ANNUAL REPORT ON GEOTRACES ACTIVITIES IN CROATIA

May 1st, 2021 to April 30th, 2022

New GEOTRACES or GEOTRACES relevant scientific results

The Croatian GEOTRACES activities were related to:

1) 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;

2) mercury speciation and determination by CV-AAS in natural waters, including monitoring of the coastal and open waters of the Adriatic Sea;

3) study of geochemistry of redox proxies and redox transformations in seawater under a range of critical environmental conditions (Cu, V, Re, Mo and U);

4) study of geochemistry of technology critical elements (Li, Nb, Sc, Ga, Y, La, Sb, Ge, Te and W) in marine sediments;

5) geochemical research and biological response in different environmental systems (coastal and open sea, marine lakes, anchialine caves, submarine groundwater discharge);

6) 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);

7) development of electroanalytical method for determination and characterization of polysulfides in anoxic seawater conditions;

8) study of interactions between surface water chemistry, phytoplankton, atmospheric chemistry, and climate;

9) characterization of atmospheric precipitation (rain, aerosols - PM2.5) regarding presence of major cations and anions, organic matter, sulphur species and trace metals;

10) 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;

11) 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):

- 2018-2022, CSF project: Biochemical REsponses of oligotrophic Adriatic surface ecosystems to atmospheric Deposition Inputs (BiREADI) (PI. Sanja Frka)

- 2018-2022, CSF project: MARine lake (Rogoznica) as a model for EcoSystem functioning in a changing environment (PI. I. Ciglenečki-Jušić)
- 2018-2022, CSF project: Geochemistry and Records of Redox Indicators in Different Environmental Conditions: Towards a better understanding of redox conditions in the past (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)
- 2020-2024: SNSF/CSF: Understanding copper speciation and redox transformations in seawater (PI: E. Bura-Nakić)

Other projects:

2020-2023: HAMAG-BICRO: "Application of artificial intelligence in advanced predictive technologies for online water quality control". (PI. D. Omanović)

2020-2023: INTERREG CRO-ITA: InnovaMare - "Model of innovation ecosystem in the field of underwater robotics and sensors for control and monitoring purposes with a mission focused on the sustainability of the Adriatic Sea". (PI. M. Mlakar)

2021-2022: Providing a service of systematic testing of the state of transitional and coastal waters in the Adriatic Sea (Croatia) (PI. I. Ciglenečki-Jušić)

2020-2022: INTERREG ADRION: "SEAVIEWS - Sector Adaptive Virtual Early Warning System for marine pollution". (AP. D. Omanović)

2020-2022: SKLEC China Open Research Fund: "Eco-environmental impacts of submarine groundwater discharge-derived nutrients, carbon and metal in oligotrophic karstic estuary of the Krka River (Adriatic Sea, Croatia)". (PI. N. Cukrov)

2020-2021: Partnerships between scientists and fishermen (1. cooperation in Ploče: PI. V. Filipović Marijić; 2. cooperation in Gradac: PI. D. Kapetanović).

GEOTRACES workshops and meetings organized

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Outreach activities conducted

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Other GEOTRACES activities

- D. Omanović is a member of the new GESAMP working group 45 - Climate Change and Greenhouse Gas Related Impacts on Contaminants in the Ocean.
- I.Ciglenečki-Jušić is appointed Croatian representative in the Oceans Knowledge Hub within the JPI Oceans initiative Ocean Carbon Capacities
- I. Ciglenečki-Jušić is a member of the new European Marine Board Working Group on Ocean Oxygen

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

- Elvira Bura-Nakić, Lucija Knežević, Jelena Mandić, Chromatographic and spectrophometric studies of vanadate (+V) reduction by 3-mercaptopropionic acid, *Journal of Inorganic Biochemistry*, 230 (2022) 111747.
- Saša Marcinek, Ana Marija Cindrić, Jasmin Pađan and Dario Omanović, Trace Metal Partitioning in the Salinity Gradient of the Highly Stratified Estuary: A Case Study in the Krka River Estuary (Croatia), *Applied Sciences*, 12 (2022) 5816.
- Duc Huy Dang, Dario Omanović, Alfonso Mucci, Wei Wang, Allison Sikma, Anique Chatzis, The winter estuarine geochemistry of platinum in the Estuary and Gulf of St. Lawrence, *Marine Chemistry*, 242 (2022) 104123.
- Abra Penezić, Blaženka Gašparović, Vlado Cuculić, Slađana Strmečki, Tamara Djakovac and Marina Mlakar, Dissolved trace metals and organic matter distribution in the Northern Adriatic, an increasingly oligotrophic shallow sea, *Water*, 14 (2022) 349.
- Nevenka Mikac, Ivan Sondi, Neda Vdović, Kristina Pikelj, Maja Ivanić, Mavro Lučić, Niko Bačić, Martina Turk Furdek, D. Srečo Škapin, Slađana Krivokapić, Origin and history of trace elements accumulation in recent Mediterranean sediments under heavy human impact. A case study of the Boka Kotorska Bay (Southeast Adriatic Sea), *Marine pollution bulletin*, 179 (2022), 113702.
- Anđela Bačinić, Sanja Frka and Marina Mlakar, A study of cobalt (II) complexes involved in marine biogeochemical processes: Co(II)-1,10-Phenanthroline and Co(II)-1,10-Phenanthroline-L-α-Phosphatidylcholine, *Bioelectrochemistry*, 144 (2022) 108009.
- Boris Mifka, Maja Telišman Prtenjak, Josipa Kuzmić, Milan Čanković, Sarah Mateša and Irena Ciglenečki, Climatology of dust deposition in the Adriatic Sea; a possible impact on marine production, *Journal of Geophysical Research: Atmospheres*, 127 (2022) e2021JD035783.
- Katarina Kajan, Neven Cukrov, Nuša Cukrov, Renée Bishop-Pierce and Sandi Orlić, Microeukaryotic and prokaryotic diversity of anchialine caves from eastern Adriatic Sea Islands, *Microbial Ecology*, 83 (2021) 257-270.
- Robert Casotto, Ana Cvitešić Kušan, Deepika Bhattu, Tianqu Cui, Manousos-Ioannis Manousakas, Sanja Frka, Ana Kroflič, Irena Grgić, Irena Ciglenečki, Urs Baltenspergera, Jay G. Slowik, Kaspar R. Daellenbacha and Andre S. H. Prévôta, Chemical composition and sources of organic aerosol on the Adriatic coast in Croatia, *Atmospheric Environment: X*, 13 (2022) 100159.
- Palma Orlović-Leko, Niki Simonović, Ivan Šimunić, and Irena Ciglenečki, Fast methodology (warning tools) for tracking changes of the aquatic organic material, *Reliability: Theory & Applications*, 17 (2022) 168-171.
- Slađana Strmečki, Lora Pereža, Electrochemistry of chitosan amino-glycan and BSA protein mixture under seawater conditions, *Journal of Electroanalytical Chemistry*, 898 (2021) 115630.
- Andrea Milinković, Asta Gregorič, Vedrana Grgičin, Sonja Vidič, Abra Penezić, Ana Cvitešić Kušan, Saranda Alempijević, Anne Kasper-Giebl, Sanja Frka, Variability of black carbon aerosol concentrations and sources at a Mediterranean coastal region, *Atmospheric Pollution Research*, 12 (2021) 101221.

- Hrvoje Carić, Neven Cukrov, Dario Omanović, Nautical tourism in marine protected areas (MPAs): evaluating an impact of copper emission from antifouling coating, *Sustainability*, 13 (2021) 11897.
- Niko Bačić, Nevenka Mikac, Mavro Lučić and Ivan Sondi, Occurrence and distribution of technology-critical elements in recent freshwater and marine pristine lake sediments in Croatia: A case study, *Archives of environmental contamination and toxicology*, 81 (2021) 574-588.
- Irena Ciglenečki, Paolo Paliaga, Andrea Budiša, Milan Čanković, Jelena Dautović, Tamara Djakovac, Mathieu Dutour-Sikirić, Romina Kraus, Nataša Kužat, Davor Lučić, Daniela Marić Pfannkuchen and Jakica Njire, Dissolved organic carbon accumulation during a bloom of invasive gelatinous zooplankton *Mnemiopsis leidyi* in the northern Adriatic Sea; case of the anomalous summer in 2017, *Journal of Marine Systems*, 222 (2021) 103599.
- Paolo Paliaga, Andrea Budiša, Jelena Dautović, Tamara Djakovac, Mathieu Andre Dutour-Sikirić, Hrvoje Mihanović, Nastjenjka Supić, Igor Celić, Neven Iveša, Moira Buršić, Ivan Balković and Lara Jurković, Microbial response to the presence of invasive ctenophore Mnemiopsis leidyi in the coastal waters of the Northeastern Adriatic." *Estuarine, Coastal and Shelf Science* 259 (2021): 107459.
- Ivana Jakovljević, Iva Šimić, Gordana Mendaš, Zdravka Sever Štrukil, Silva Žužul, Valentina Gluščić, Ranka Godec Gordana Pehnec, Ivan Bešlić, Andrea Milinković, Saranda Alempijević and Martin Šala, Pollution levels and deposition processes of airborne organic pollutants over the central Adriatic area: Temporal variabilities and source identification, *Marine Pollution Bulletin*, 172 (2021) 112873.
- Elvira Bura-Nakić, Lucija Knežević, Jelena Mandić, Ana-Marija Cindrić and Dario Omanović, Rhenium distribution and behavior in the salinity gradient of a highly stratified estuary and pristine riverine waters (the Krka River, Croatia), *Archives of Environmental Contamination and Toxicology*, 81 (2021) 564-573.
- Leja Rovan, Tea Zuliani, Barbara Horvat, Tjaša Kanduč, Polona Vreča, Qasim Jamil, Branko Čermelj, Elvira Bura-Nakić, Neven Cukrov, Marko Štrok and Sonja Lojen, Uranium isotopes as a possible tracer of terrestrial authigenic carbonate, *Science of the Total Environment*, 797 (2021) 149103.
- Željka Fiket, Martina Furdek Turk, Maja Ivanić and Goran Kniewald, Non-traditional stable isotope signatures in geological matrices as a tool for interpreting environmental changes–a review, *Geologia Croatica* 74 (2021) 177-187.
- Milan Čanković, Mathieu Dutour-Sikirić, Iris Dupčić Radić, and Irena Ciglenečki, Bacterioneuston and bacterioplankton structure and abundance in two trophically distinct marine environments - a marine lake and the adjacent coastal site on the Adriatic Sea, *Microbial ecology*, (2021) 1-15.
- Abra Penezić, Adrea Milinković, Saranda Alempijević, Silva Žužul and Sanja Frka, Atmospheric deposition of biologically relevant trace metals in the eastern Adriatic coastal area, *Chemosphere*, 283 (2021) 131178.

Completed GEOTRACES PhD or Master theses

- Doctoral Thesis: Saša Marcinek, Multimethodological study of trace metal speciation and organic matter in estuarine waters, University of Zagreb, December 2021. (URL: https://www.bib.irb.hr/1199097/download/1199097.Marcinek-PhD_Thesis.pdf)

- Master Thesis: Iva Dešpoja, Electrochemical determination of cooper complexing capacity in the surface layer of the coastal middle Adriatic sea, University of Split, April 2021.

GEOTRACES presentations in international conferences

- *The Iron at the Air-Sea Interface Workshop*, Asheville, USA, July 2021; Diel variability of iron in the estuarine surface microlayer – a preliminary study. Marcinek, S., Cindrić, A. M., Pađan, J. and Omanović, D.
- *ASLO 2021 Aquatic Sciences Meeting*; Virtual Meeting, June 2021; Atmospheric deposition impacts on the sea surface microlayer in the coastal environment. Penezić A., Milinković A., Alempijević S., Žužul S. and Frka S.
- *International scientific conference 'Marine Ecosystems: Research and Innovations'*, Odessa, Ukraine, October 2021; Differences in metal accumulation and condition of marine fish species potentially impacted by the port of Ploče in the eastern Adriatic Sea. Mijošek T. Filipović Marijić V., Redžović Z., Erk M., Ivanković D., Lučev A.J., Brkić A., Kapetanović D., Gavrilović A., Radočaj T., Omanović, D., Cindrić, A.-M. and Dragun Z.
- Copper speciation by anodic stripping voltammetry in the surface layers of the oligotrophic sea influenced by atmospheric deposition. Strmečki, S.; Dešpoja, I.; Alempijević, S and Frka S.; *72nd Annual Meeting of the International Society of Electrochemistry*, Jeju Island, Korea, September 2021
- *EGU General Assembly 2021*, Virtual Meeting, April 2021; Impact of specific atmospheric depositions on Cu-organic matter interaction in the sea-surface microlayer of the Middle Adriatic. Strmečki, S.; Dešpoja, I. and Alempijević, S.
- *Goldschmidt*, Lion France, July 2021; Polysulfide dynamics in a marine euxinic environment (Rogoznica Lake, Croatia); importance of anoxygenic photosynthesis. Mateša S., Šegota S., Čanković M. and Ciglenečki I.
- *Goldschmidt*, Lion France, July 2021; Geochemical evidence for water column sulfidic holomixia in the sediment of a marine lake. Ciglenečki I., Čanković M., Marguš M., Mateša S., Simonović N., Dutour Sikirić M. and Mikac N.
- Complexation of V(IV) and V(V) with succinic and oxalic acids in aqueous acid solution using affinity capillary electrophoresis. Bura-Nakić E., Knežević L., Nowak A., Medina M., Tulashi N. and Vorlicek P. T.; *NECTARs Spring Web meeting*, March 2021
- Complexation of V(IV) and V(V) with succinic and oxalic acids in aqueous acid solution using affinity capillary electrophoresis. Knežević L., Zanda E, Bura-Nakić E. and Sladkov V.; *NECTARs Spring Web meeting*, March 2021
- *28th AMOS Annual Conference: 'Science for Impact'*; Virtual Meeting, February 2021; Atmospheric deposition of biologically relevant trace metals in an oligotrophic Adriatic Sea area. Penezić A., Milinković A., Alempijević S., Žužul S. and Frka S.
- *27th Croatian Meeting of Chemists and Chemical Engineers*, with international participation, Veli Lošinj, Croatia, October 2021; Application of the electrochemical method for monitoring polysulfides (S_x^{2-}) in marine euxinic environment (Rogoznica Lake, Croatia). Mateša S. and Ciglenečki I.
- *27th Croatian Meeting of Chemists and Chemical Engineers*, with international participation, Veli Lošinj, Croatia, October 2021; Dynamics of organic matter in

Rogoznica lake as an indication of global change. Simonović N., MargušM., Dutour-Sikirić M. and Ciglenečki I.

- *27th Croatian Meeting of Chemists and Chemical Engineers*, with international participation, Veli Lošinj, Croatia, October 2021; Long-term (30 years) study of dissolved organic matter in te Northern Adriatic sea; an indication of global changes and the BiOS variations. Ciglenečki I., Vilibić I., Dautović J., Simonović N., Vojvodić V., Ćosović B., Zemunik P., Dunić N. and Mihanović H.

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