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Biomethylation of Metall(oid)s in Freshwater Environments. A Factor affecting water management?

by Lars Düster

Contents

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I. Organometallic Compounds.

What is an organometal(loid) compound?

Compound *with min. one Me-C bond*. Depending on the size and the metal(loid) with a more or less *amphiphil character*.

Sources of organometal(loid) compounds:

Man-made for example TBT (an alkyltin compound) *or* by *methylation* in the environment.

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I. Organometallic Compounds.

Which elements can be biomethylated and biodegredated?

Elements of main interest:
Hg, As, Sn, Se, Sb

Less studied Elements: Bi, Ge, Te, Cd, Ni, Co, I, Tl, Pb, Po, Br

Periodic group number								
9	10	11	12	13	14	15	16	17
				Al	Si	P	S	Cl
				NR	NR	1	1–4	2,3
Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br
1–4	1	NR	NR	NR	1(?)	1–4	1–4	2,3
			Cd	In	Sn	Sb	Te	I
			1(?)	NR	1,2	1,2	1,2,4	1–3
			Hg	Tl	Pb	Bi	Po	At
			1	1	1,2(?)	1	1,2	NR

[a] Methylation and classes of organisms: (1) bacteria; (2) fungi/algae/yeast; (3) plants; (4) animals. NR: biomethylation not reported.

Tab.1 Element biomethylation by type of organism, (Thayer, 2002)

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I. Organometallic Compounds.

Toxicology:

Strongly dependent on the element and the exposed organism.

General statements for methylmercury towards inorganic mercury:

- Enhanced mobility
- Enhanced accumulation in the foodchain
- Enhanced toxicity towards organisms

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II. Scenarois

Generally, organometal(loid) compounds can be found in the environment where a biological activity is associated with a given load of inorganic metal(loid)s.

Concrete:

Constructed environments:

- Composting facilities
- Sewage treatment facilities
- Plant wastewater treatment facilities
- Constructed wetlands on abandoned industrial sites
- Restoration of wetlands, streams and lakes
- Stormwater overflows and the associated retention buildings just as the assosciated drainage brooks
- Landfill sites

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II. Scenarois

Concrete:

Near- natural environments:

- Pollution of wetland and water influenced ecosystems with metal(loid)s (for example omnipresent deposition of mercury in a world wide range = „…wetlands are sites of MeHg production.“, Grigal, 2003)
- Flooding of near- natural soils with a high geogenic background of metal(loid)s or flooting of agricultural soils
- Climatic changes and thereby enhanced biological activity (boreal soils)
- Use of organometal(loid) compounds in animal farming to increase weight gain and control infections
- Thausends of square miles in Bangladesh (maybe the biggest wetland on earth), India and Vietnam suffer from arsenic pollution

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III. Conclusions and activities in Essen

The knowledge base shows that biomethylation of metal(loid)s influences the biocoenosis of wetlands.

Therefore it is reasonable to increase efforts made in understanding the formation conditions, accumulation in the foodchain and pollution scenarios, in order to control remobilisation of organometal(loid)s.

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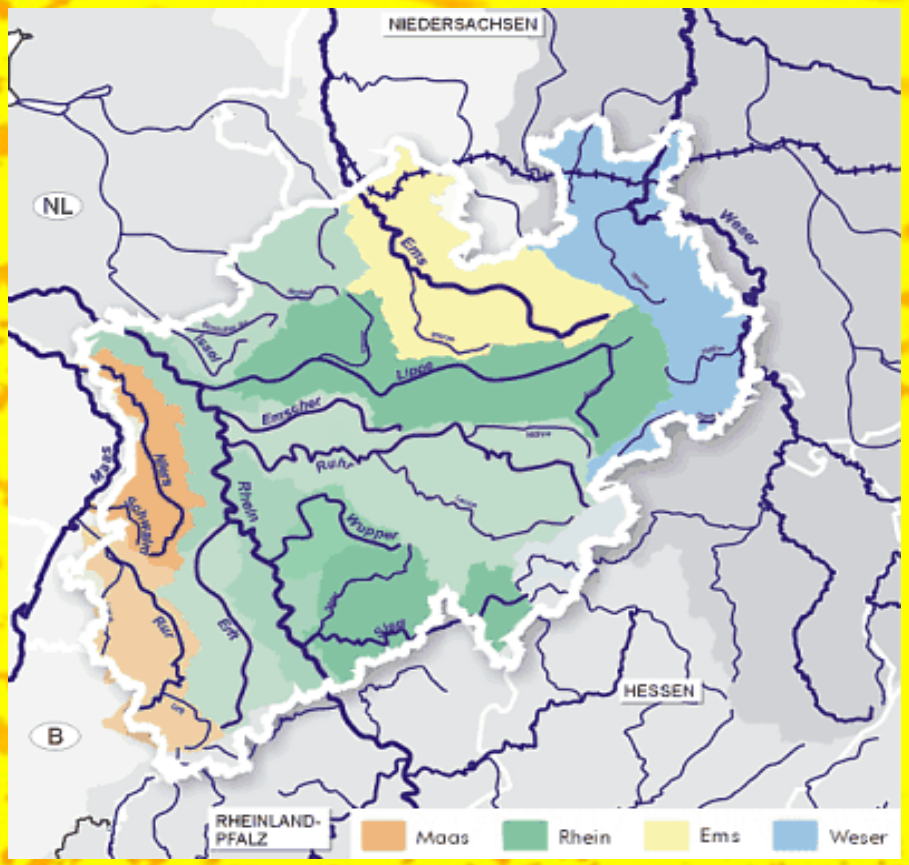
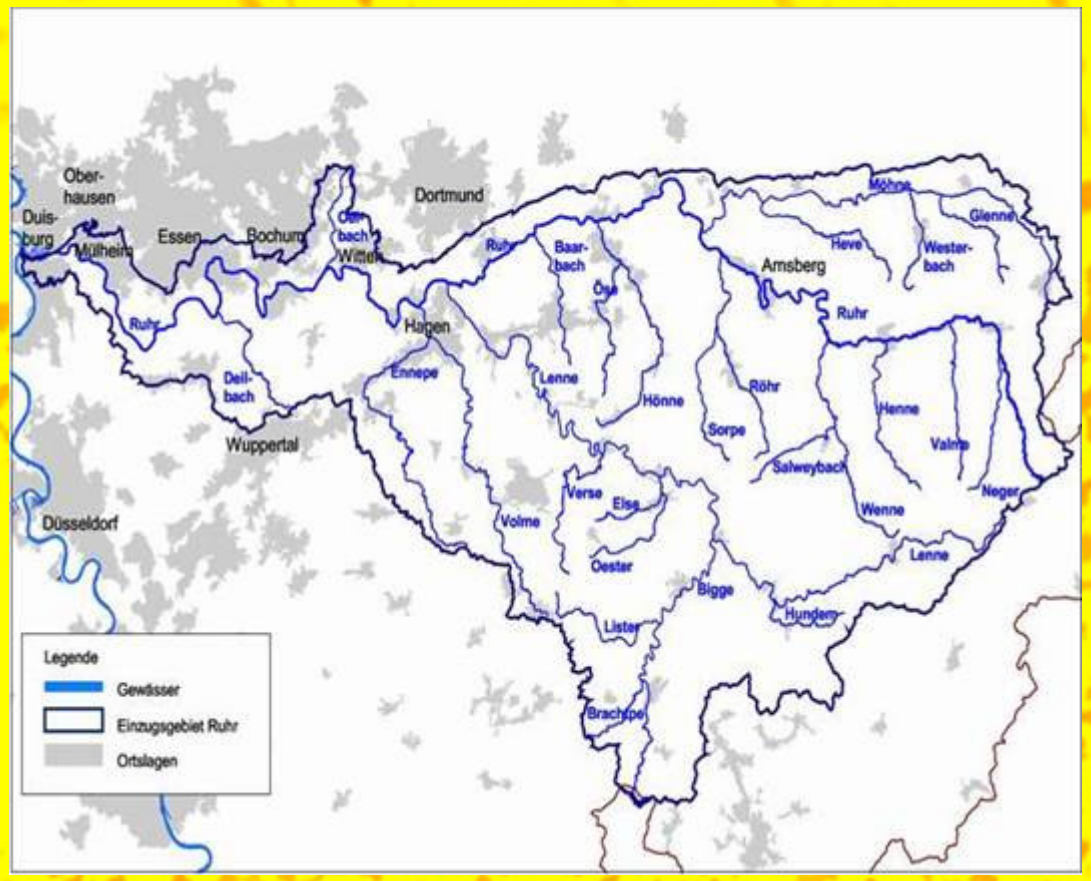
III. Conclusions and activities in Essen

The Institute of Environmental Analytical Chemistry, University of Duisburg-Essen



Map of NRW and its main rivers incl. the drainage areas



The Ruhr area and the confluent stream of the river Ruhr

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III. Conclusions and activities in Essen

Analysis equipment

- **Inductively coupled plasma-massspectrometer (ICP-MS):**
- 7500cs with Octapole-reaction cell (Agilent)
- 7500a (Agilent)
- Plasmaquad PQ II (Thermo Elemental)
- **Atomfluorescencspectrometer (AFS):**
- GC-AFS-coupling for mercury speciation (Merlin, PS-Analytical)
- HPLC (1100 Agilent) coupled with AFS for speciation of organometal(loid)s (Excalibur, PS-Analytical)
- **X-ray spectrometric methods:**
- TXRA Extra 2 (Seifert)
- X-ray Fluorescence Spectrometer SRS 3000 (Siemens)
- **Chromatography (GC / GC-MS, HPLC):**
- HP 5890 GC with different detectors (WLD, FID, ECD, Brimstone detector) (Agilent)
- GC-MSD 5973N with low temp. sample introduction system (Agilent)
- MS Engine (Agilent)
- Metal free HPLC for metal speciation (BioLC, Dionex)
- **Sample treatment**
- Microwave-pressure-disintegration Mars V (CEM)
- Laser ablation UP213 (New Wave Research)
- Cryomill, Freezer Mill 6300 (C3-Analysetechnik)

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III. Conclusions and activities in Essen

Projects and Partnership:

- Head of DFG Group: In July 2001 a collaboration between chemists, analysts, microbiologists and medical researchers was awarded a research grant ("Organometal(loid) Compounds in the Environment" FOR 415) by the Deutsche Forschungsgemeinschaft

- This project is a cooperation between:
  Westfälischen Wilhelms – University of Münster
  University of Karlsruhe
  (Forschungszentrum Jülich)
  and the University Duisburg Essen

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III. Conclusions and activities in Essen

Projekts and Partnership:

TWIN – Trans-national ecosystem-based water management, cooperation of the Universities Nijmegen, Wageningen and Duisburg-Essen for the construction and management of a master study course for „Ecosystem-based Water Management“

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Non University Cooperations:

The North Rhine Westphalia State Environment Agency (LUA NRW)

The Ruhrverband (Water Quality and Quantity Management)

Rijksinstituut voor Integraal Zoetwaterbeheer en Afvalwaterbehandeling - RIZA and it‘s Sediment Or Fauna Incubation Experiment (SOFIE)

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Institut für Umweltanalytik

Thank you for your attention!