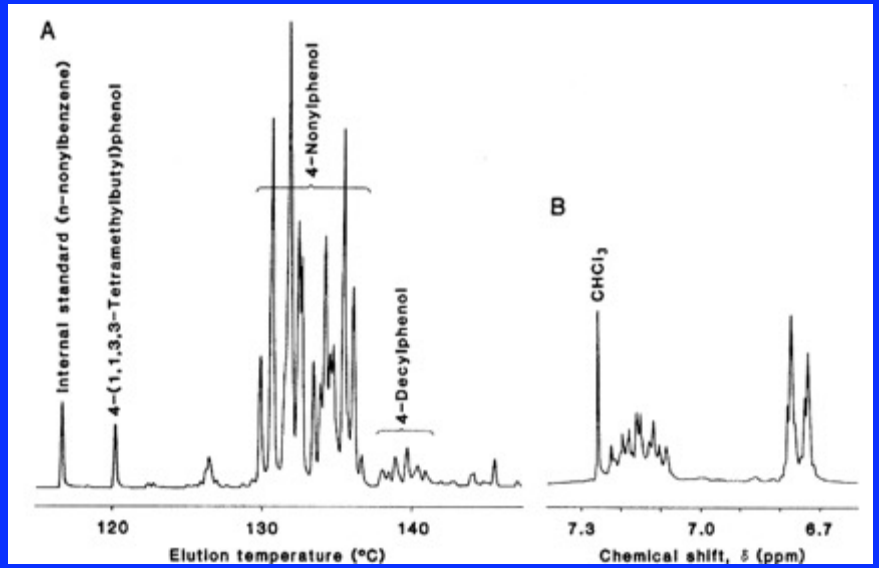
Peaks in science and life: looking back on 50 years of research on micropollutants

Walter Giger



Peaks in science and life: looking back on 50 years of research on micropollutants

- Title: adapted from Naomi Lubick, ES&T, Sep. 2008
- Professional phases in a scientist's career
- The unfairness of scientific awards
- Thanks to mentors, coworkers, colleagues
- Key role of progressing analytical methods
- Selected case stories
- Contaminant classes
- Environmental issues

Professional phases in a scientist's career

Position	*Research*	*Conferences*
graduate student postdoc	primary producer	poster
assistent/junior scientist	primary producer	oral presentation
senior scientist group leader	secondary producer consumer, herbivore	invited presentation scientific committee
department head	tertiary producer consumer, carnivore	plenary/keynote lecture
Retiree **Emeritus**	**Consultant** **Historic reviewer**	**Dinner/lunch talk** **Award lecture**

teachers

advisors

mentors

students

coworkers

colleagues

Members of the Giger Group 1972–2005

Martin Reinhard	1972 – 1976
Christian Schaffner	1972 – 2005
Fritz Zürcher	1972 – 1980
Lise-Marion Schlatter	1972 – 1975
Eva Molnar	1975 – 1978
	1980 – 1983
	1989 – 2005
Vlasta Drevenkar	1974 – 1975
Christina Müller	1975 – 1980
Robert Kummert	1975 – 1977
Jürg Meili	1975 – 1976
Stuart Wakeham	1976 – 1978
René Schwarzenbach	1977 – 1983
Jürg Schneider	1978 – 1981
	1983 – 1984
Richard Bromund	1980 – 1981
Euripides Stephanou	1980 – 1981
	1985, 1987
	1994/5
Kurt Schellenberg	1981 – 1982
Eduard Hoehn	1981 – 1982
Robert Coney	1981
Zelimira Vasilic	1981
Martin Jones	1981/2
Christian Leuenberger	1981 – 1983
	1984 – 1986
Marijan Ahel	1982 – 1983
	1984, 1990, 1997
Helga Ponusz	1983 – 1987
James Graydon	1983 – 1984
Mark Loosdrecht	1984
Yael Zelikovitz	1984
Hans Senn	1984
Antonio Marcomini	1985 – 1987
Fabiola Filipuzzi	1985 – 1986
James McEvoy	1985 – 1986
Josef Tremp	1985 – 1990
Jean Czuzwa	1985 – 1986
Paul Capel	1986 – 1987
Alfredo Alder	1986 – 2005
Steve McDow	1986 – 1988
Emily Heyerdahl	1986
Silvio Capri	1986
Gordon McFeters	1987 – 1988
Dea Renggli	1987
Daniel Baschnagel	1987,1988, 1999
Thomas Wechsler	1988 – 1989
André Chaperon	1988
Andri Caliesch	1988/9, 1990/1
Ken Hart	1989 – 1991
Esther Werth	1989, 1990
Sanja Fingler	1989 – 1990
Olaf Cirpka	1990
Claudia Müller	1990
Dagmar Krcmeryova	1990
David Scheidegger	1990 – 1995
Thomas Poiger	1990 – 1994
Franz Günter Kari	1991 – 1994
Marc Suter	1991 – 1999
Jean-Claude Sonderegger	1992
René Reiser	1992 – 1997
Jennifer Field	1992 – 1994
Tom Field	1992 – 1994
Beat Altenbach	1992 – 1996
Pilar Fernandez	1992 – 1993
Sabine Hilger	1992 – 1993
Adamantia Kampioti	1993
Heidi Toljander	1993 – 1994
Sabine Hilger	1994
Christian Eggenberger	1994
Margot Nölke	1994
Mauro Zanette	1994
Jean-Marc Stoll	1994 – 1997
Sonja Riediker	1994 – 1999
Carlo Kanz	1995 – 1996
Christa McArdell	1996 – 2005
Nina Schittli	1996 – 1997
Claudia Ruprecht	1997
Séverine Dédier	1997
Eva Golet	1997, 1998 – 2002
Barbara Horlacher	1998 – 1999
Sabine Ruckstuhl	1998 – 2001
Virginie Schwoerer	1998 – 2000
Andreas Hartmann	1998
Felix Wettstein	1999 – 2003
Slavica Ibric	1999 – 2001
Norriel Nipales	1999 – 2000
Franziska Pfister	2000 – 2004
Bettina Giger	2000
Valentin Lanz	2000
Christian Bachofen	2000
Anke Göbel	2001 – 2005
Elvira Keller	2001 – 2004
Paul Hartmann	2001 – 2004
Andrian Strehler	2001 – 2003
Irene Xifra	2001
Hong Anh Duong	2001
Holger Kuch	2001 – 2002
Claudia Sulitzky	2002 – 2003
Barabara Bago	2002
Frédéric Gabriel	2002 – 2005
Hajnalka Plüss-Csoka	2002 – 2003
Angela Thomsen	2003 – 2004
Ewa Felis	2003 – 2004
Quhangshu Zhai	2003 – 2004
Ngoc Anh Pham	2003 – 2004
Verena Schmid	2003 – 2005
Philipp Richle	2004 – 2005
Marco Zedda	2004
Andreas Heidlberger	2004
Dimitra Voutsa	2004/5
Ngoc Ha Pham	2004/5
Karin Ghilardi	2005
Niels Jonkers	2005
Andreas Buser	2005
Holger Lutze	2005
Hong Zhao	2005

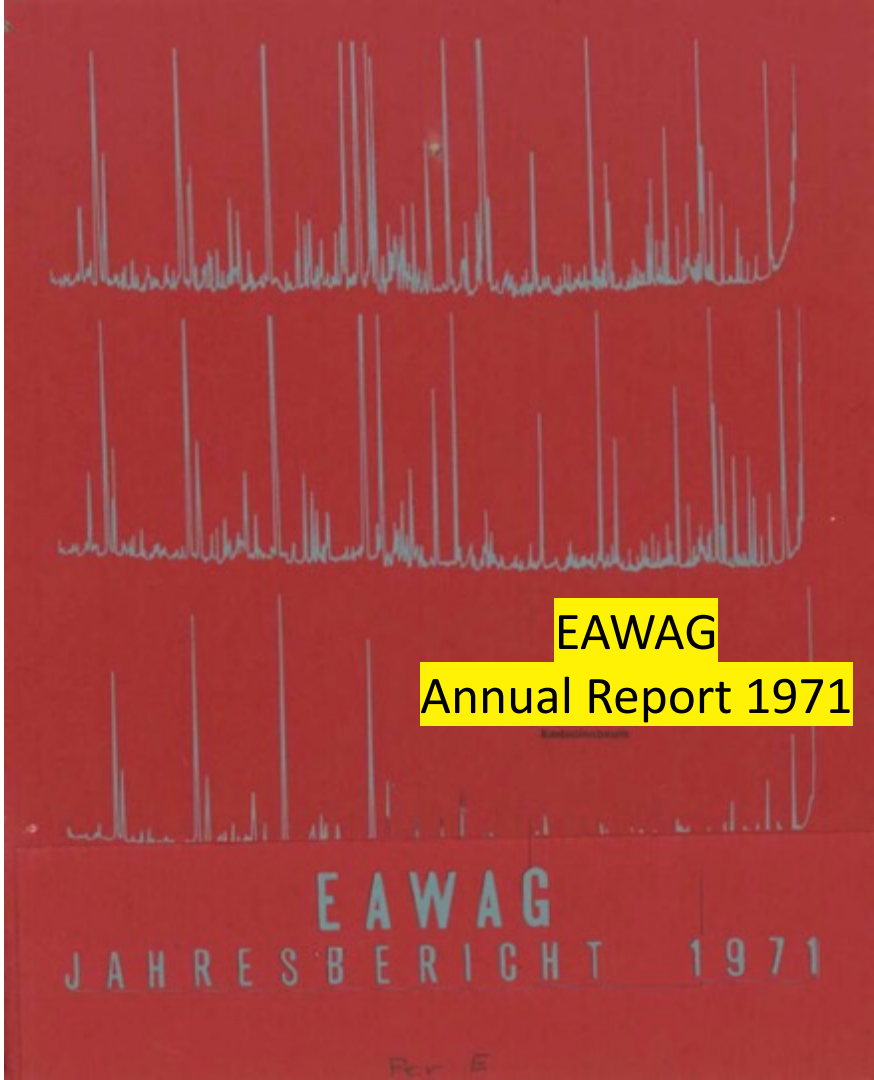
Werner Stumm

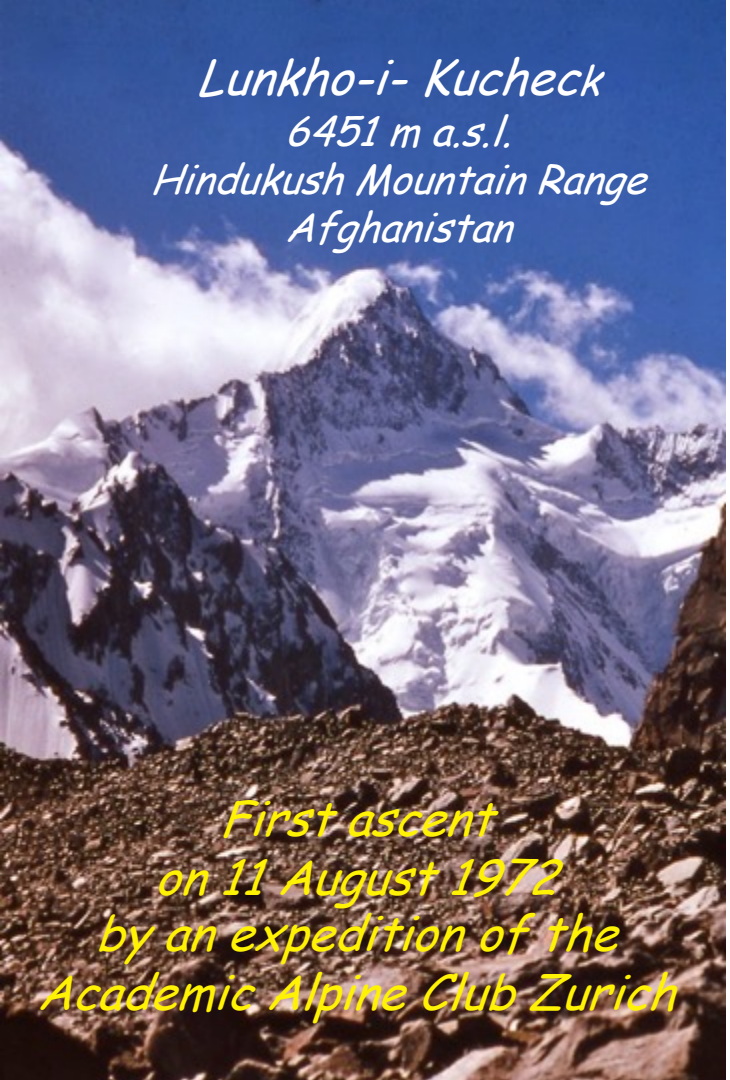
Since 1971
Director of Eawag

- **Vision**
  Eawag should become
  the Harvard of aquatic science and
  technology.

- **Young scientists and engineers**
  Bundi, Boller, Davis, Gächter, Gujer, Giger,
  Hohl, Hoigné, Imboden, Kavanaugh,
  Roberts, Schertenleib, Wasmer, Zobrist

- **Generosity**





Christian Schaffner
1972–2005

Martin Reinhard
1972–1976

Fritz Zürcher
1972–1980

ENVIRONMENTAL Science & Technology

Volume 8, Number 5, May 1974 455

Petroleum-Derived and Indigenous Hydrocarbons in Recent Sediments of Lake Zug, Switzerland

Walter Giger,[1] Martin Reinhard, Christian Schaffner, and Werner Stumm

Institute for Water Resources and Water Pollution Control,
Swiss Federal Institute of Technology, CH-8600 Dübendorf, Switzerland

■ Presented are hydrocarbon analyses of recent sediments from Lake Zug, Switzerland. The sediments near the densely populated northern shores of the lake contain large amounts of hydrocarbons, predominantly derived from fossil fuels; indigenous hydrocarbons, presumably derived from aquatic organisms, predominate in the middle part of the lake, adjacent to less densely populated areas.

Experimental

Samples of

Received for review July 9, 1973. Accepted November 1, 1973.

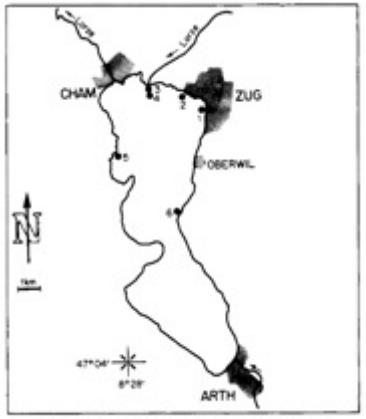


Figure 1. Lake Zug, locations of sampling stations

Table I. Organic Matter of Lake Zug Sediments Determined by Infrared Spectroscopy and Gas Chromatography

Station no.[a]	CCl_4 extractable, µg/g dry wt	Hydrocarbons, µg/g dry wt	n-$C_{17}H_{36}$/pristane	Pristane/phytane
1	2350	900	1.8	0.8
2	1590[b]	610[b]	1.0	1.0
3	570	240	2.8	1.0
4	2470	860	2.0	1.3
5	1010[b]	140[b]	[c]	[c]
6	300	50	[c]	[c]

Aliphatic hydrocarbons: n-alkanes, pristane, phytane

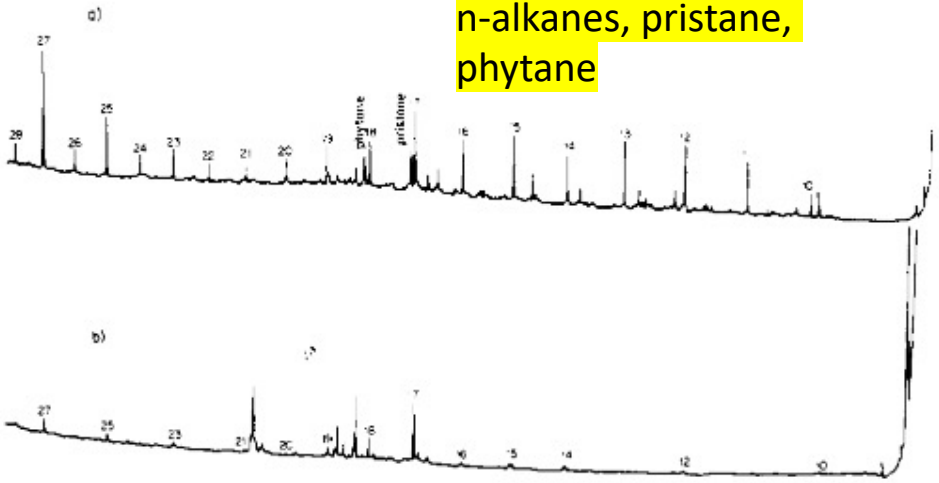


Figure 2. Gas chromatograms of sediment extracts
a. Station 4. b. Station 6. Numbers indicate carbon numbers of *n*-alkanes

Source recognition:
- petroleum-derived - motorboats - biogenic

Max Blumer

Woods Hole Oceanographic Institution WHOI

Polycyclic Aromatic Hydrocarbons in the Environment: Isolation and Characterization by Chromatography, Visible, Ultraviolet, and Mass Spectrometry

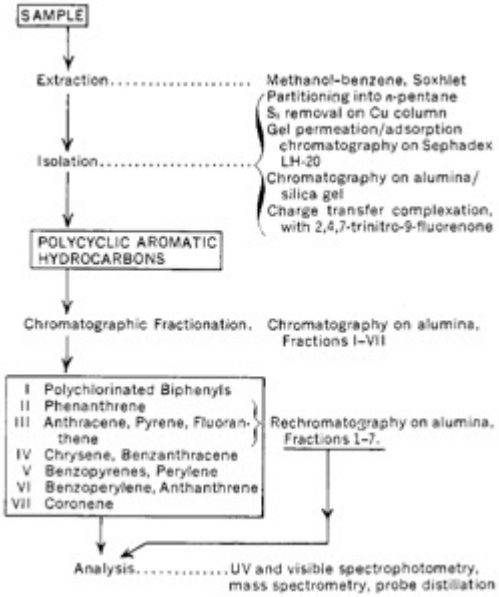
Walter Giger[1] and Max Blumer[2]

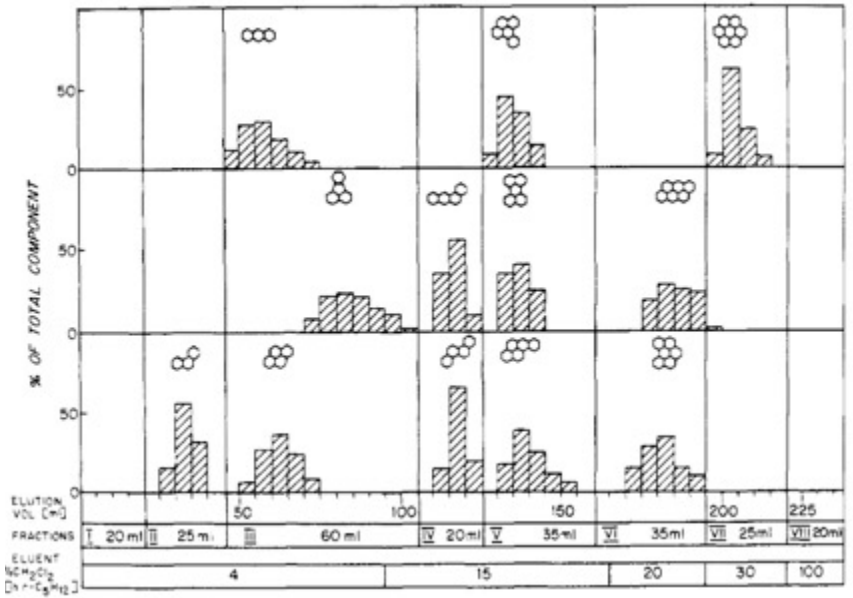
Woods Hole Oceanographic Institution, Woods Hole,

3-7 ring PAH: parent compounds and alkylated homologues

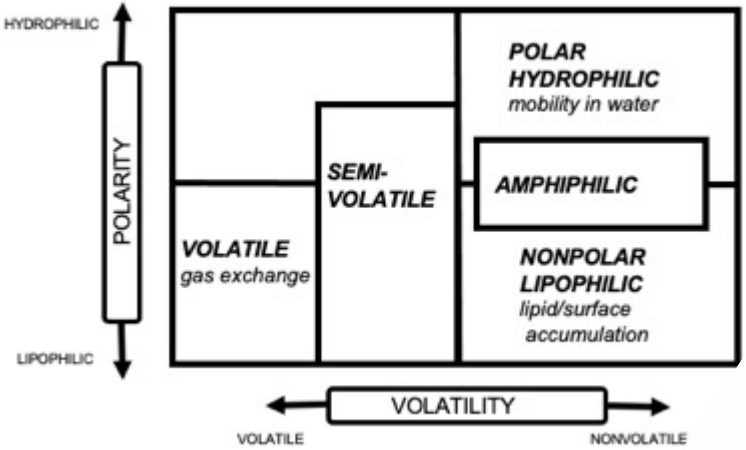
Side product: PCBs in recent sediments of New Bedford Harbour

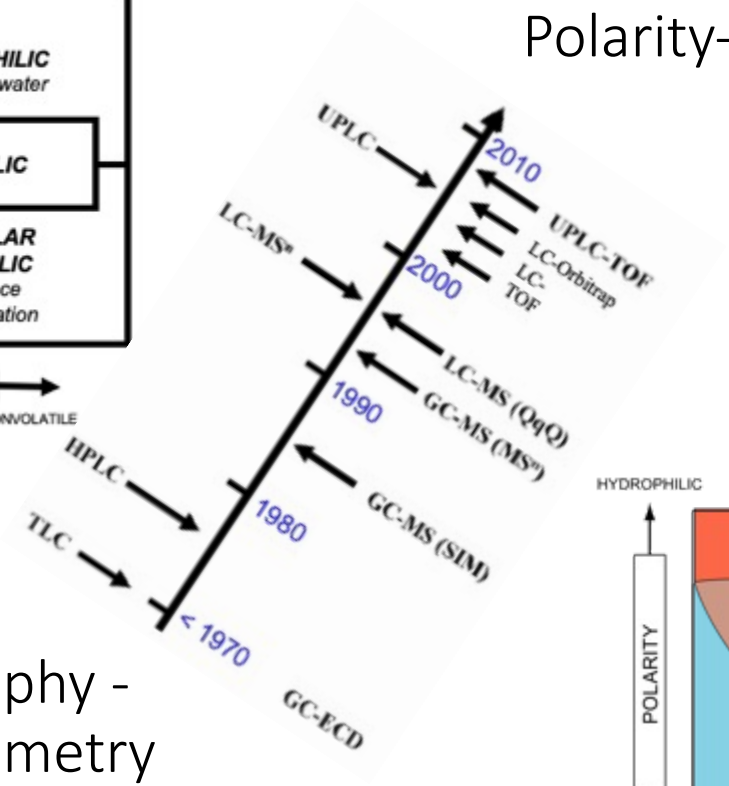
ANALYTICAL CHEMISTRY, VOL. 46, NO. 12, OCTOBER 1974 • 1663

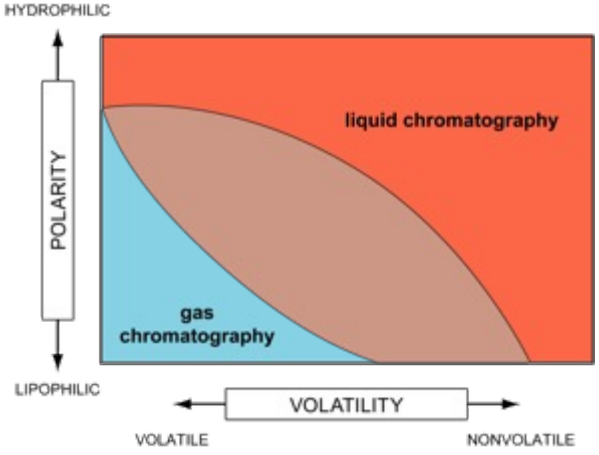




Polarity-volatility diagrams







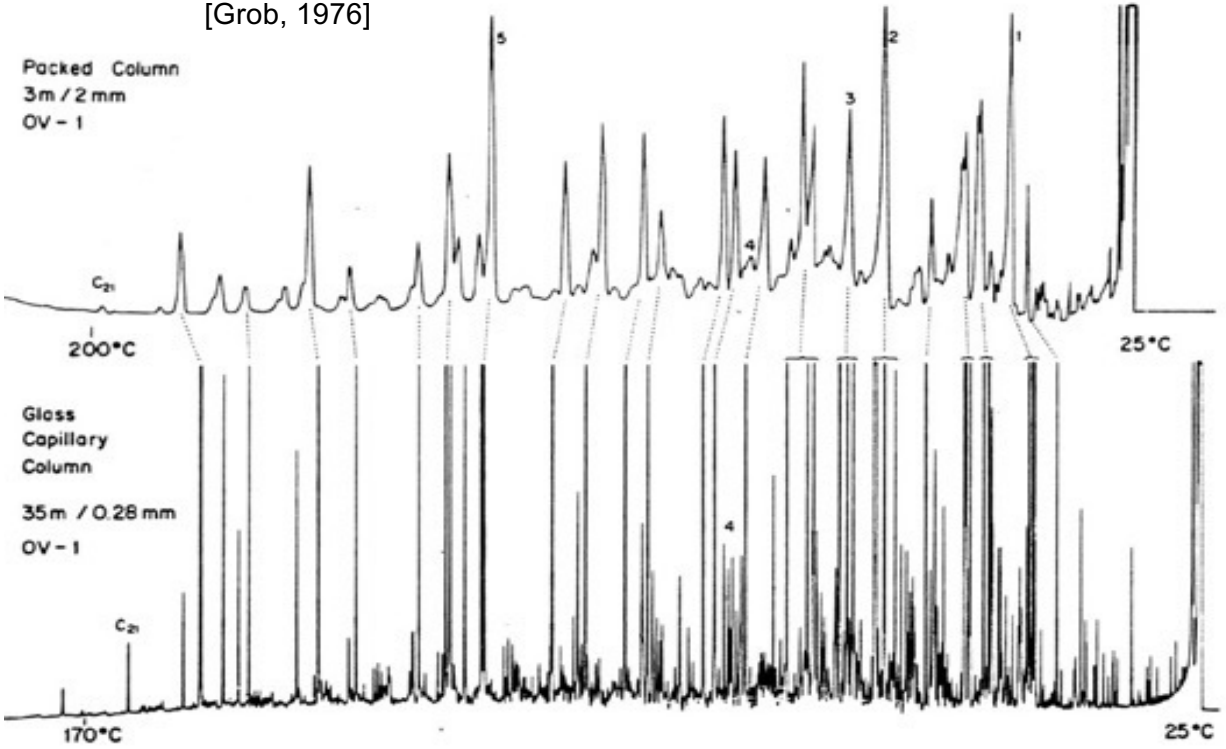
Chromatography - mass spectrometry

modified from De Brabander et al. J. Chromatogr. A 2009

Kurt Grob

High-resolution gas chromatography with glass capillaries

[Grob, 1976]



Extract of a water sample from the Glatt River near Zurich, Switzerland

Greifensee
with partial panorama of the Swiss Alps

Freeze core of Greifensee sediments

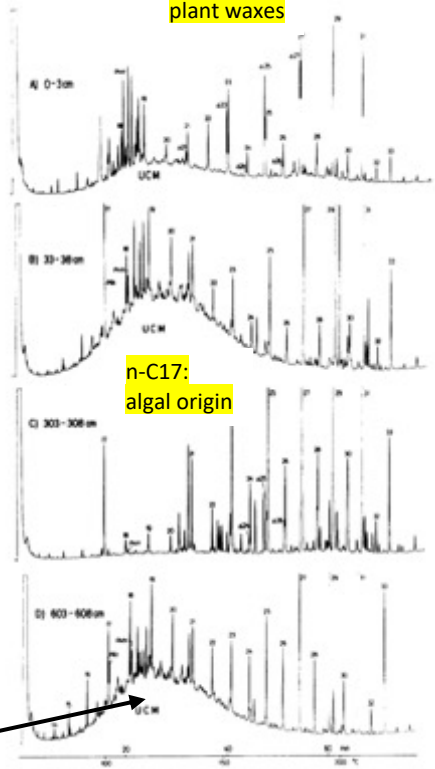
Geochimica et Cosmochimica Acta
Volume 44, Issue 1, January 1980, Pages 119-129

Aliphatic and olefinic hydrocarbons in recent sediments of Greifensee, Switzerland

Odd>even n-alkanes:
plant waxes

n-C17:
algal origin

UCM:
unresolved
complex mixture

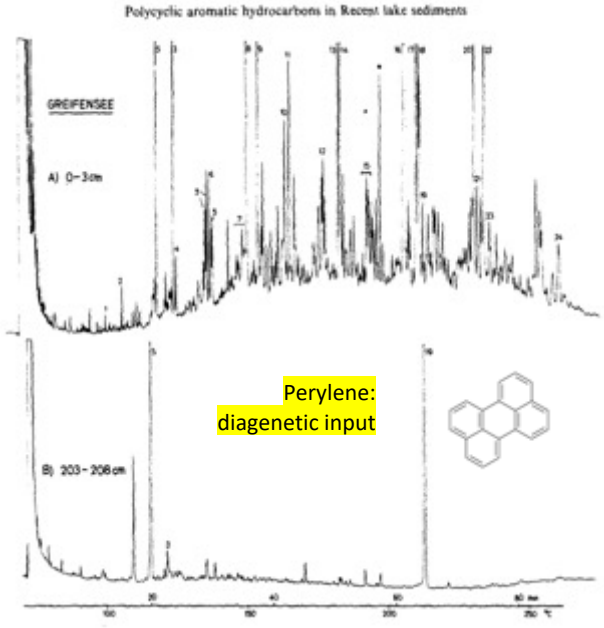


Geochimica et Cosmochimica Acta
Volume 44, Issue 3, March 1980, Pages 403-413

Polycyclic aromatic hydrocarbons in Recent lake sediments—I. Compounds having anthropogenic origins

Geochimica et Cosmochimica Acta
Volume 44, Issue 3, March 1980, Pages 415-429

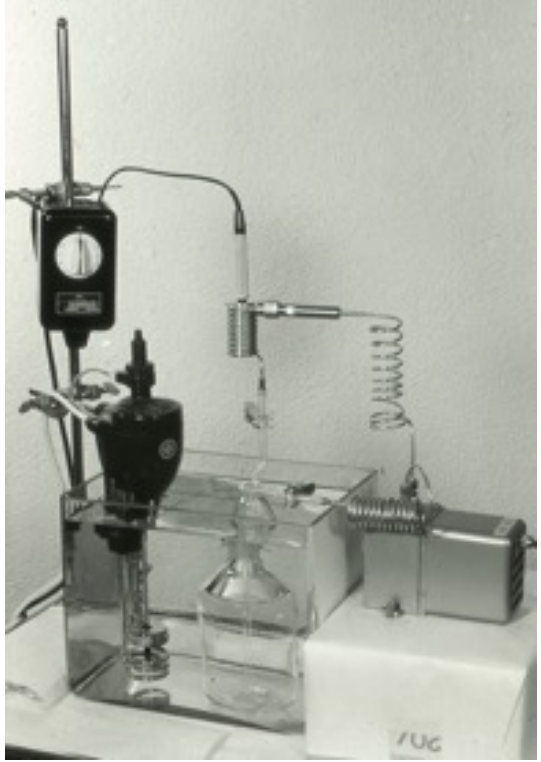
Poly cyclic aromatic hydrocarbons in Recent lake sediments—II. Compounds derived from biogenic precursors during early diagenesis



Perylene:
diagenetic input

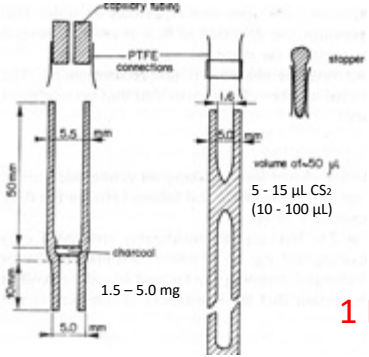
Stuart Wakeham
1976-1978

Denali / Mount McKinley
6194 m a.s.l., Alaska, USA,
1979



Coopération européenne scientifique et technique, ***Cost 64b*** *Analysis of organic micropollutants in water 1972-1983*

Closed-loop gaseous stripping (CLSA)



1 L H_2O → 5 µL CS_2

Fritz Zürcher
1972-1980

Jim Graydon
1983-1984

Journal of Chromatography, 117 (1976) 285–294

STRIPPING OF TRACE ORGANIC SUBSTANCES FROM WATER
EQUIPMENT AND PROCEDURE

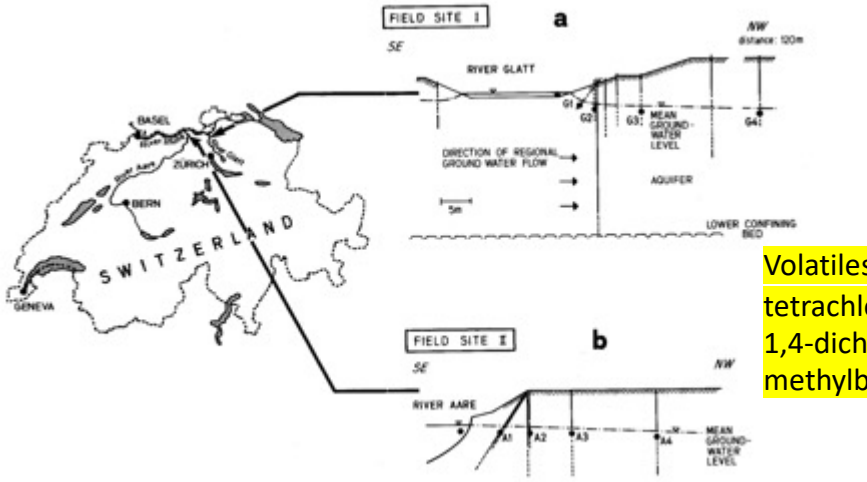
K. GROB and F. ZÜRCHER

Journal of Chromatography, 285 (1984) 307–318

DETERMINATION OF HIGHLY VOLATILE ORGANIC CONTAMINANTS IN WATER BY THE CLOSED-LOOP GASEOUS STRIPPING TECHNIQUE FOLLOWED BY THERMAL DESORPTION OF THE ACTIVATED CARBON FILTERS

J. W. GRAYDON*, K. GROB, F. ZUERCHER and W. GIGER*

Infiltration from river into groundwater



Volatiles:
tetrachloroethylene,
1,4-dichlorobenzene,
methylbenzenes

Eva Molnar
1975–2006

René Schwarzenbach
1977–1983

Edi Hoehn
1975–2006

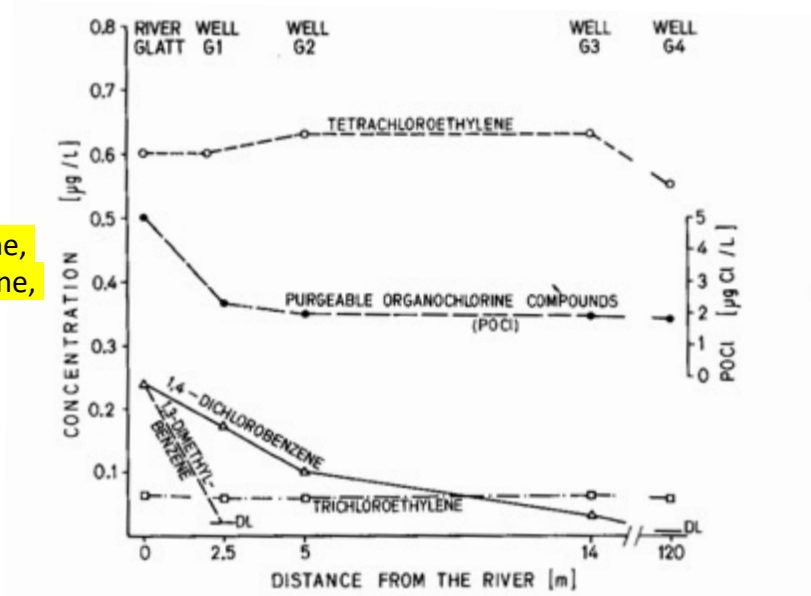


Figure 4. Field site I: average concentrations of selected organic micropollutants in the River Glatt and in the upper layers of the groundwater at various distances from the river (DL = detection limit).

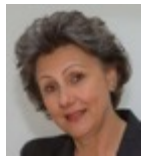
Swiss National Science Foundatio n National Research Programme ***NRP 2***
«Fundamental Problems of the Swiss Hydrologic Cycle»
Programme Part B: Quantitative and qualitative aspects of groundwater supply" – development of methods to determine the productivity of groundwater sources and to record changes in quality as a result of infiltration processes. 1982-1985

Water Research Vol. 15. pp. 1271 to 1279. 1981

TRANSFER OF VOLATILE SUBSTANCES FROM WATER TO THE ATMOSPHERE

CHRISTINE MATTER-MÜLLER, WILLI GUJER and WALTER GIGER

Willi Gujer



Christine Matter-Müller 1975-1977

Water Res. Vol. 18. No. 12. pp. 1515–1522. 1984

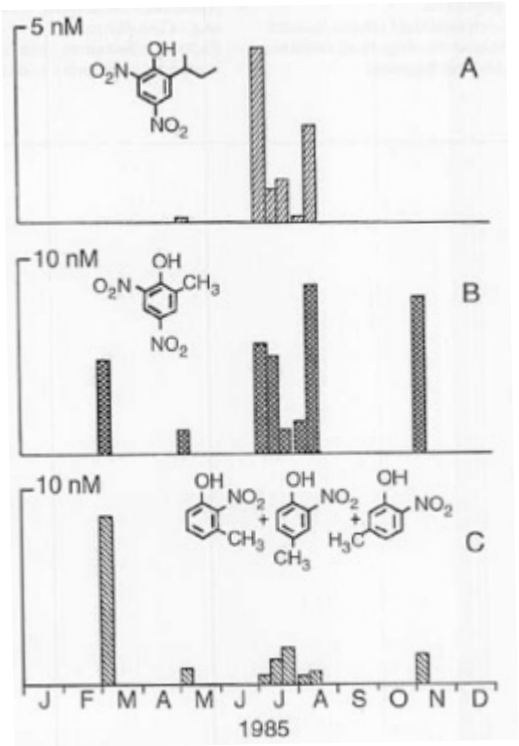
ANALYTICAL FRACTIONATION OF DISSOLVED ORGANIC MATTER IN WATER USING ON-LINE CARBON DETECTION

J. K. SCHNEIDER, R. GLOOR, W. GIGER and R. P. SCHWARZENBACH

Rolf Gloor

Jürg Schneider 1978-1981, 1983/4

Organic contaminants in atmospheric deposition

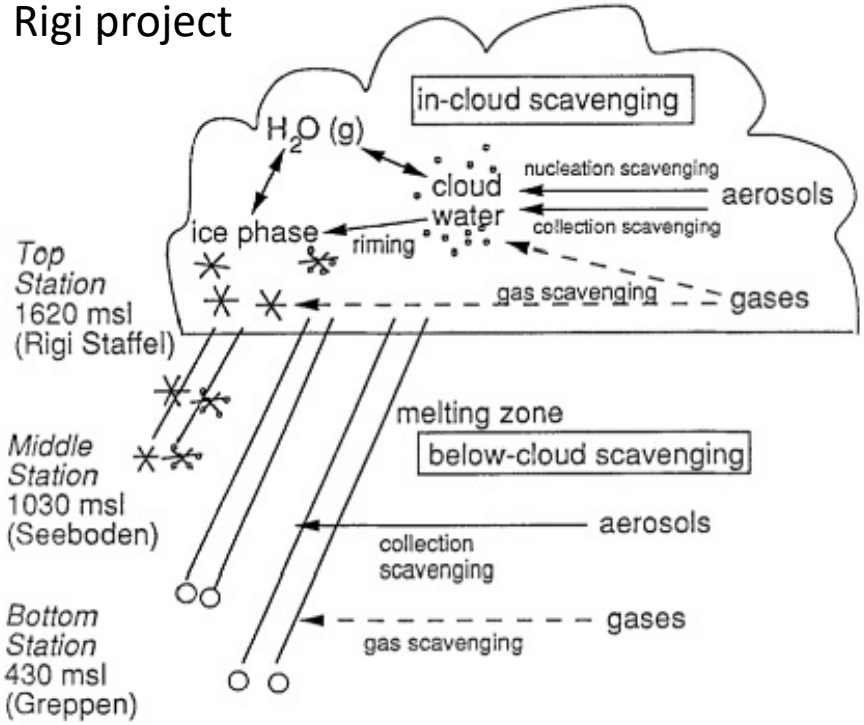


polycyclic aromatic hydrocarbons, alkanes, methylbenzenes phenols, nitrophenols

Christian Leuenberger
1981-1983, 1984-1986

Josef Tremp
1985-1990

Rigi project

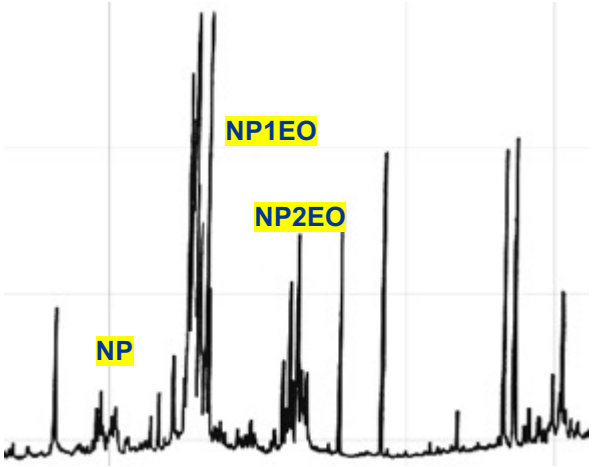


- **NRP 14** «Circulation and Pollution of air and forest damage in Switzerland», 1980 - 1990

- ETHZ Project „Wasser Boden Luft“ **WaBoLu,** Pollution in the air and the effect on water and soil ecosystems, 1985-1989

Gas chromatogram of an extract of a secondary sewage effluent, 1980

Euripides Stephanou
1980/1981, 1985, 1987, 1994/95



Stephanou, Schaffner, Giger et al., *EST*, 1981

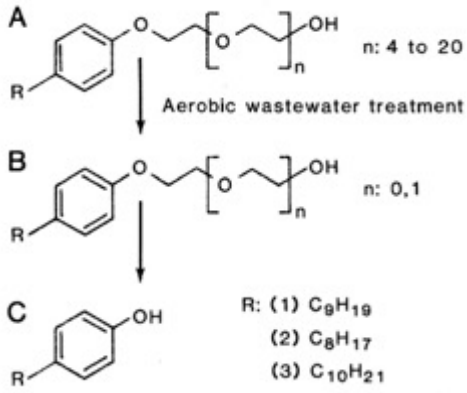


Table III. Toxicity to Aquatic Fauna of Nonylphenol Polyethoxylates and Nonylphenols

nonylphenol polyethoxylates[a]	no effect level, mg/L			
	Pseudomonas	*Scendesmus*	*Colpoda*	*Daphnia*
30	1000	5000	250	>10000
20	1000	125	250	1000
10	1000	31	31	10
7	63-500	16	31	10
6	500	10	16	5
4	50	6	5	5

	lethal thresholds (96 h, LC_{50}), mg/L			
	shrimp	salmon	fingerling rainbow trout	fingerling brook trout
nonylphenol	0.30	0.13-0.19	0.230	0.145

[a] Average number of oxyethylene groups.

Table II. Concentrations of Nonylphenols and Nonylphenol Ethoxylates in Secondary Sewage Effluents

sewage treatment plant	concn, μg/L[a]				DOC, mg C/L[b]	rel amt, %[c]	no. of determinations
	NP	NP1	NP2	total			
Dübendorf	10-35	83-133	13-70	78-202	6.4-12.9	0.6-2.3	9
Opfikon	nd-17	70-133	31-67	137-181	5.0-15.1	0.8-2.1	2
Zürich	10-23	24-52	nd-50	36-125	4.6-6.3	0.5-2.1	3
Bülach	nd	nd	nd	nd	5.4-6.2	nd	3
Fällanden					5.4-7.2		3
Niederglatt					3.2		1

[a] nd: not determinable, i.e., below detection limit of 10 μg/L. [b] DOC: dissolved organic carbon. [c] Sum of NP, NP1, and NP2 calculated as percentage of DOC.

SCIENCE 10 August 1984, Volume 225, pp. 623–625

4-Nonylphenol in Sewage Sludge: Accumulation of Toxic Metabolites from Nonionic Surfactants

Walter Giger, Paul H. Brunner, and Christian Schaffner

Marijan Ahel Christian Schaffner Walter Giger

Paul Brunner

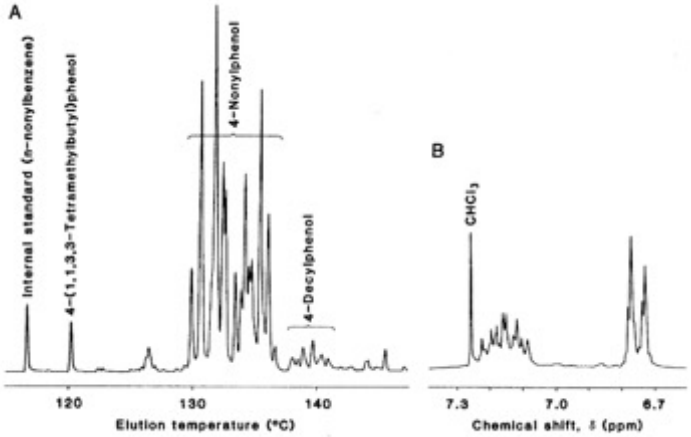
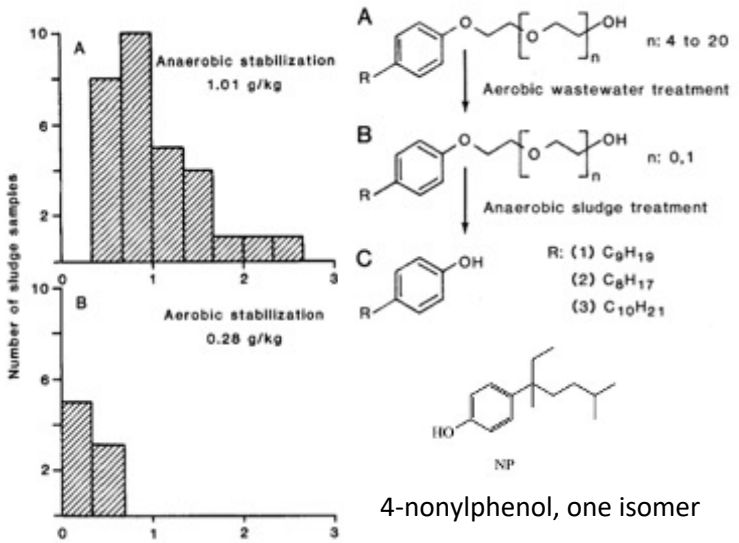
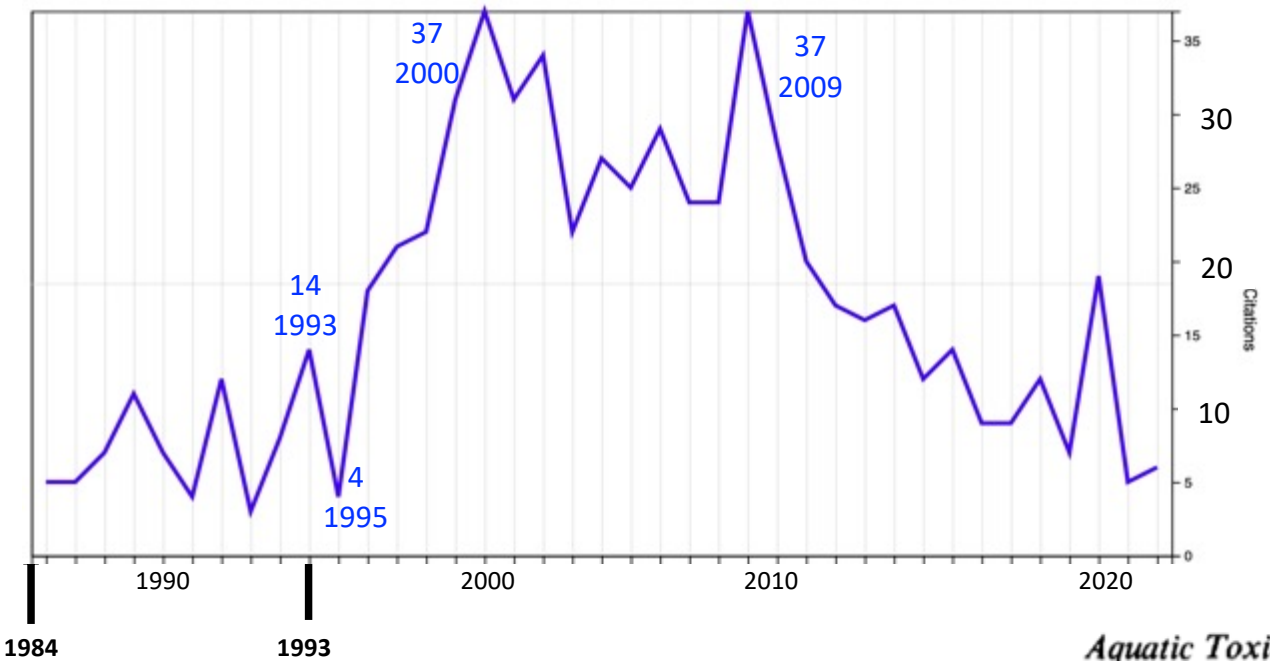


Fig. 2. Partial gas chromatogram (A) and proton NMR spectrum (B) of an extract of anaerobically treated sewage sludge.



4-nonylphenol, one isomer



John Sumpter

Susan Jobling

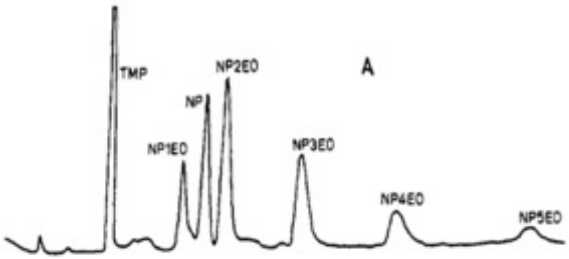
Aquatic Toxicology, 27 (1993) 361–372

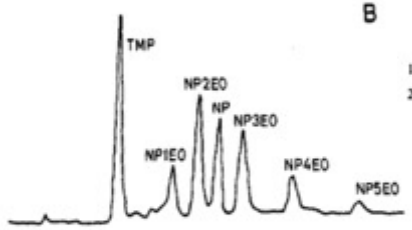
- EU program **COMPREHEND** "Endocrine Disruptors and Hormonally Active Chemicals in the Environment" 1999-2001

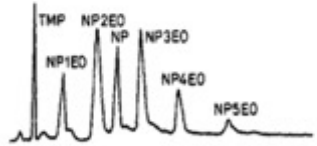
- **NRP 50** Endocrine Disruptors: Relevance to Humans, Animals and Ecosystems 2002-2007

Detergent components in sewage effluent are weakly oestrogenic to fish: An in vitro study using rainbow trout (*Oncorhynchus mykiss*) hepatocytes

S. Jobling and J.P. Sumpter







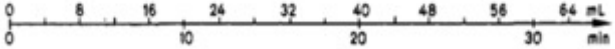


Figure 2. Normal-phase high-performance liquid chromatograms of reference mixtures containing Marlophen 83, technical 4-nonylphenol, and 2,4,6-trimethylphenol. Three different aminosilica columns (A, B, and C) were used as described in the text. A and B: Lichrosorb–NH_2, irregularly shaped 10 μm, 250 mm × 4.6 mm i.d.. C: Hypersil APS, spherical 3 μm, 60 mm × 4 mm i.d.. NP: 4-nonylphenol, NP1EO–NP5EO: 4-nonylphenol monoethoxylate to 4-nonylphenol pentaethoxylate, TMP: 2,4,6-trimethylphenol.

ELSEVIER

Water Research
Volume 28, Issue 5, May 1994, Pages 1131-1142

Behaviour of alkylphenol polyethoxylate surfactants in the aquatic environment—I. Occurrence and transformation in sewage treatment

MARIJAN AHEL[1]*, WALTER GIGER[2] and MARKUS KOCH[3]

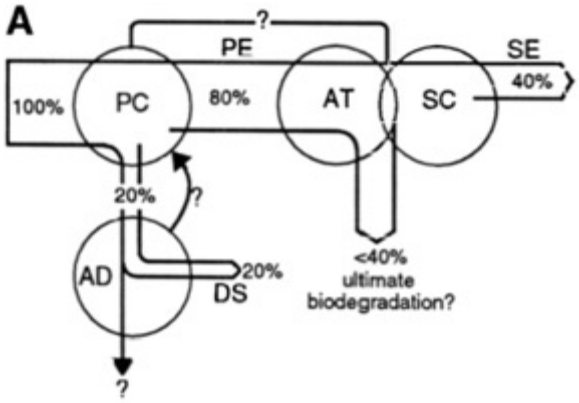
[1]Center for Marine Research Zagreb, Rudjer Bošković Institute, P.O. Box 1016, 41001 Zagreb, Croatia,
[2]Swiss Federal Institute for Environmental Science and Technology (EAWAG), CH-8600 Dübendorf and
[3]Control Laboratory, Department of Water Pollution Control, CH-8005 Zürich, Switzerland

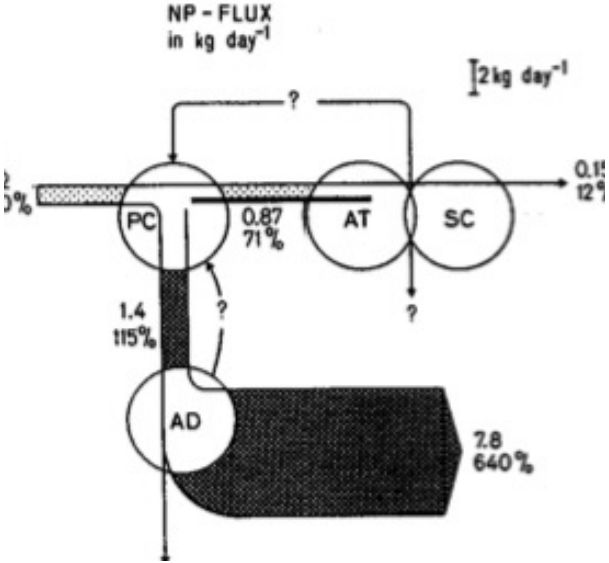
Marijan Ahel

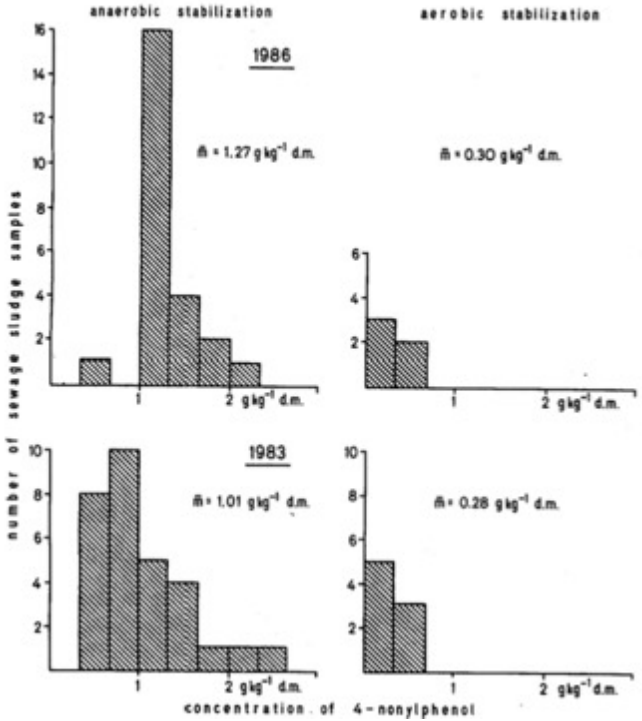
1982/83, 1884, 1990, 1997

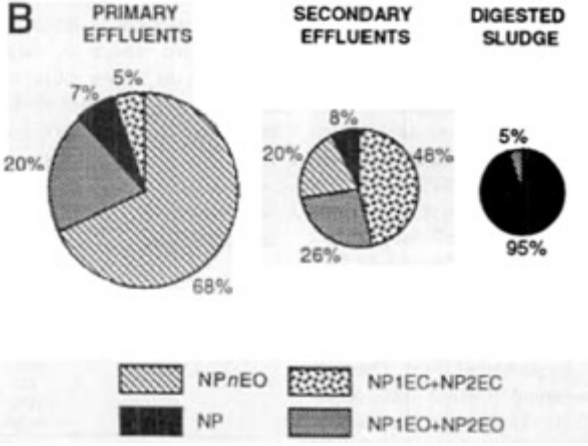
Markus Koch
Canton Zurich

Ph. D. Thesis, University of Zagreb, 1987,
1985-2000: 17 scientific articles,
>2670 times cited







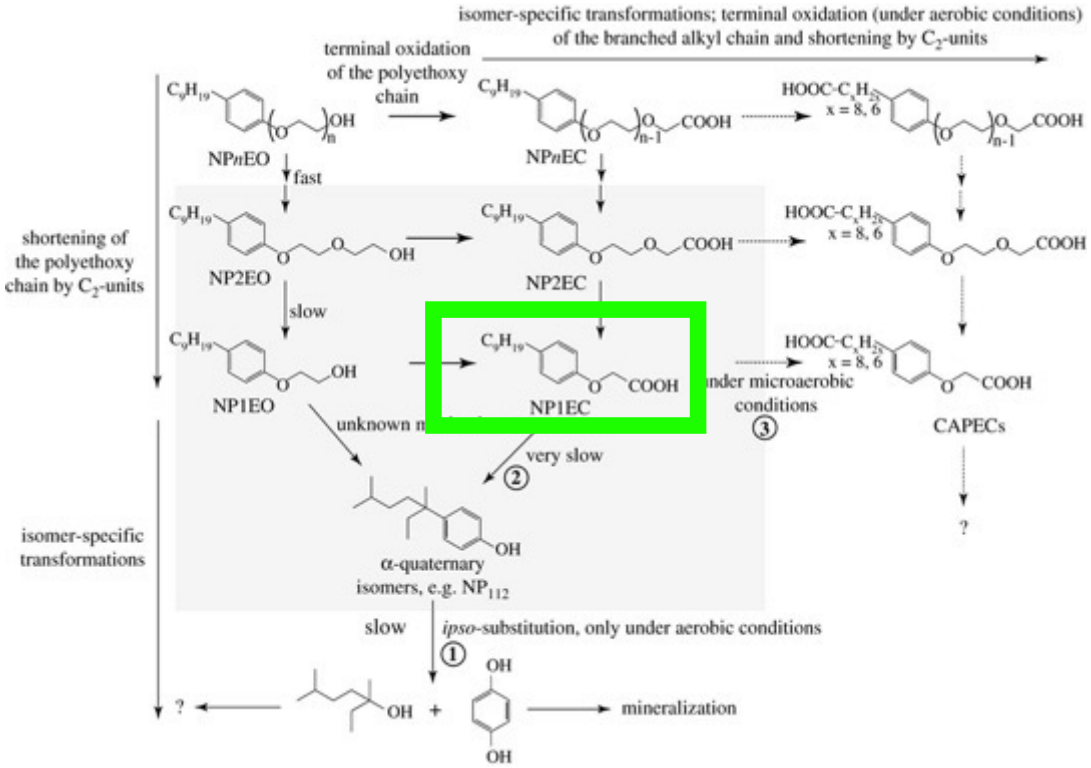


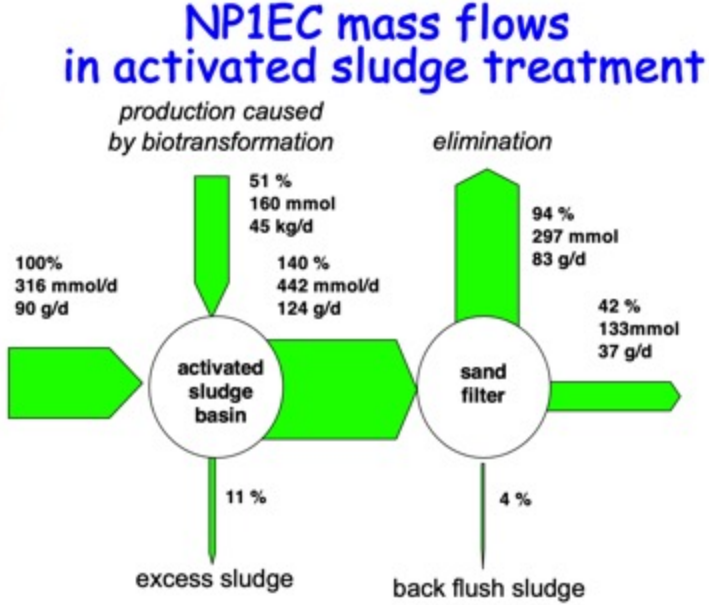
NRP 07 "Problems of raw and other materials"
Programme Part D "Sewage sludge" 1982-1985

Hans-Peter Kohler

Frédéric Gabriel 2002-2007

Felix Wettstein 2003-2005





Environmental Pollution 157 (2009) 714–723

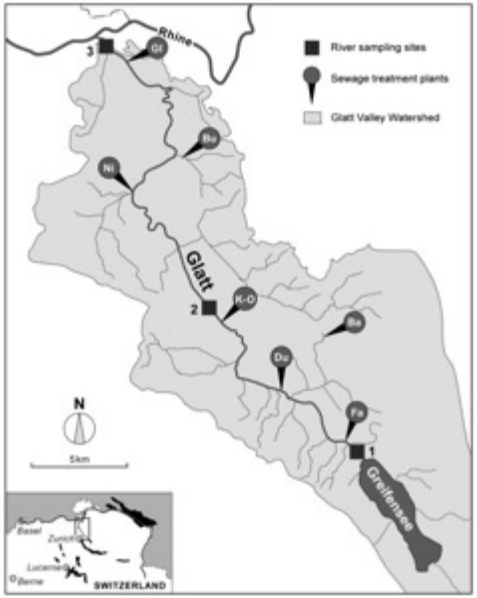
Niels Jonkers
2003-2005

Mass flows of endocrine disruptors in the Glatt River during varying weather conditions

Niels Jonkers [1], Hans-Peter E. Kohler, Anna Dammshäuser, Walter Giger*

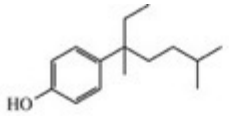
Eawag, Swiss Federal Institute of Aquatic Science and Technology, 8600 Duebendorf, Switzerland

Mass balance of endocrine disruptors in a wastewater-river system is strongly influenced by water flow condition

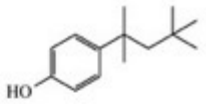


Phenolic endocrine disrupting compounds (EDCs) including parabens, alkylphenolic compounds, phenylphenol (PhP) and bisphenol A (BPA).

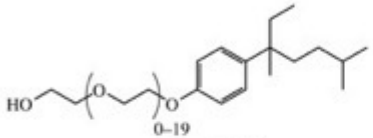
- solid-phase-extraction and LC-MS/MS techniques
- influents and effluents of wastewater treatment plants (WWTPs) and river water samples.
- mass flow analysis provided insight into the main sources and the fate of these contaminants during different weather conditions.



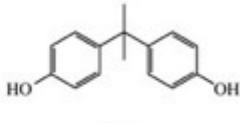
NP



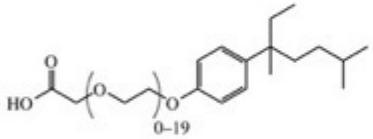
OP



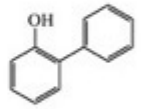
NPnEO



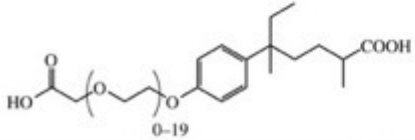
BPA



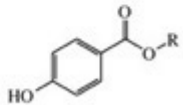
nonylphenol ((poly)ethoxy)acetic acids (NPnEC)



ortho-phenylphenol (PhP)



carboxyoctylphenol ((poly)ethoxy)acetic acids (CAPnEC)



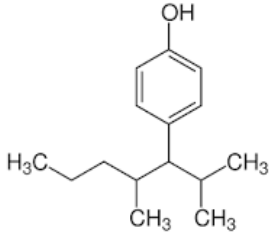
parabens

R = CH_3, C_2H_5, C_3H_7, C_4H_9, $CH_2C_6H_6$

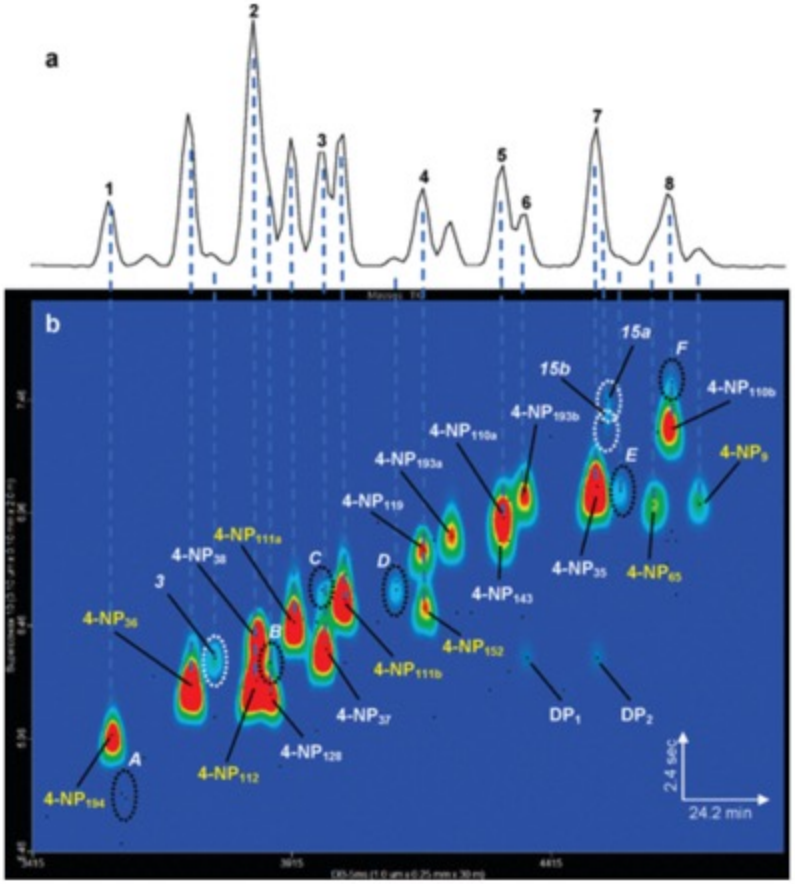
Environ. Sci. Technol. 2009 43, 9306–9313

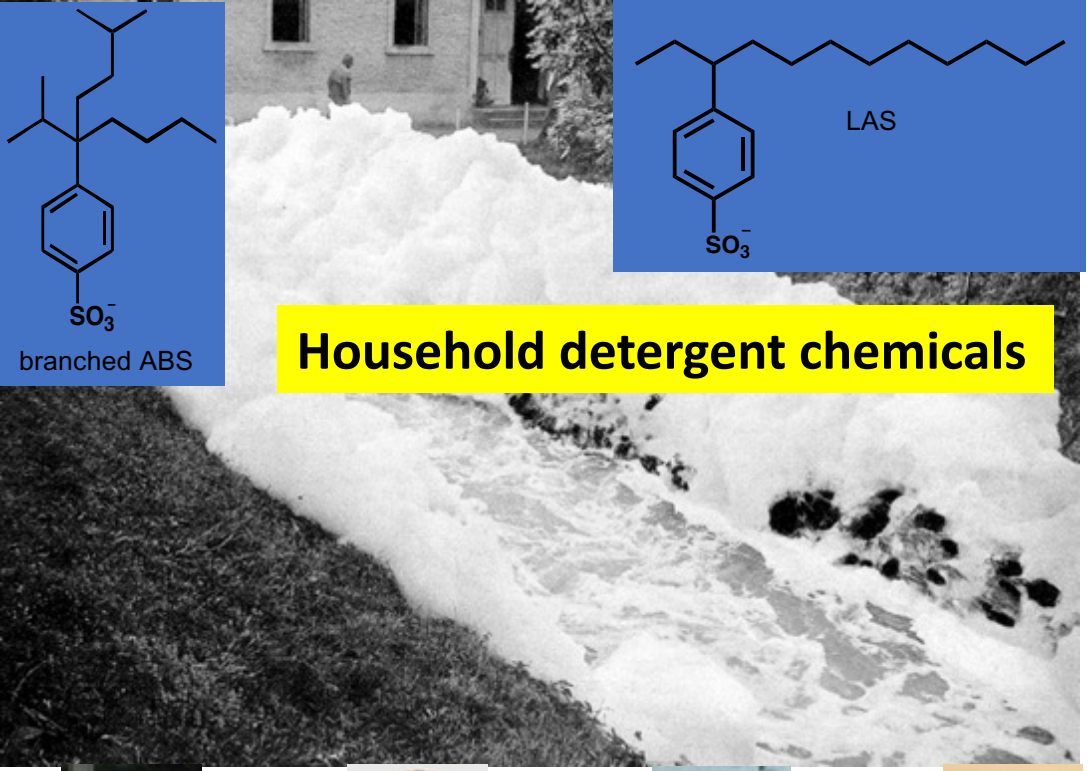
Isomer-Specific Determination of 4-Nonylphenols Using Comprehensive Two-Dimensional Gas Chromatography/Time-of-Flight Mass Spectrometry

ROBERT P. EGANHOUSE,*,†
JAMES PONTOLILLO,†
RICHARD B. GAINES,‡
GLENN S. FRYSINGER,‡
FRÉDÉRIC L. P. GABRIEL,§
HANS-PETER E. KOHLER,§
WALTER GIGER,§ AND LARRY B. BARBER⊥



Bob Eganhouse
USGS



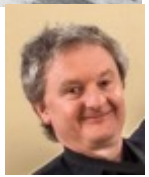


- NPnEO, NP1EO, NP2EO, NP
- NP1EC, NP2EC
- tert-OP
- AnEO
- LAS, ABS
- SAS
- DTDMAC
- NTA, EDTA
- fluorescent whitening agents

Alfredo Alder
1986-2005

Marc Suter
1991-2005

David Scheidegger
1990-1995



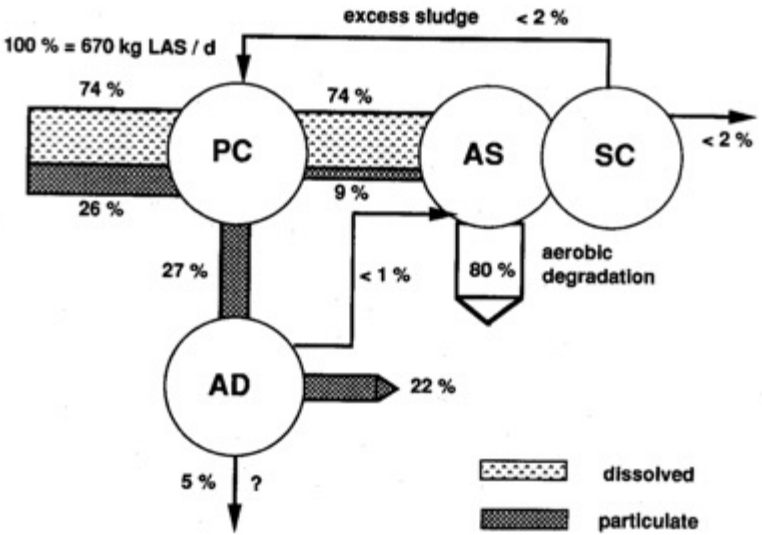
Franz Günter Kari
1991-1994

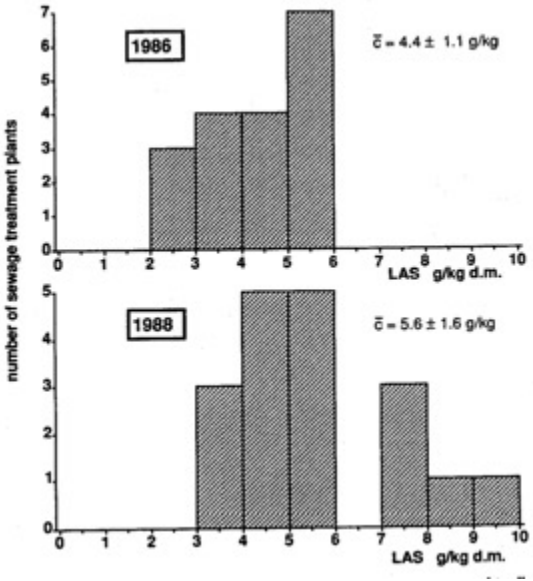
Pilar Fernandez
1992-1993

Wat. Res. Vol. 22, No. 12, pp. 1465–1472, 1988

OCCURRENCE AND BEHAVIOUR OF LINEAR ALKYLBENZENESULPHONATES, NONYLPHENOL, NONYLPHENOL MONO- AND NONYLPHENOL DIETHOXYLATES IN SEWAGE AND SEWAGE SLUDGE TREATMENT

PAUL H. BRUNNER, SILVIO CAPRI*, ANTONIO MARCOMINI† and WALTER GIGER





Antonio Marcomini
1985–1987

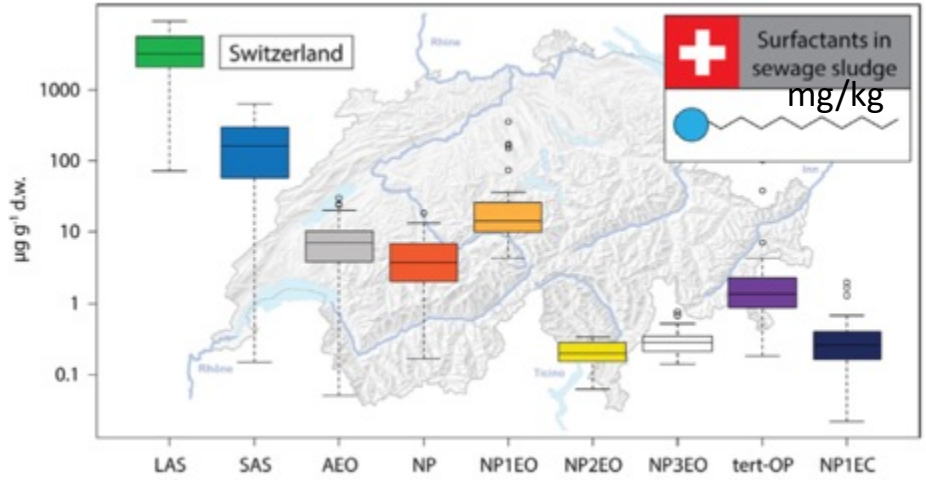
Lena Schinkel

Science of the Total Environment 808 (2022) 151361

Synthetic surfactants in Swiss sewage sludges: Analytical challenges, concentrations and per capita loads

Lena Schinkel [a,*], Pablo A. Lara-Martín [b], Walter Giger [c], Juliane Hollender [a,d], Michael Berg [a,*]

Pablo Lara-Martín



- Swiss Federal Office of the Environment (FOEN) Project SludgeWatch 2018-2023
- Spanish Ministry of Science, Innovation and Universities

Pablo A. Lara-Martín, et al., in preparation. Suspect and nontarget screening of organic pollutants in Swiss sludge: a national survey

Weighted mean (WM) surfactant concentrations in sewage sludge of the 36 studied wastewater treatment plants, the average per capita loads, and the total daily loads in sewage sludge extrapolated for the entire country of Switzerland.

	LAS	SAS	AEO	NP	NPEO	NP1EC	*tert*-OP
WM conc. in sewage sludge (µg g^{-1} d.w.)	3700	190	8.30	3.1	62 (16)[a]	0.35	3.8 (1.8)[b]
Average per capita load in sludge (mg day^{-1} $capita^{-1}$)	380	18	1.4	0.4	5.2 (1.8)[a]	0.03	0.51 (0.17)[b]
Total daily load of Switzerland (in sludge)	3.04 t	0.16 t	6.8 kg	2.6 kg	51 kg (13 kg)[a]	0.29 kg	3.1 kg (1.4 kg)[b]

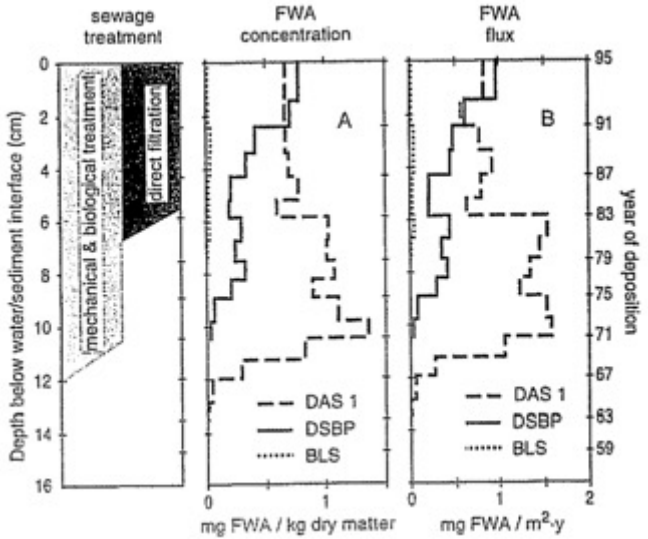
Stoll, J. M. A.; Poiger, T. F.; Lotter, A. F.; Sturm, M.; Giger, W.,

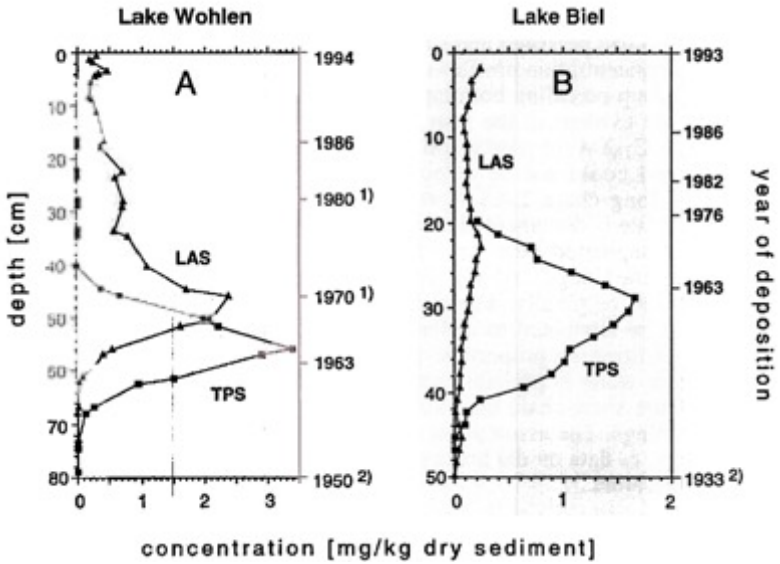
Fluorescent whitening agents as molecular markers for domestic wastewater in Recent sediments of Greifensee, Switzerland.

Reiser, R.; Toljander; Albrecht A.; Giger, W.,

Alkylbenzenesulfonates as molecular markers for the environmental behavior of detergent-derived chemicals.

In Molecular Markers in Environmental Geochemistry,
Eganhouse, R. B., Ed. 1997; Vol. *671*, pp 231-241 and 196-212.





Thomas Poiger
1990-1994

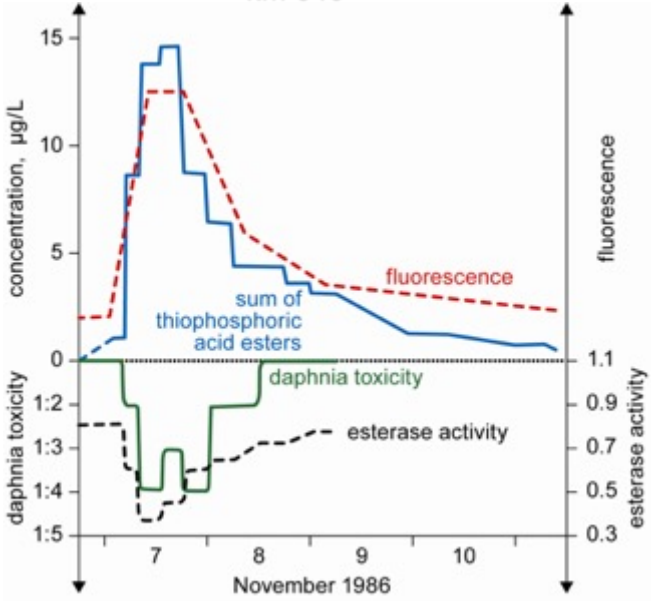
Jean-Marc Stoll
1994-1997

René Reiser
1992-1997

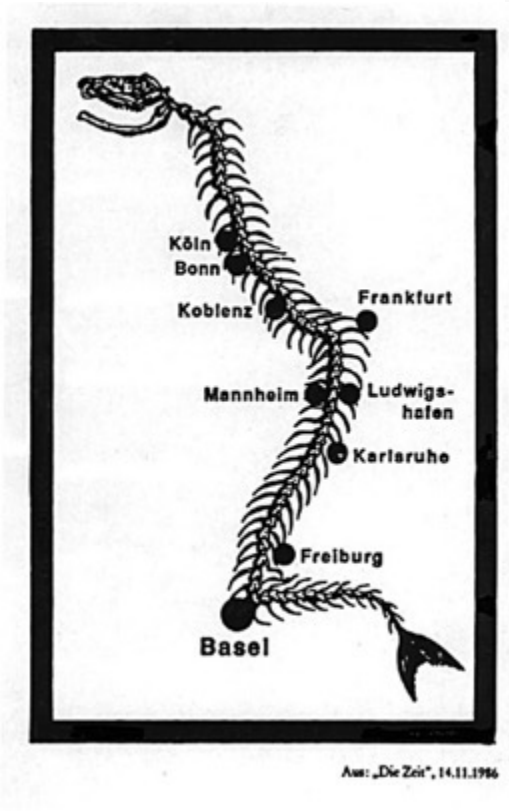
Schweizerhalle/Sandoz, 1986

The “Sandoz wave”

Bad Honnef
km 640



Giger, *ESPR* (2008)



Paul Capel
1986-1987

ES&T
FEATURE

Accidental input of pesticides into the Rhine River

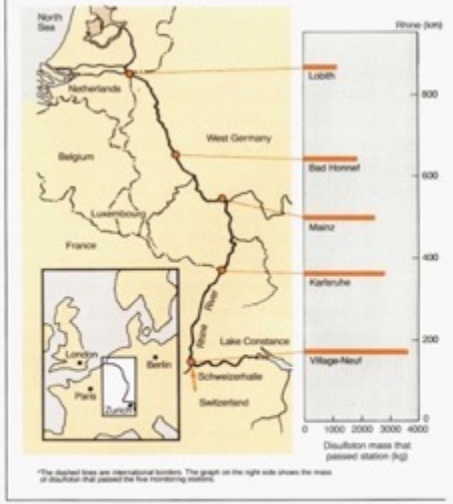
Environmental impact and behavior of pollutants discharged during a chemical storehouse fire

Paul D. Capel
U.S. Geological Survey
St. Paul, MN 55101

Walter Giger
Peter Reichert
Oskar Wanner
Swiss Federal Institute for Water Resources and Water Pollution Control (EAWAG)
CH-8600 Dübendorf, Switzerland

The Nov. 1, 1986, fire at a Sandoz Ltd. storehouse at Schweizerhalle, an industrial area near Basel, Switzerland, resulted in chemical contamination of the atmosphere, the surrounding soils, and the Rhine River. The chemicals discharged into the Rhine caused massive kills of benthic organisms and fish (*1*, *2*). The 90 × 50-m storehouse, which was completely destroyed by the fire, contained pesticides (Table 1), solvents, dyes, and various raw and intermediate materials. The majority of the more than 1300 metric tons of stored chemicals (*3*) was destroyed in the fire, but large quantities were introduced into the atmosphere, into the Rhine River through runoff of the fire-fighting water, and into the soil and groundwater at the site. Public and private reaction to the fire and subsequent chemical spill was strong. Even though this was “one of the worst chemical spills ever” (*4*), the nature of the chemicals and the powerful self-cleansing mechanisms of the river have made the predictions of a long-term “dead” Rhine unfounded. The recovery of the Rhine from this accident is well underway, but the problems from chronic chemical contamination still remain.

FIGURE 1
Map of the Rhine River with its monitoring stations*



*The dashed lines are international borders. The graph on the right side shows the mass of disulfoton that passed the five monitoring stations.

Chli Windgällen, 1993

René Reiser, Marc & Monika Suter

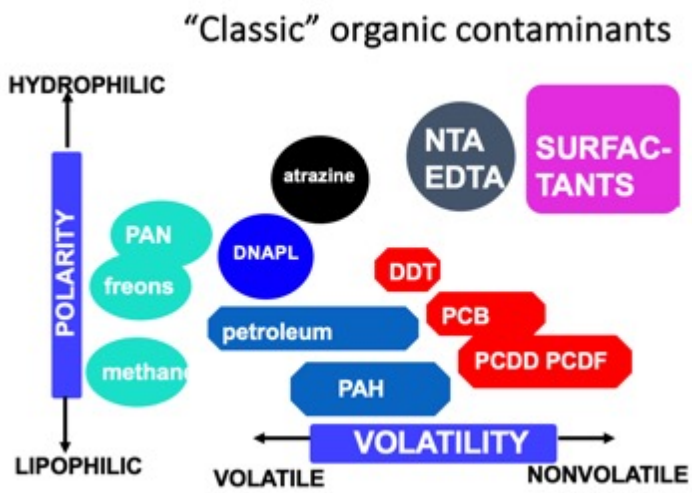
Franz Günter Kari

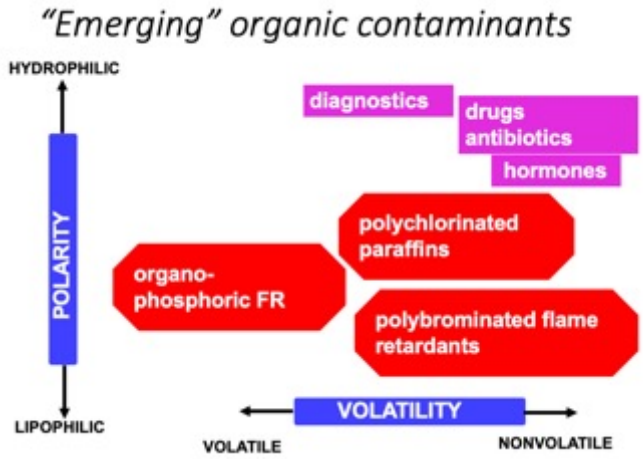
Alfredo Alder

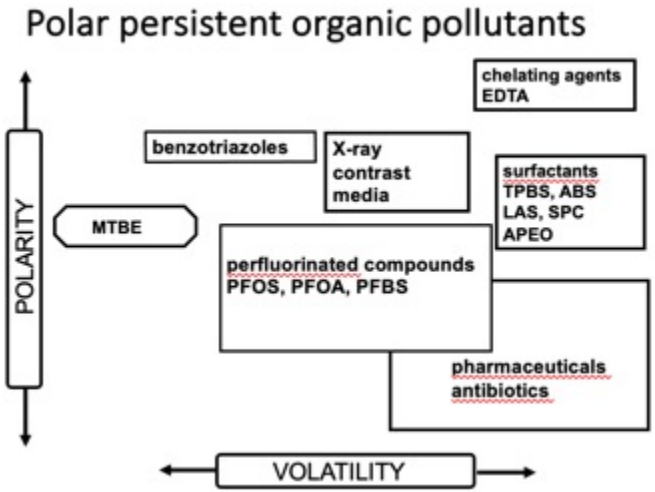
Tom & Jennifer Field

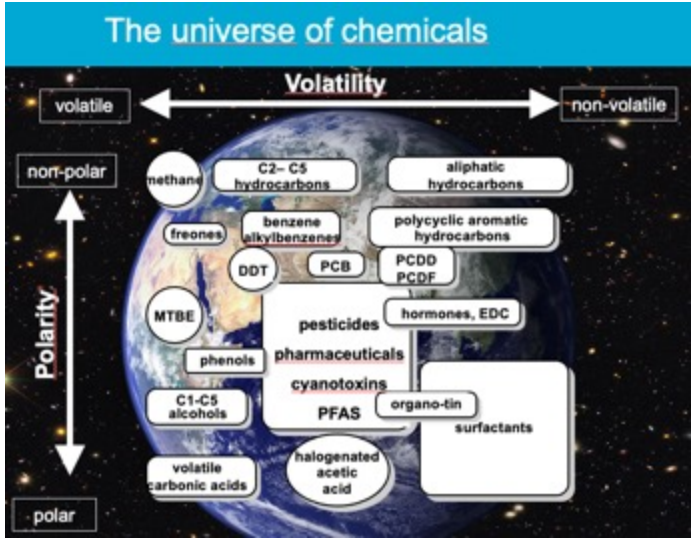
David Scheidegger

Erika Giger









Heinz Singer
Euroanalysis
2023

Analytical Chemistry, 1995, *67*.

Determination of Benzene- and Naphthalenesulfonates in Wastewater by Solid-Phase Extraction with Graphitized Carbon Black and Ion-Pair Liquid Chromatography with UV Detection

Beat Altenbach and Walter Giger*

Beat Altenbach
1992-1996

Environ. Sci. Technol. **2002**, *36*, 3284–3289

Leaching and Primary Biodegradation of Sulfonated Naphthalenes and Their Formaldehyde Condensates from Concrete Superplasticizers in Groundwater Affected by Tunnel Construction

SABINE RUCKSTUHL, MARC J.-F. SUTER,* HANS-PETER E. KOHLER, AND WALTER GIGER

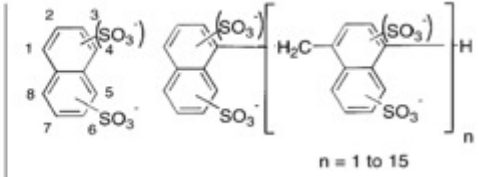


FIGURE 1. Chemical structures of the components of technical SNFC mixtures.

combination with cement. Symptoms characteristic for exposure to the toxic grouting agents based on acrylamide were observed in tunnel workers. In one of the two cases the

Sabine Ruckstuhl
1998-2001

Wat. Res. Vol. 34, No. 7, pp. 2069–2079, 2000

BENZENE- AND NAPHTHALENESULFONATES IN LEACHATES AND PLUMES OF LANDFILLS

S. RIEDIKER*, M. J.-F. SUTER† and W. GIGER

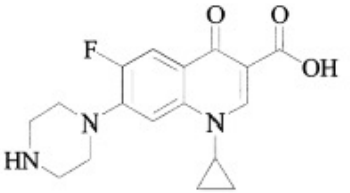
Sonja Riediker
1997-2002

- EU research program **ANACAD**, *Analysis and Fate of Concrete Admixtures in Waste Water Treatment and in Natural Waters* 1997-2000

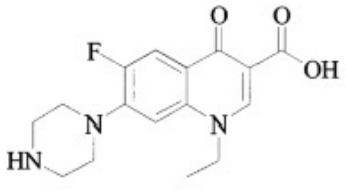
- International research program funded by Hewlett-Packard : **Rhine Basin Program**, *Aromatic Sulfonates* 1990-1998

Environmental Exposure and Risk Assessment of Fluoroquinolone Antibacterial Agents in Wastewater and River Water of the Glatt Valley Watershed, Switzerland

EVA M. GOLET,
ALFREDO C. ALDER,* AND
WALTER GIGER



ciprofloxacin (CIP)

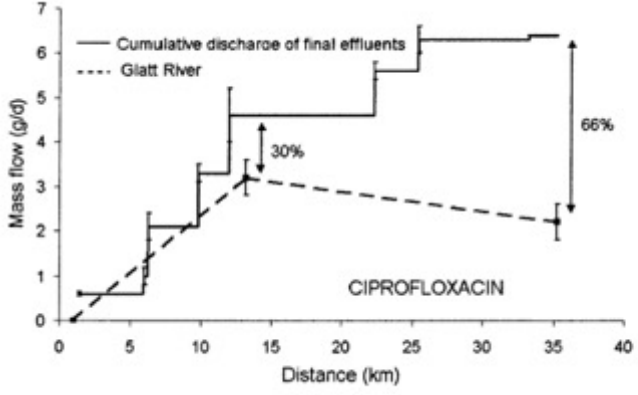


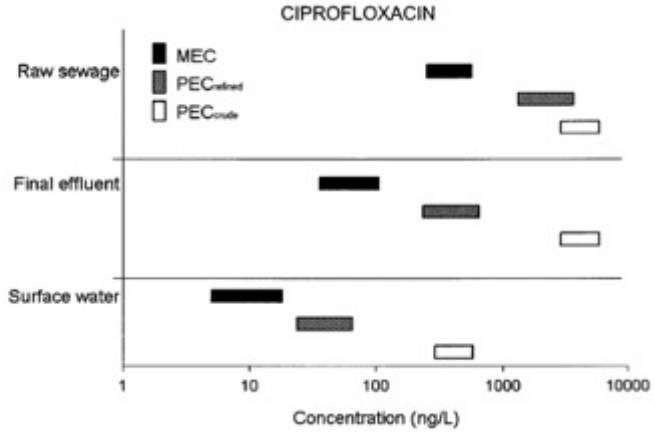
norfloxacin (NOR)

FIGURE 1. Chemical structures of ciprofloxacin and norfloxacin, the two fluoroquinolone antibacterial agents determined in the Swiss aquatic environment.

VOL. 36, NO. 17, 2002 / ENVIRONMENTAL SCIENCE & TECHNOLOGY ■ 3645

Eva Golet
1997-2002

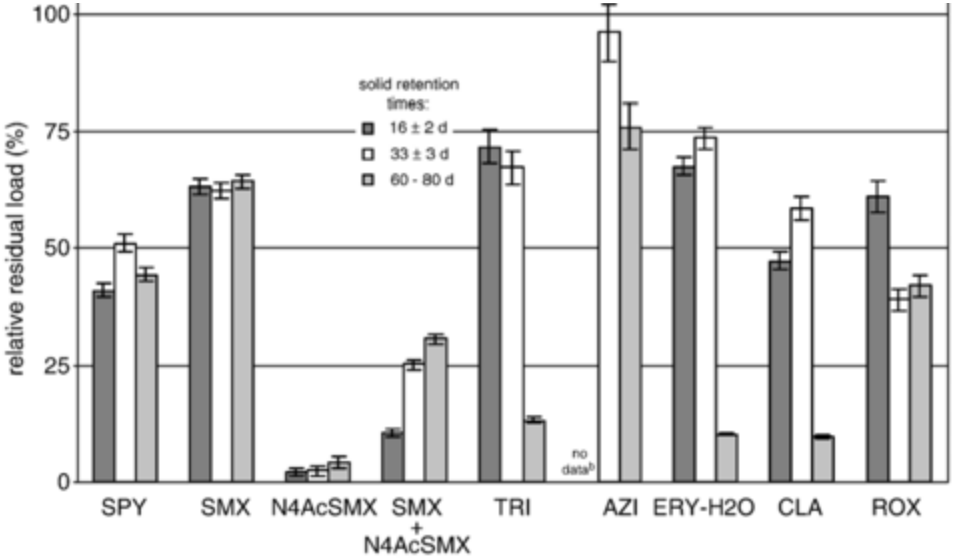




Science of the Total Environment 372 (2007) 361–371

Fate of sulfonamides, macrolides, and trimethoprim in different wastewater treatment technologies

Anke Göbel, Christa S. McArdell *, Adriano Joss, Hansruedi Siegrist, Walter Giger



Anke Göbel
2001-2005

Hansruedi Siegrist

Andriano Joss

Christa McArdell
1996-2005

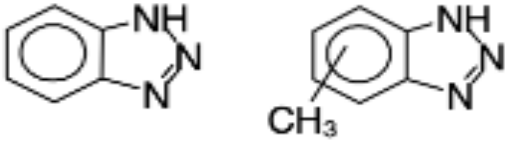
- **NRP 49** "Antibiotic resistance" 2001-2006
- EU Project "Assessment of technologies for the removal of pharmaceuticals and personal care products in sewage and drinking water facilities to improve the indirect potable water reuse" **POSEIDON** 2001-2004

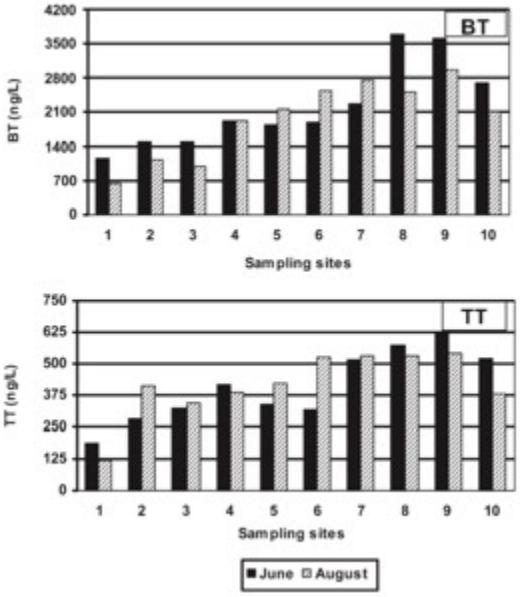
Compound[a]	Acronym
Sulfapyridine	SPY
Sulfamethoxazole	SMX
N^4-acetylsulfamethoxazole	N4AcSMX
	SMX+N4AcSMX[c]
Trimethoprim	TRI
Azithromycin	AZI
Erythromycin	ERY-H2O
Clarithromycin	CLA
Roxithromycin	ROX

Dimitra Voutsa
2004/5

Environ. Sci. Pollut. Res. 13 (5) 333 – 341 (2006)

Benzotriazoles, Alkylphenols and Bisphenol A in Municipal Wastewaters and in the Glatt River, Switzerland





Environ. Sci. Technol. **2006**, *40*, 7186−7192

Benzotriazole and Tolyltriazole as Aquatic Contaminants. 1. Input and Occurrence in Rivers and Lakes†

WALTER GIGER,*
CHRISTIAN SCHAFFNER, AND
HANS-PETER E. KOHLER

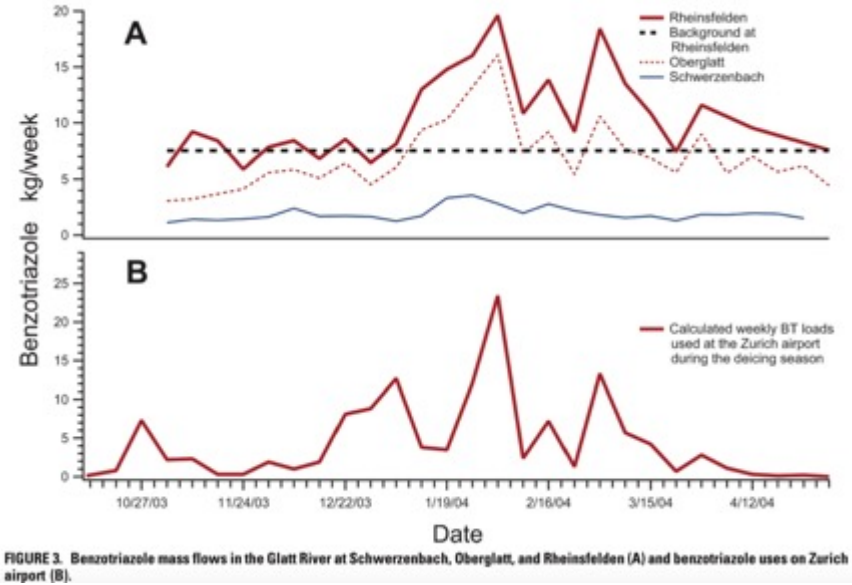


FIGURE 3. Benzotriazole mass flows in the Glatt River at Schwerzenbach, Oberglatt, and Rheinsfelden (A) and benzotriazole uses on Zurich airport (B).

Michael Berg Viet Pham Roland Schertenleib

VOL. 35, NO. 13, 2001

Arsenic Contamination of Groundwater and Drinking Water in Vietnam: A Human Health Threat

Chimia 57 (2003) 529–536

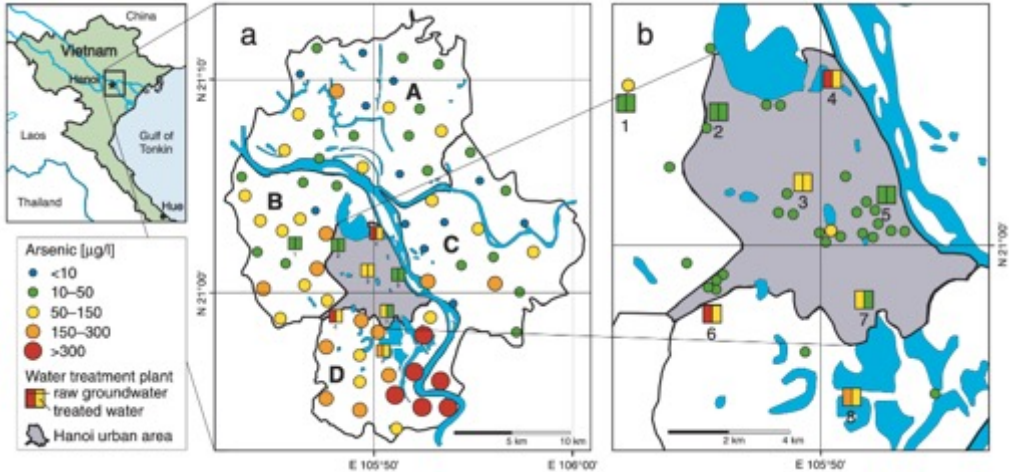
Environmental Analytical Research in Northern Vietnam – A Swiss-Vietnamese Cooperation Focusing on Arsenic and Organic Contaminants in Aquatic Environments and Drinking Water

Swiss-Vietnamese co-operation program **ESTNV** 1998-2010

Analytes	Samples	Analytical methods	Refs
Arsenic and other heavy metals such as iron and manganese	GW, DW, SED	Atomic absorption spectroscopy Atomic fluorescence spectroscopy	[2]
Volatile organic compounds including trihalomethanes	GW, DW	Head-space, GC/MS	[1]
Ammonium, nitrate, bromide, DOC, alkalinity	GW, DW	Various standard methods for water analysis	
Organophosphorus pesticides	SW	Solid-phase microextraction GC/MS	[3]
Chlorinated phenols	IWW, SW	Solvent extraction, GC/MS	[8]
Adsorbable organic halogen (AOX)	IWW	Combustion, coulometric tritration	[8]
Polycyclic aromatic hydrocarbons	SED	Soxhlet extraction, GC/MS	

GW: groundwater; DW: drinking water; SW: surface water; IWW: industrial wastewater; SED: sediment; GC/MS: gas chromatography/mass spectrometry

Arsenic concentrations in the Hanoi area in September 1999



Environ. Sci. Technol. **2008,** *42,* 6369–6377

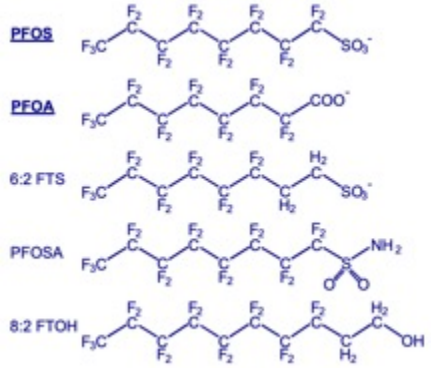
Occurrence and Mass Flows of Fluorochemicals in the Glatt Valley Watershed, Switzerland

CARIN A. HUSET,[†,‡] AUREA C. CHIAIA,[†]
DOUGLAS F. BAROFSKY,[†]
NIELS JONKERS,[§,∥]
HANS-PETER E. KOHLER,[§]
CHRISTOPH ORT,[§] WALTER GIGER,[§] AND
JENNIFER A. FIELD*,[⊥]

Aurea Chiaia

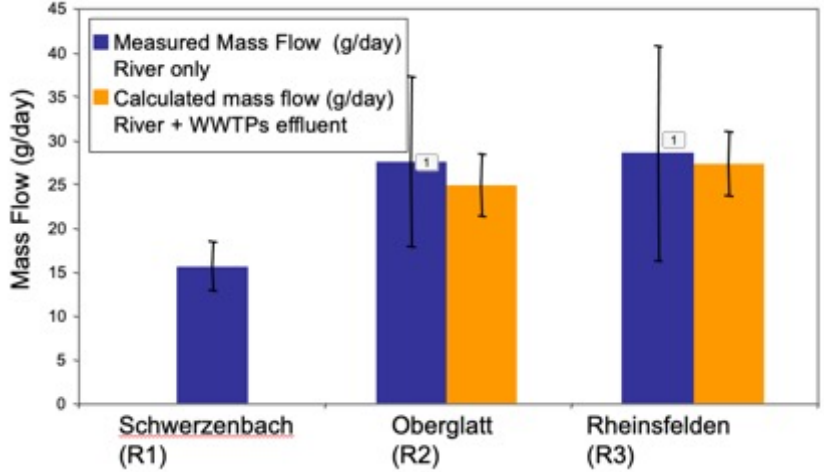
Jennifer Field

Christoph Ort



PF..: perfluoro...
FT..: fluorotelomer...
...S: ...sulfonate
...A:...acid/carboxylate
...SA: …sulfonamide
..OH: ..alcohol

B	butyl (C4)
Hx	hexyl (C6)
O	octyl (C8)
N	nonyl (C9)
D	decyl (C10)



- Equivalent measured and calculated mass flows indicate no removal processes occur
- WWTPs account for all observed increases in PFOS mass flows

Environmental Pollution 159 (2011) 654–662

Long-chain perfluorinated chemicals in digested sewage sludges in Switzerland

Hongwen Sun [a], Andreas C. Gerecke [b], Walter Giger [c], Alfredo C. Alder [d,*]

Hongwen Sun

Chemosphere 129 (2015) 62–73

Contents lists available at ScienceDirect

Chemosphere

journal homepage: www.elsevier.com/locate/chemosphere

Occurrence and point source characterization of perfluoroalkyl acids in sewage sludge

Alfredo C. Alder *, Juergen van der Voet [1]

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HIGHLIGHTS

- High spatial and temporal variability of PFAA concentrations among different WWTPs.
- Metal plating, aqueous firefighting foams (AFFF), and landfill leachates are significant point sources for PFSAs.
- Carpet and textile protection are most relevant for the emissions for PFCAs.
- Temporal trends between 2008 and 2011 show a decrease of PFOS levels.

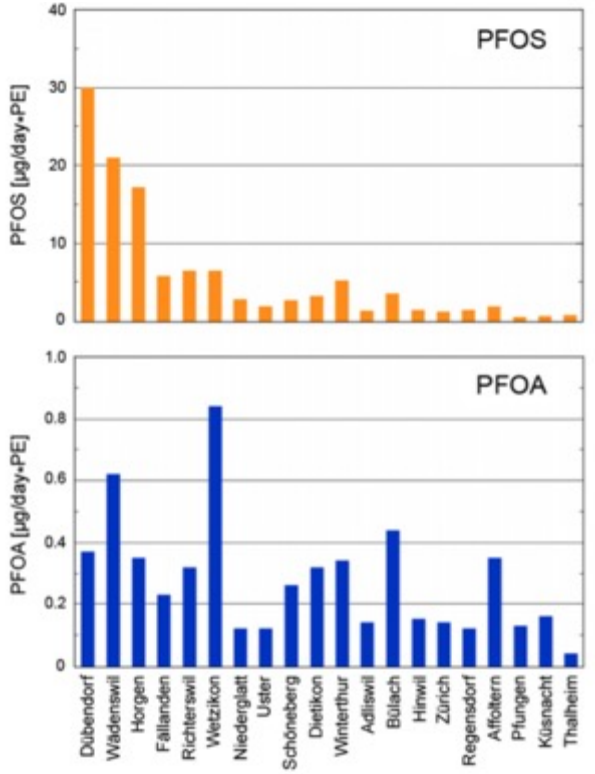
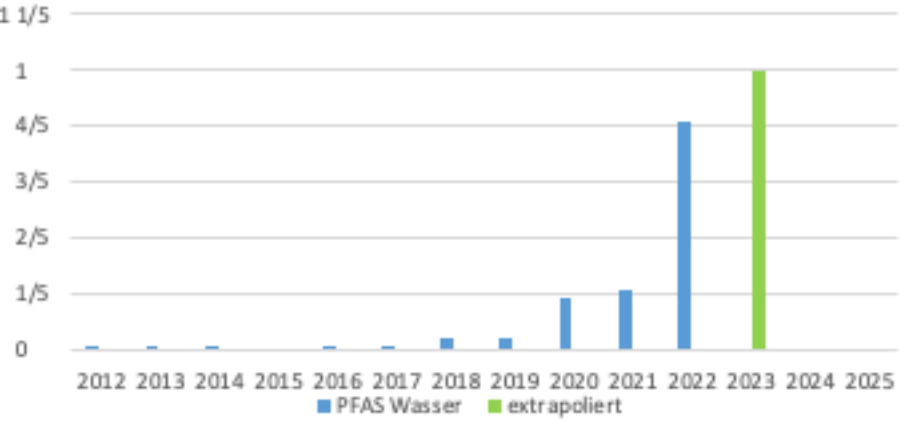
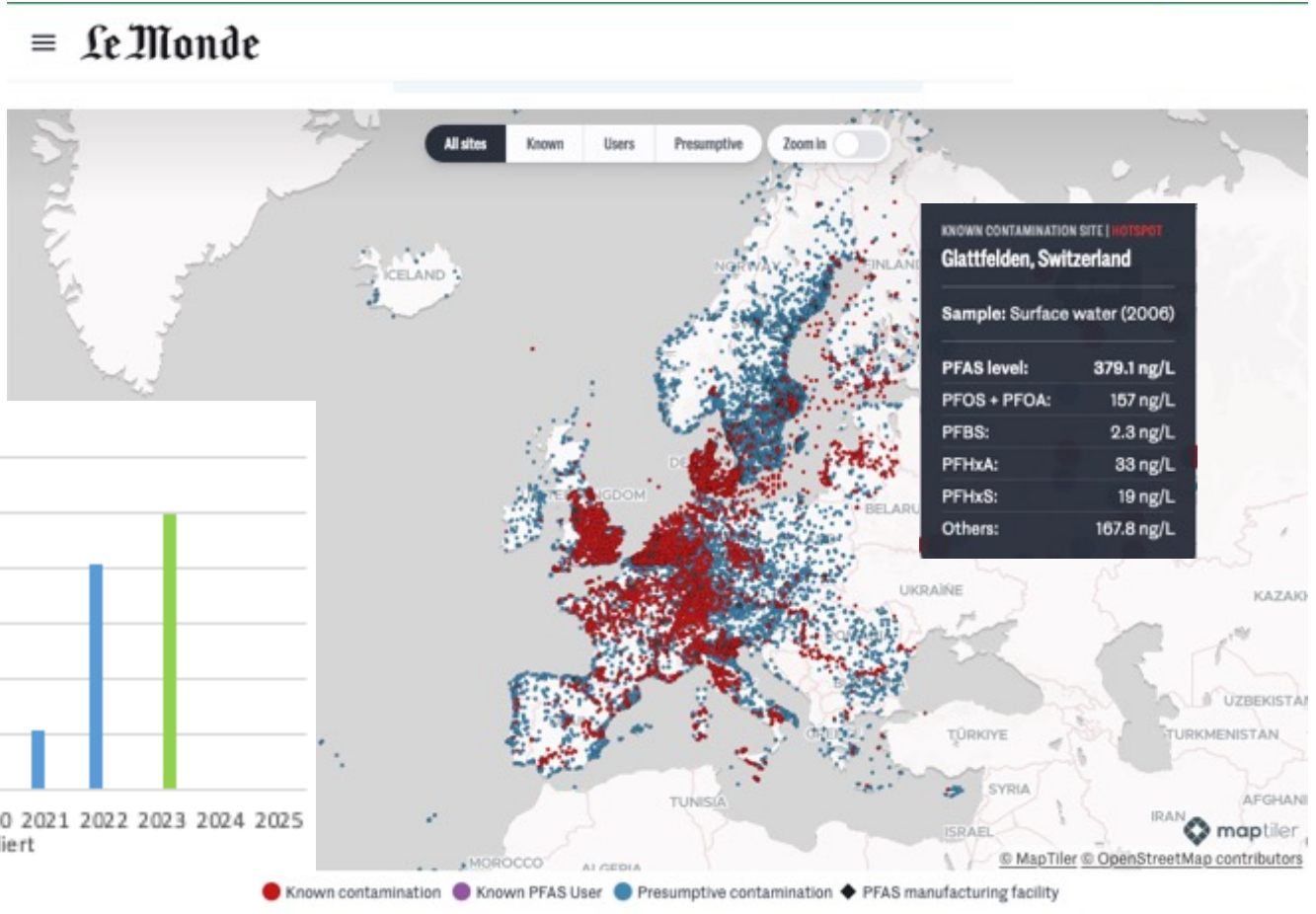


Fig. 5. Daily mass loads per population equivalents (PE) of PFOS and PFOA in digested sewage sludges from 20 WWTPs in Switzerland.

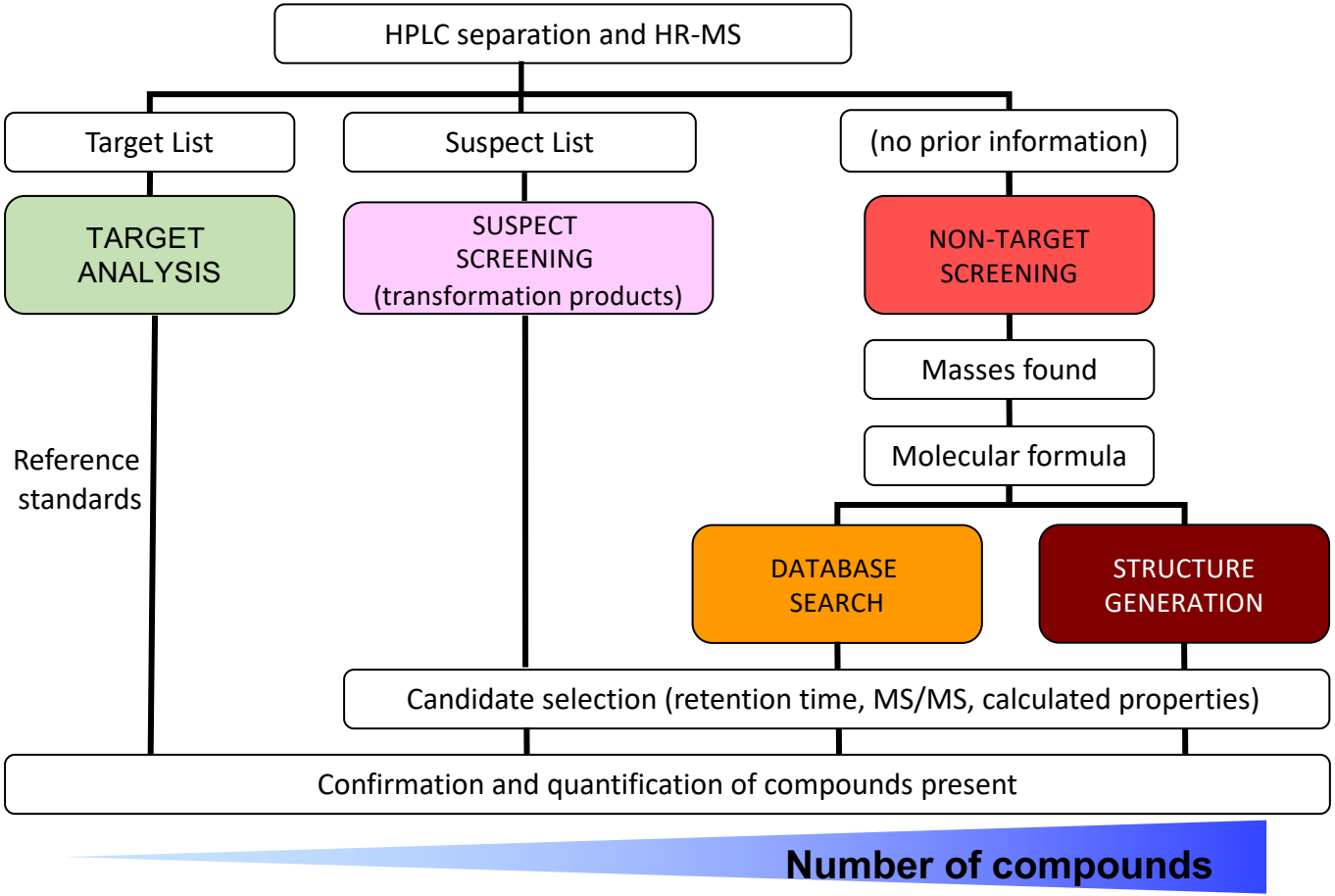
Forever Pollution Map, February 2023

Bachema
PFAS Determinations in water





Target, Suspect and Non-target analysis

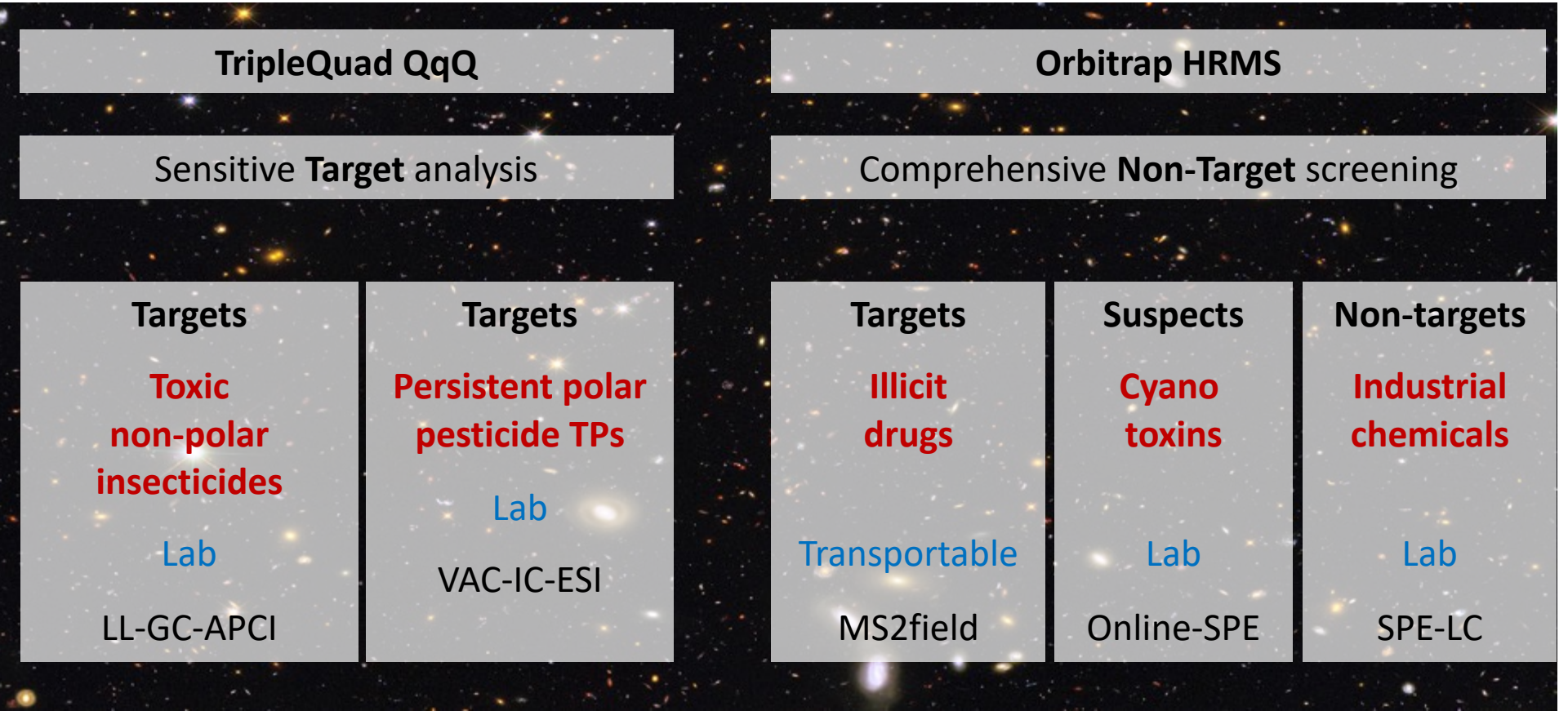


Aurea Chiaia, Eawag and University of Bern

Juliane Hollender, Heinz Singer, Eawag

Environmental mass spectrometry

Heinz Singer, Eawag, Euroanalysis 2023



High resolution mass spectrometry

Juliane Hollender, Eawag, Anakon 2023

- **Instrumentation**
- high mass accuracy (< 0.001 Da)
- high mass resolution (m/Δm > 40’000)
- high sensitivity in fullscan mode
- chromatographic resolution
- soft ionization (ESI, APCI)

Data analysis /Databases

- compound databases
- suspect lists

- exposure relevant compounds
- predicted transformation products

- spectra libraries
- computational tools

➢ Comprehensive and sensitive multitarget screening
➢ Suspect screening of exposure relevant compounds
➢ Identification of non-target compounds

Tom Field Hanspi Kohler Walter Giger Jennifer Field 1994

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