135.
- Rapljenović, A., Kwokal, Ž., Purgar, M., Viskić, M., & Cuculić, V. (2024). Adsorption of trace metals onto different plastics during long-term exposure in an estuarine environment: Influence of time, stratified water column, and specific surface area. *Marine chemistry*, *265*, 104431.
- Rapljenović, A., Fajković, H., Kapetanović, D., Lakuš, I., Pikelj, K., Purgar, M., ... & Cuculić, V. (2025). Seasonal and spatial distribution of trace metals and bacteria on beached plastics in the Adriatic sea. *Estuarine, coastal and shelf science*, *318*, 109223
- Rapljenović, A., Viskić, M., Frančišković-Bilinski, S., & Cuculić, V. (2024). Influence of organic matter and speciation on the dynamics of trace metal adsorption on microplastics in marine conditions. *Toxics*, *12*(11), 820.
- Žurga, P., Dubrović, I., Kapetanović, D., Orlić, K., Bolotin, J., Kožul, V., ... & Perić, L. (2024). Performance of mussel Mytilus galloprovincialis under variable environmental conditions and anthropogenic pressure: A survey of two distinct farming sites in the Adriatic Sea. *Chemosphere*, *364*, 143156.
- Vilibić, I., Terzić, E., Vrdoljak, I., Novković, I. D., Vodopivec, M., Ciglenečki, I., ... & Hamer, B. (2025). Extraordinary mucilage event in the northern Adriatic in 2024—a glimpse into the future climate?. *Estuarine, coastal and shelf science*, *317*, 109222.
- Vidović, K., Simonović, N., Tasić, N., Hočevar, S. B., & Ciglenečki, I. (2025). Study of surface-active substances using alternating current voltammetry and mercury electrode by potentiostat without phase sensitivity modules. *Electrochimica Acta*, *515*, 145709.
- Vidović, K., Hočevar, S. B., Sarang, K., Konjević, I., Tasić, N., & Ciglenečki, I. (2025). New electrochemical approach for assessing surface tension and its role in atmospheric particle growth. *Electrochimica Acta*, *514*, 145643.

Completed GEOTRACES PhD or Master theses

- Phd Thesis: Ozren Grozdanić, Distribution and speciation of trace metals in the Pula bay, Univ. of Zagreb, 2025

- ***GEOTRACES presentations in international conferences***
- Omanović, D. Analysis and speciation of trace metals in natural waters using voltammetric techniques. **Keynote**. In *36th Topical Meeting of the International*

Society of Electrochemistry, May 2024, Šibenik, Croatia.

- Marcinek, S. Pollution crossing the land-sea interface: Pollutants of concern and their pathways. Invited talk and panel discussion. In *9th European Marine Board Forum*, April 2025, Brussels, Belgium.
- Rapljenović, A., Cuculić, V. Voltammetry as a tool to study the interaction of trace metals and (micro)plastics from aquatic environments. In *36th Topical Meeting of the International Society of Electrochemistry*, May 2024, Šibenik, Croatia.
- Ciglenečki, I., Dautović, J., Dominović, I., Marguš, M., Mateša, S., Simonović, N., Vidović, K. Electroanalytical methods in the study of changes in the marine environment. In *36th Topical Meeting of the International Society of Electrochemistry*, May 2024, Šibenik, Croatia.
- Bakija Alempijević, S., Frka, S., Mihaljević, I., Strmečki, Kos S. Voltammetry of copper-nitrocatechol interactions explains their binary toxic effects to microalgae. In *36th Topical Meeting of the International Society of Electrochemistry*, May 2024, Šibenik, Croatia.
- Crmarić, D., Bura-Nakić, E., Cukrov, N., Mlakar, M. Investigation of bathocuproine disulfonate/Cu(I)/cysteine system by cathodic stripping voltammetry and spectrophotometry. In *36th Topical Meeting of the International Society of Electrochemistry*, May 2024, Šibenik, Croatia.
- Mateša, S., Ciglenečki, I., Dominović, I., Marguš M. Determination of polysulfides (Sx2-) in seawater euxinic conditions by electroanalytical methods S01C-002. In *36th Topical Meeting of the International Society of Electrochemistry*, May 2024, Šibenik, Croatia.
- Simonović, N., Budiša, A., Ciglenečki, I., Dautović, J., Marguš, M., Paliaga, P. DOC normalized surfactant activity as a practical tool for assessing organic carbon properties in the marine environment. In *36th Topical Meeting of the International Society of Electrochemistry*, May 2024, Šibenik, Croatia.
- Strmečki Kos, S., Matanović, M., Poplašen, V., Hruševar, D., Mitić, B., & Frka, S. The effect of surface-active organic substances on voltammetric determination of copper-binding organic ligands in seawater. In *36th Topical Meeting of the International Society of Electrochemistry*, May 2024, Šibenik, Croatia.
- Bakija Alempijević, S., Mihaljević, I., Frka, S., & Strmečki Kos, S. (2024). Copper-nitrocatechol interactions govern their toxic effects to microalgae. In *10th Regional Biophysics Conference (RBC2024) & 15th International Summer School of Biophysics* (pp. 82-82). August 2024, Split, Croatia.

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