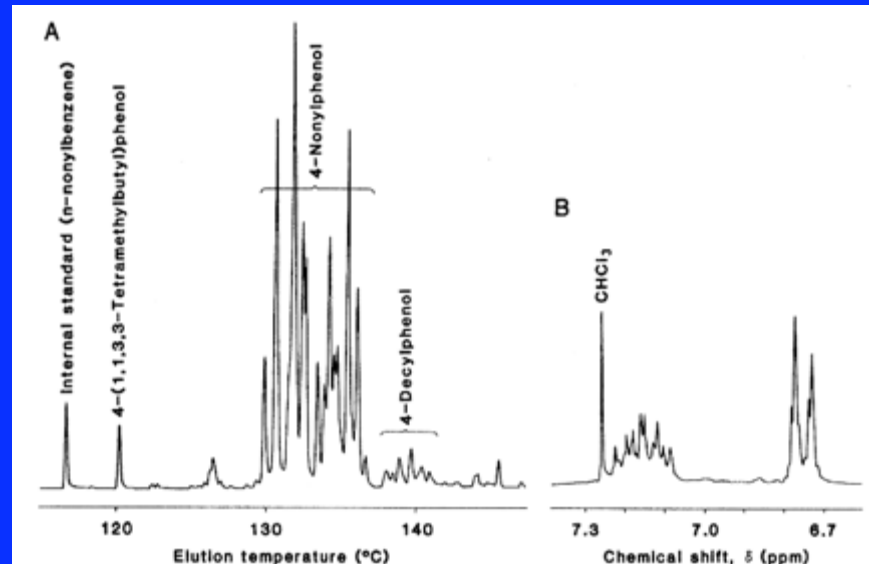




Peaks in science and life: looking back on 50 years of research on micropollutants

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

<i>Position</i>	<i>Research</i>	<i>Conferences</i>
graduate student postdoc	primary producer	poster
assistant/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

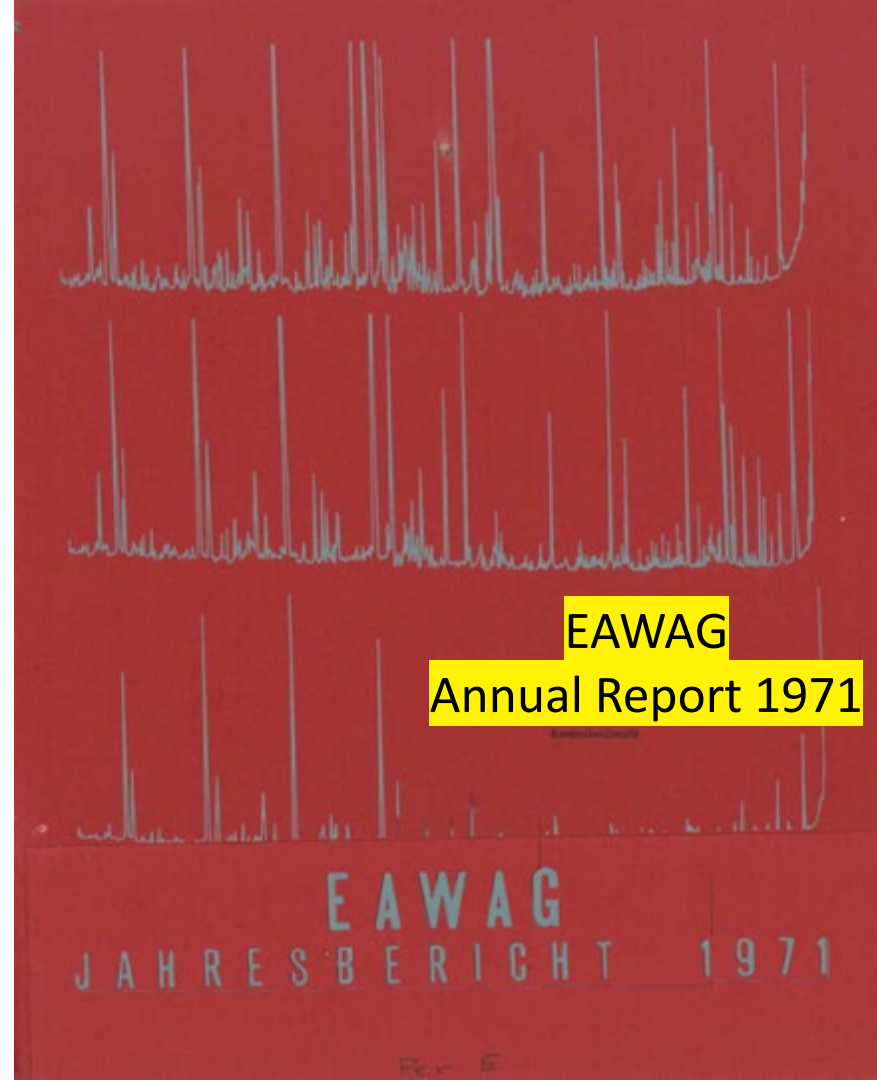
Martin Reinhard	1972 – 1976	Steve McDow	1986 – 1988	Eva Golet	1997, 1998 – 2002
Christian Schaffner	1972 – 2005	Emily Heyerdahl	1986	Barbara Horlacher	1998 – 1999
Fritz Zürcher	1972 – 1980	Silvio Capri	1986	Sabine Ruckstuhl	1998 – 2001
Lise-Marion Schlatter	1972 – 1975	Gordon McFeters	1987 – 1988	Virginie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



Lunkho-i- Kucheck
6451 m a.s.l.
Hindukush Mountain Range
Afghanistan

First ascent
on 11 August 1972
by an expedition of the
Academic Alpine Club Zurich



Christian Schaffner
Martin Reinhard 1972-2005
1972-1976
Fritz Zürcher
1972-1980

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.

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

Source recognition:

- petroleum-derived - motorboats - biogenic

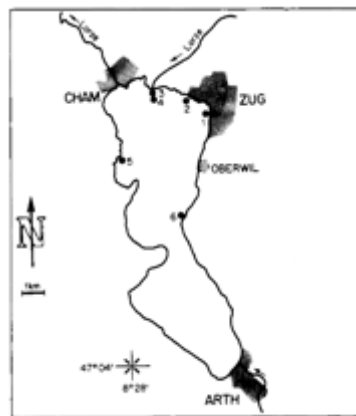


Figure 1. Lake Zug, locations of sampling stations

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

Station no. ^a	CCl ₄ extractable, $\mu\text{g/g dry wt}$	Hydrocarbons, $\mu\text{g/g dry wt}$	n-C ₁₀ -H ₂₂ /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

Experimental
Samples of

ti
di
ts
ss

w
w

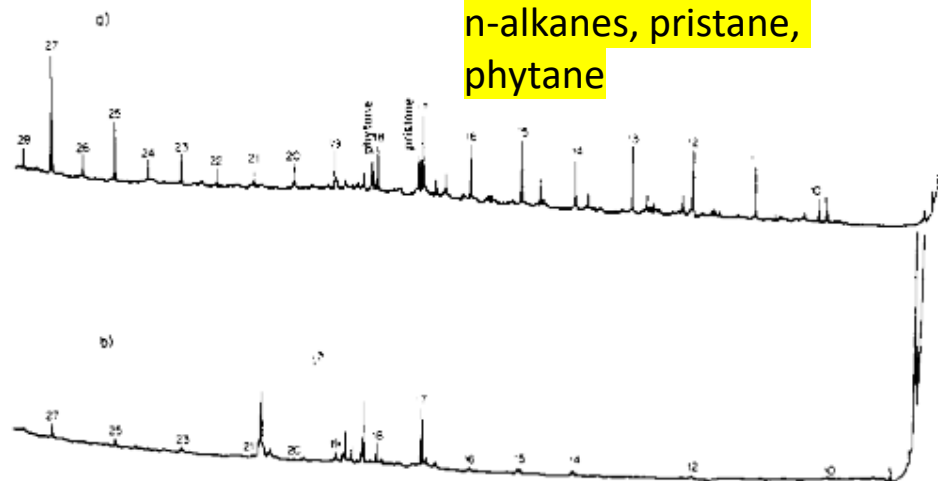


Figure 2. Gas chromatograms of sediment extracts
a. Station 4. b. Station 6. Numbers indicate carbon numbers of n-alkanes



Max Blumer

Woods Hole
Oceanographic
Institution
WHOI

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

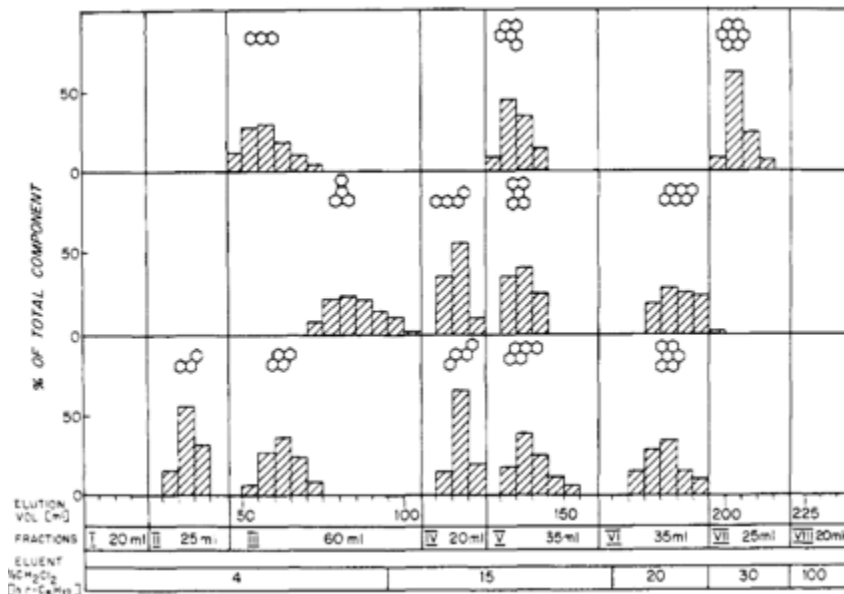
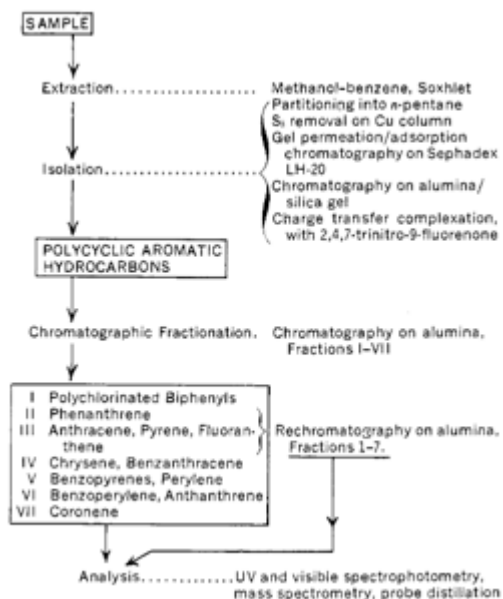
Walter Giger¹ and Max Blumer²

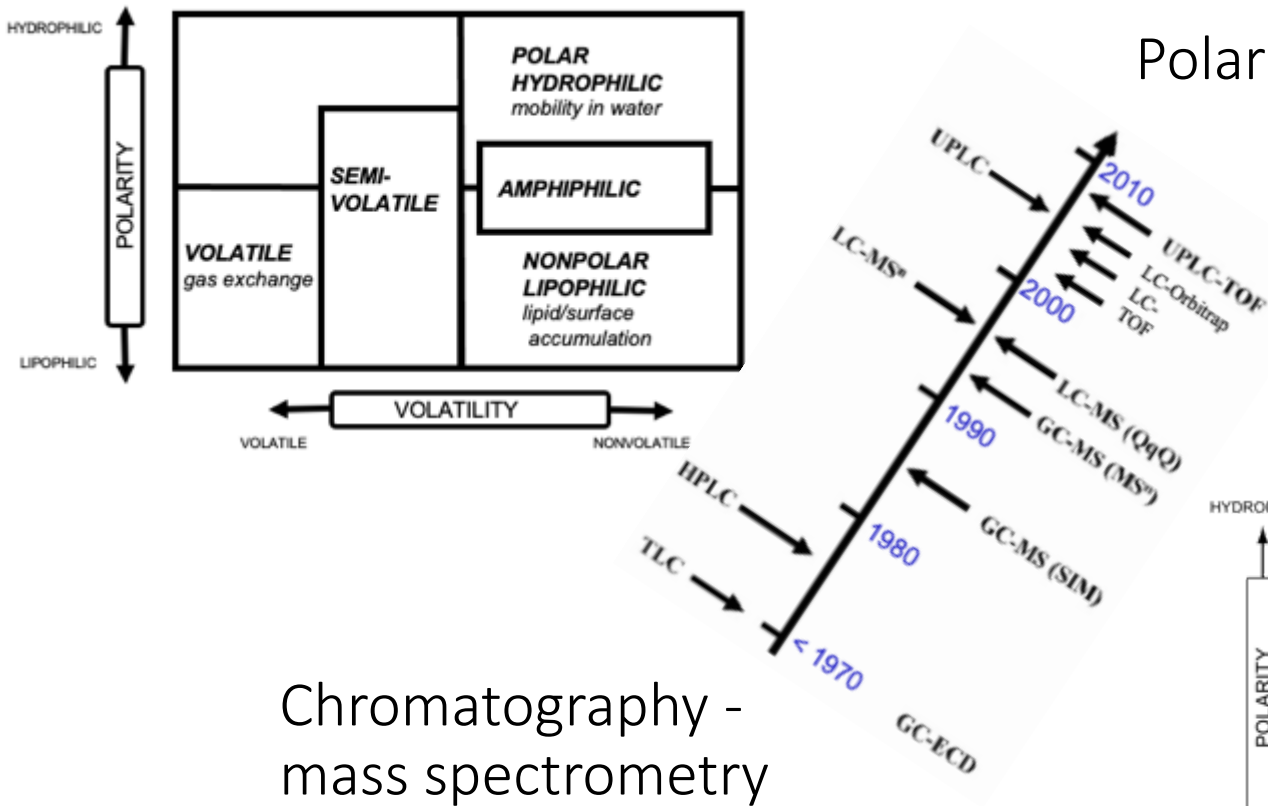
Woods Hole Oceanographic Institution, Woods Hole,

3-7 ring PAH:
parent compounds and
alkylated homologues

Side product: PCBs in
recent sediments of
New Bedford Harbour

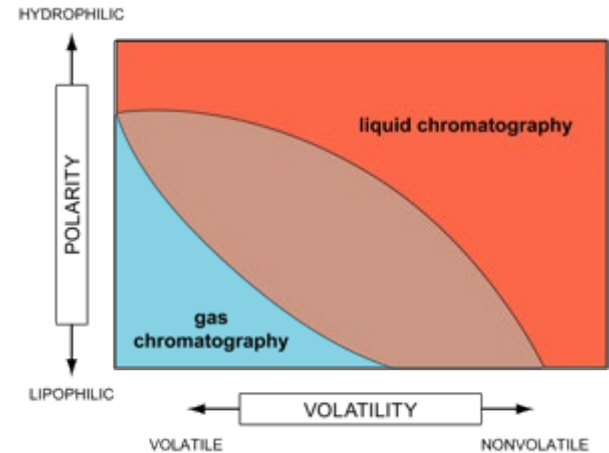
ANALYTICAL CHEMISTRY, VOL. 46, NO. 12, OCTOBER 1974 • 1663





Chromatography - mass spectrometry

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

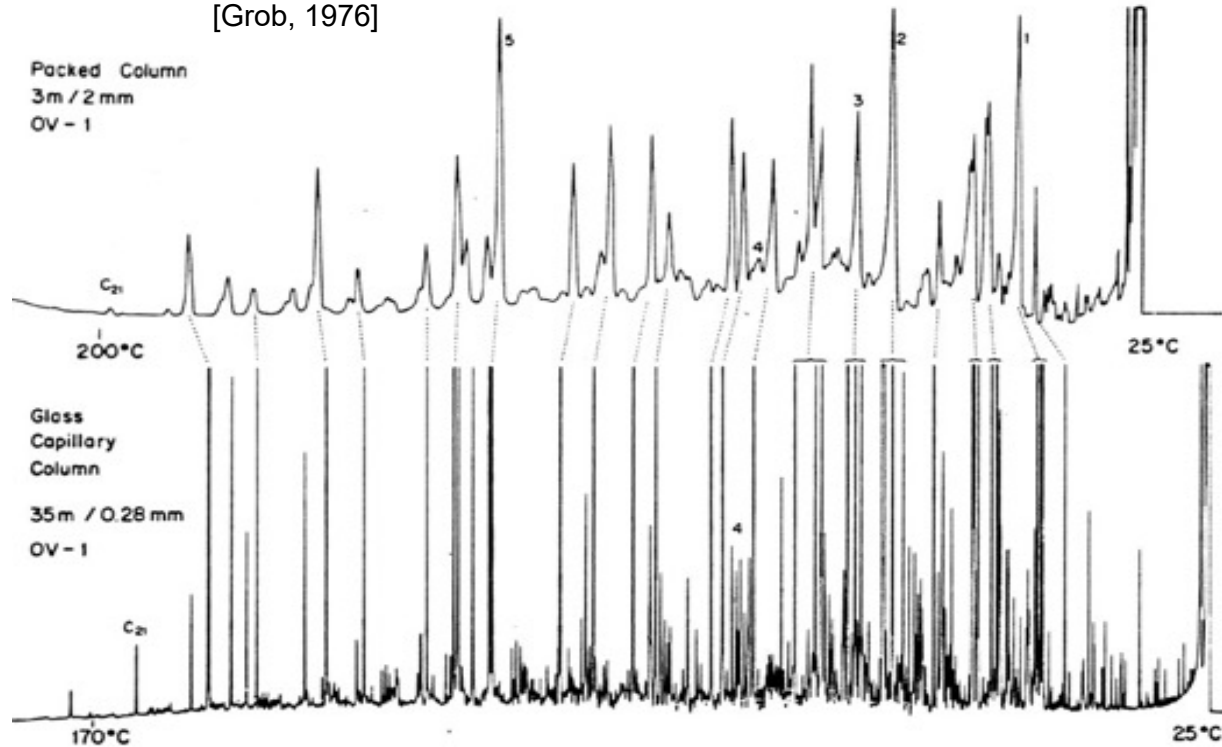




Kurt Grob

High-resolution gas chromatography with glass capillaries

[Grob, 1976]

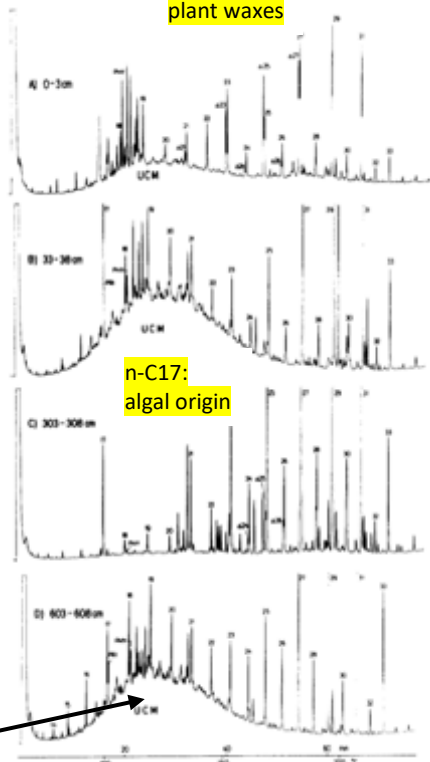


Extract of a water sample from the Glatt River near Zurich, Switzerland

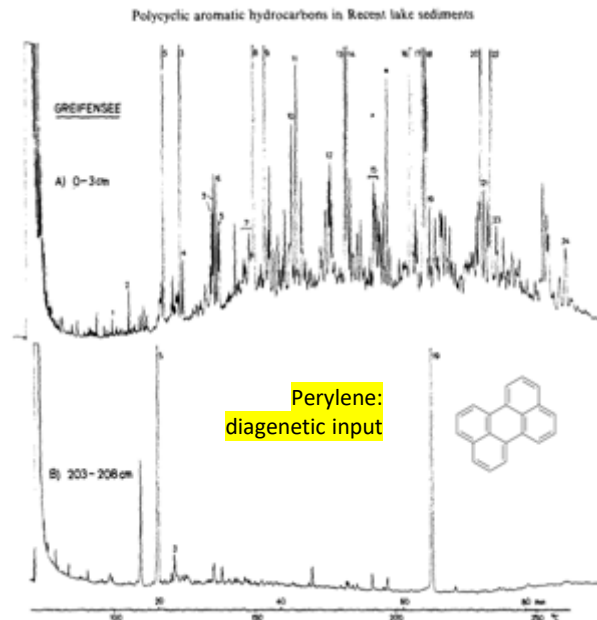


Aliphatic and olefinic hydrocarbons in recent sediments of Greifensee, Switzerland

Odd>even n-alkanes:
plant waxes



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



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



Stuart Wakeham
1976-1978

Greifensee
with partial panorama of the Swiss Alps

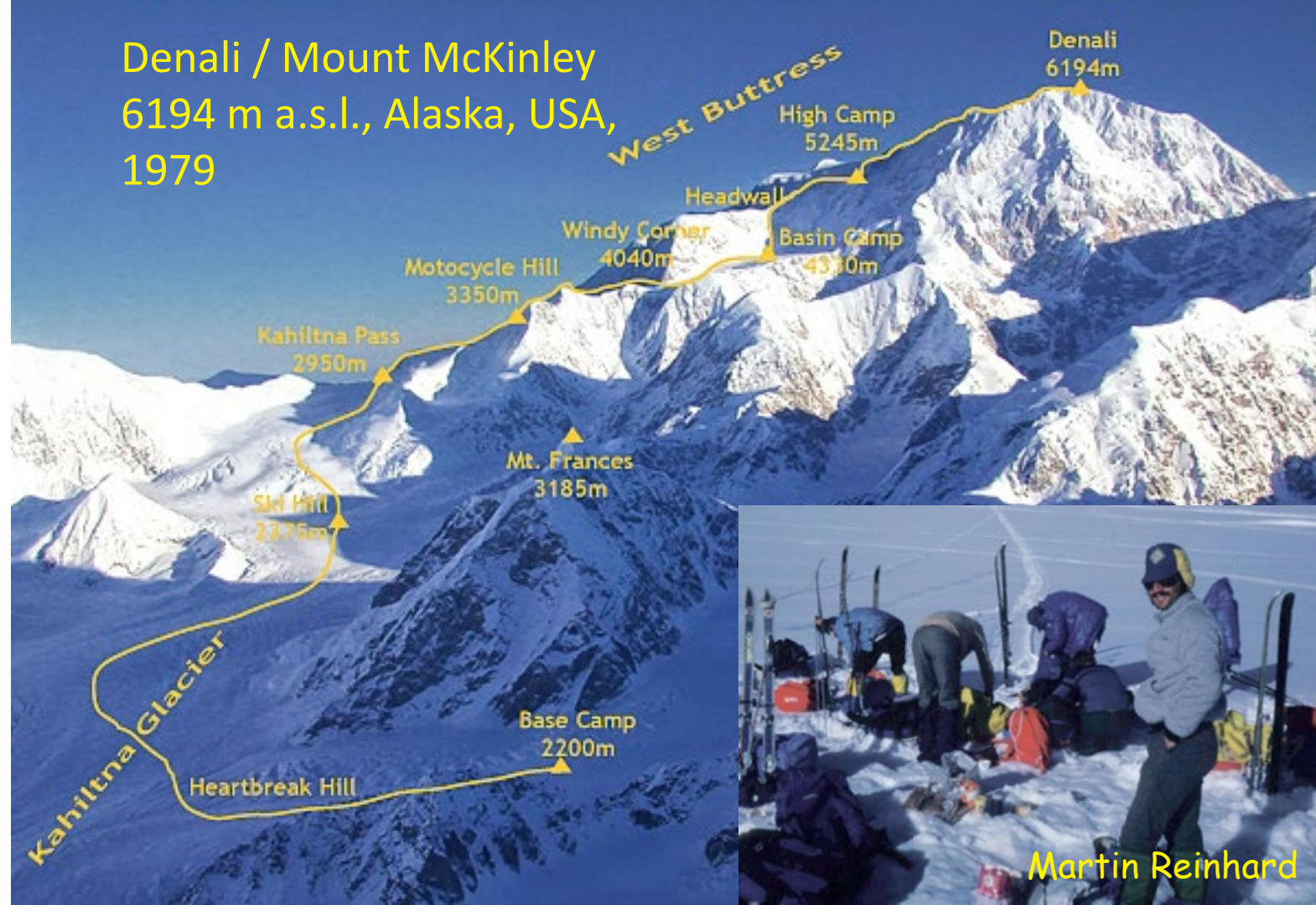


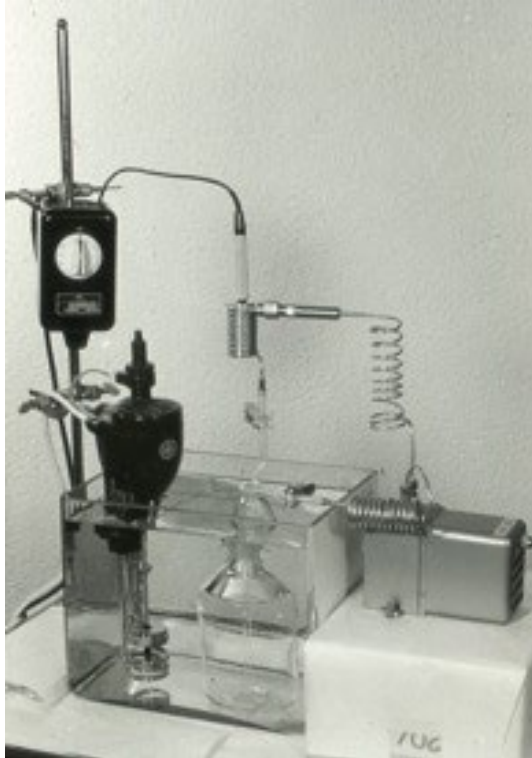
Freeze core of
Greifensee
sediments

UCM:
unresolved
complex mixture

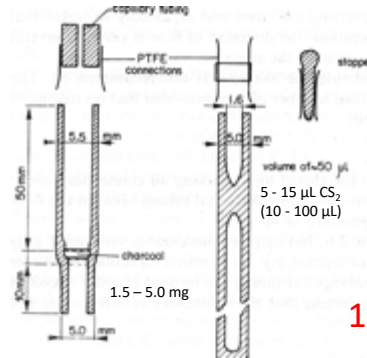
Denali / Mount McKinley

6194 m a.s.l., Alaska, USA,
1979





Closed-loop gaseous stripping (CLSA)



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

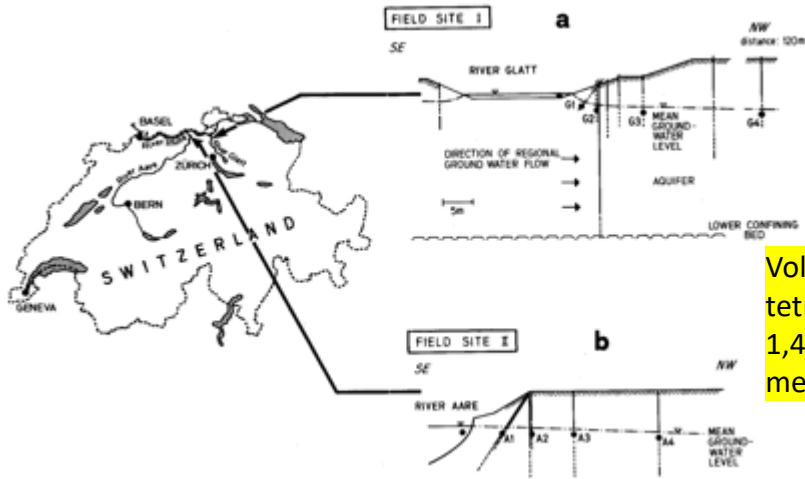
Journal of Chromatography, 285 (1984) 307-318

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*

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

Infiltration from river into groundwater



Volatiles:
tetrachloroethylene,
1,4-dichlorobenzene,
methylbenzenes



Eva Molnar
1975-2006



René Schwarzenbach
1977-1983



Edi Hoehn
1975-2006

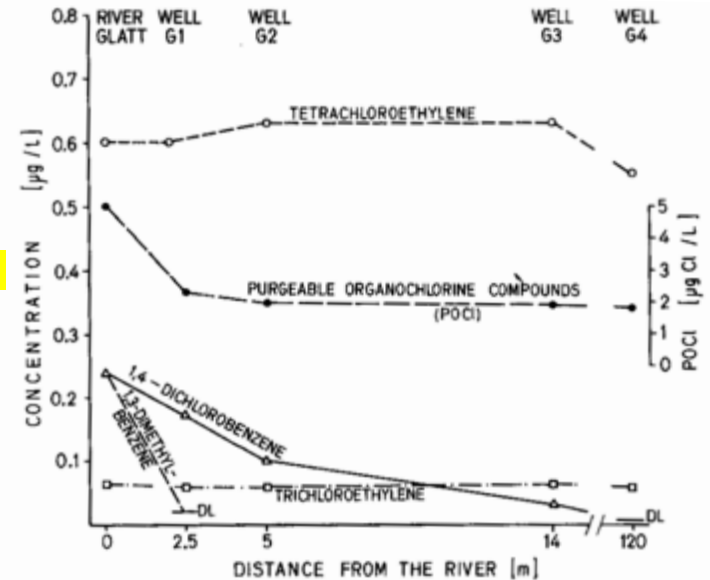


Figure 4. Field site I: average concentrations of selected organic micropollutants in the River Glatt and in the upper layers of the groundwater at various distances from the river (DL = detection limit).

Swiss National Science Foundation 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

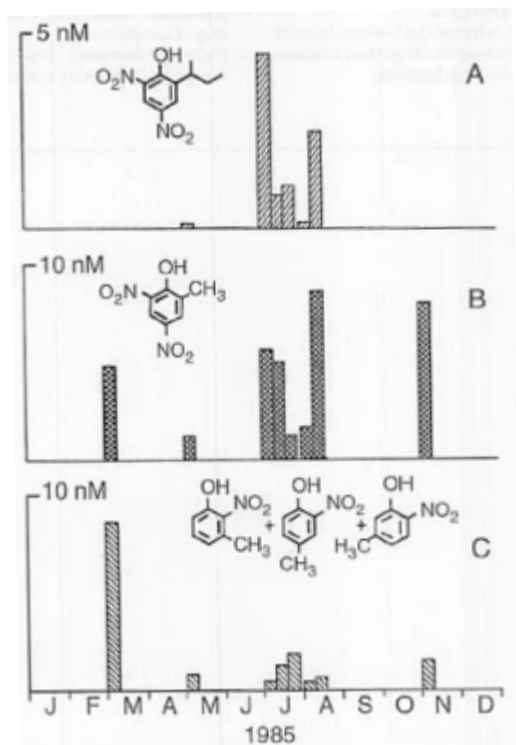


Rolf Gloor



Jürg Schneider
1978-1981,
1983/4

Organic contaminants in atmospheric deposition



polycyclic aromatic
hydrocarbons,
alkanes,
methylbenzenes
phenols,
nitrophenols

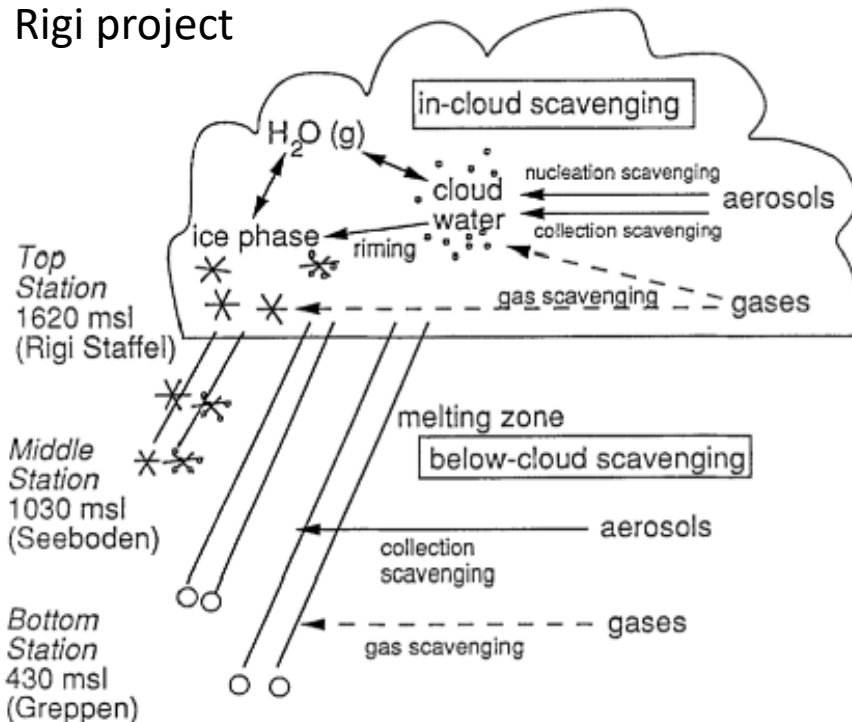


Christian Leuenberger
1981-1983, 1984-1986



Josef Tremp
1985-1990

Rigi project

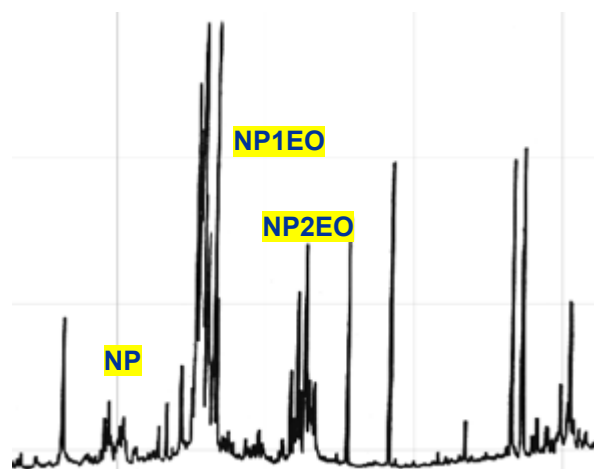


- **NRP 14** «Circulation and Pollution of air and forest damage in Switzerland», 1980 - 1990

- 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

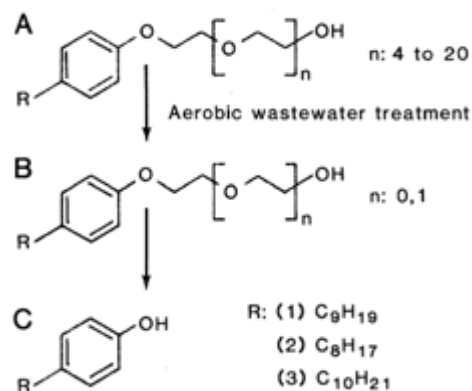


Table III. Toxicity to Aquatic Fauna of Nonylphenol Polyethoxylates and Nonylphenols

nonylphenol polyethoxylates ^a	no effect level, mg/L			
	<i>Pseudomonas</i>	<i>Scenedesmus</i>	<i>Colpoda</i>	<i>Daphnia</i>
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, $\mu\text{g/L}^a$				DOC, mg C/L ^b	rel amt, % ^c	no. of deter- minations
	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 $10 \mu\text{g/L}$. ^b DOC: dissolved organic carbon. ^c Sum of NP, NP1, and NP2 calculated as percentage of DOC.

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

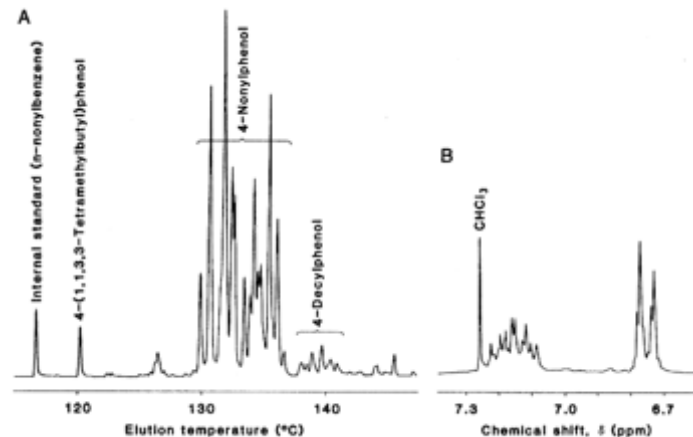
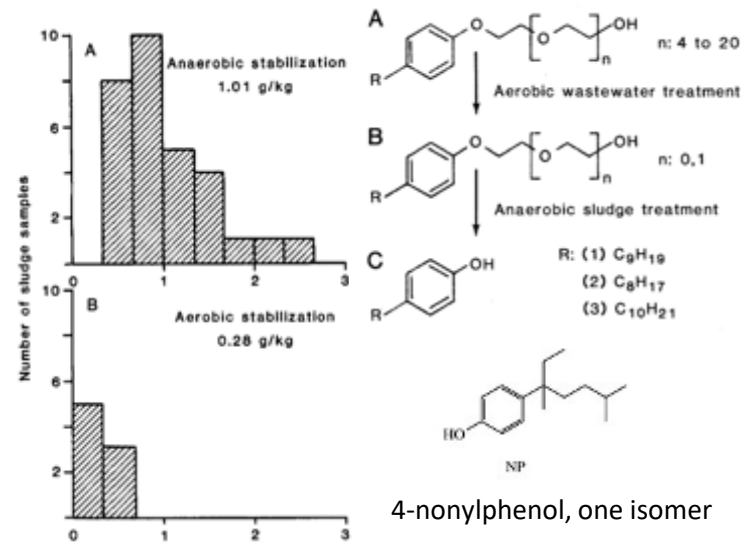
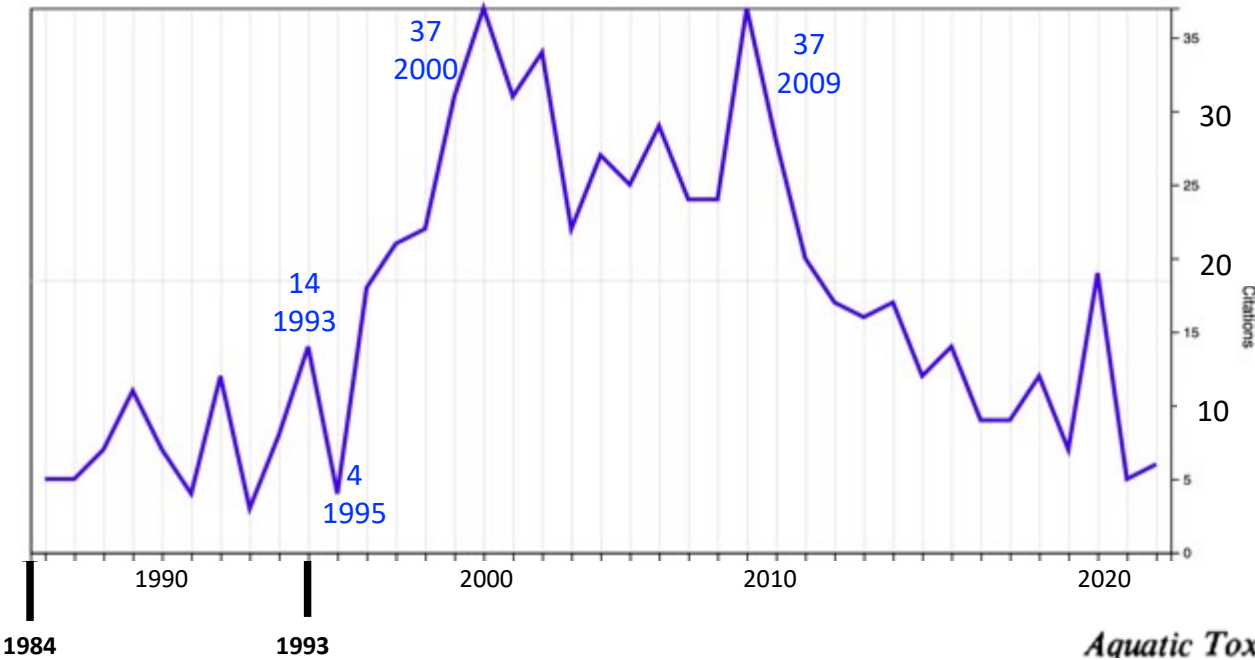


Fig. 2. Partial gas chromatogram (A) and proton NMR spectrum (B) of an extract of anaerobically treated sewage sludge.



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



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

MARIJAN AHEL^{1*}, WALTER GIGER² and MARKUS KOCH³

¹Center for Marine Research Zagreb, Rudjer Bošković Institute, P.O. Box 1016, 41001 Zagreb, Croatia,

²Swiss Federal Institute for Environmental Science and Technology (EAWAG), CH-8600 Dübendorf and

³Control Laboratory, Department of Water Pollution Control, CH-8005 Zürich, Switzerland

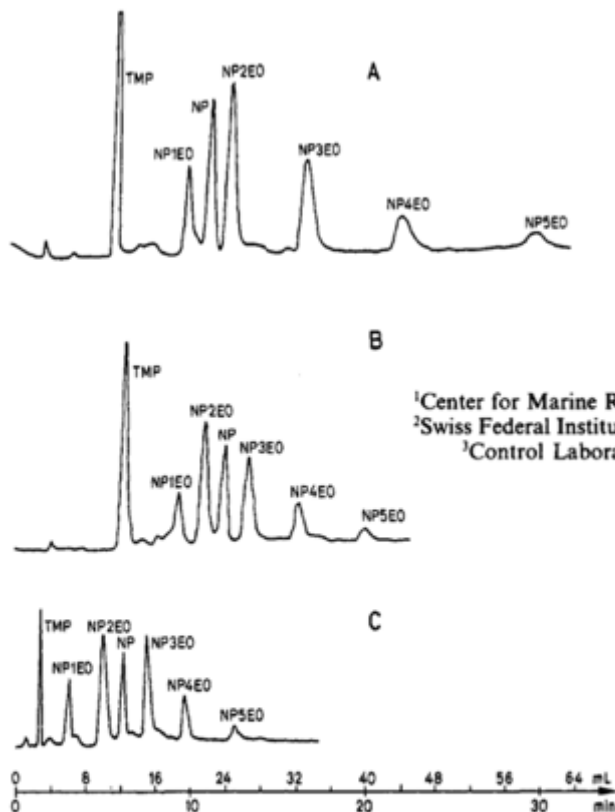


Figure 2. Normal-phase high-performance liquid chromatograms of reference mixtures containing Marlophen 83, technical 4-nonylphenol, and 2,4,6-trimethylphenol. Three different aminosilica columns (A, B, and C) were used as described in the text. A and B: Lichrosorb-NH₂, irregularly shaped 10 μ m, 250 mm $\times$ 4.6 mm i.d.. C: Hypersil APS, spherical 3 μ m, 60 mm $\times$ 4 mm i.d.. NP: 4-nonylphenol, NP1EO–NP5EO: 4-nonylphenol monoethoxylate to 4-nonylphenol pentaethoxylate, TMP: 2,4,6-trimethylphenol.



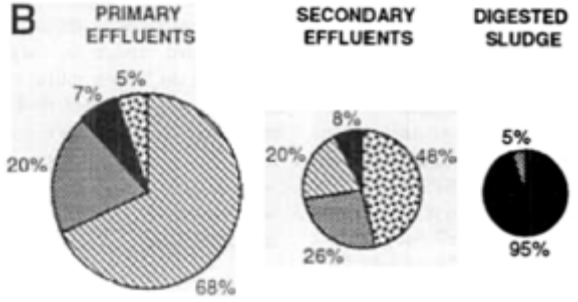
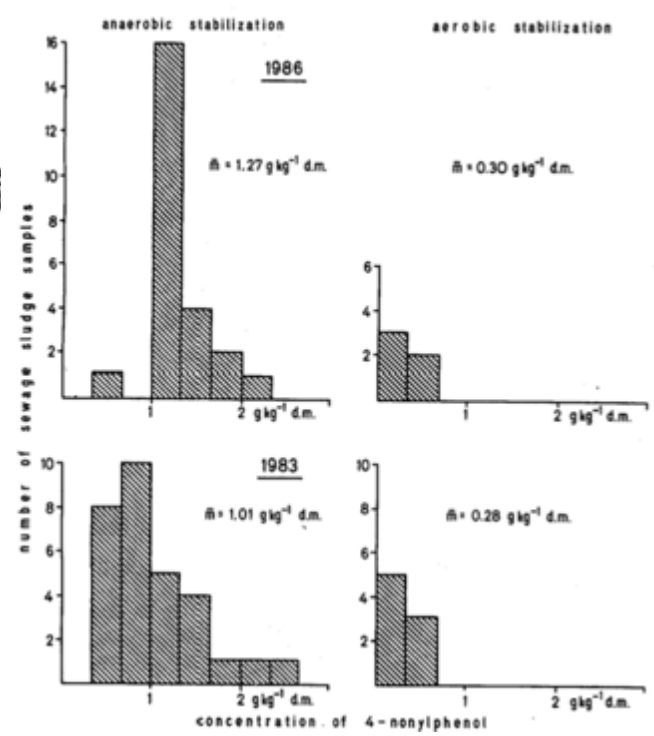
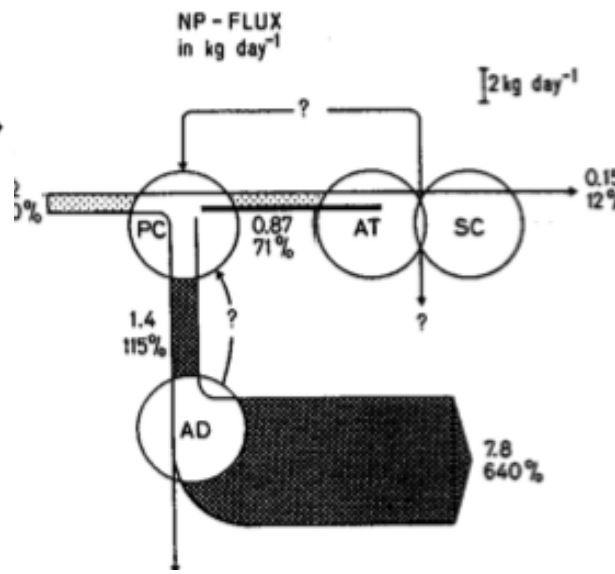
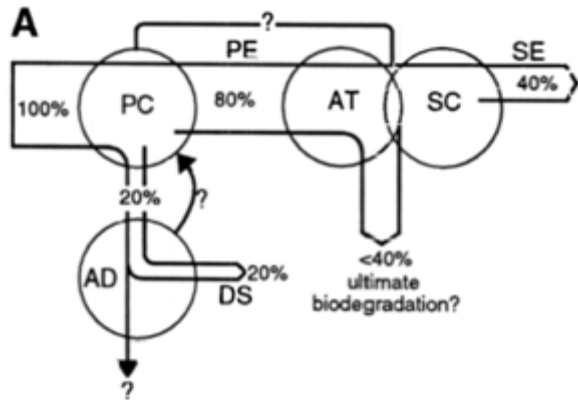
Marijan Ahel

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



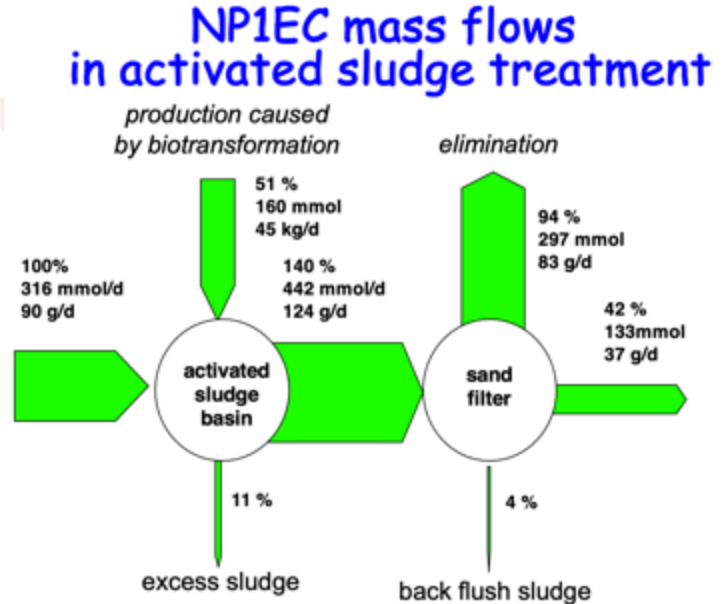
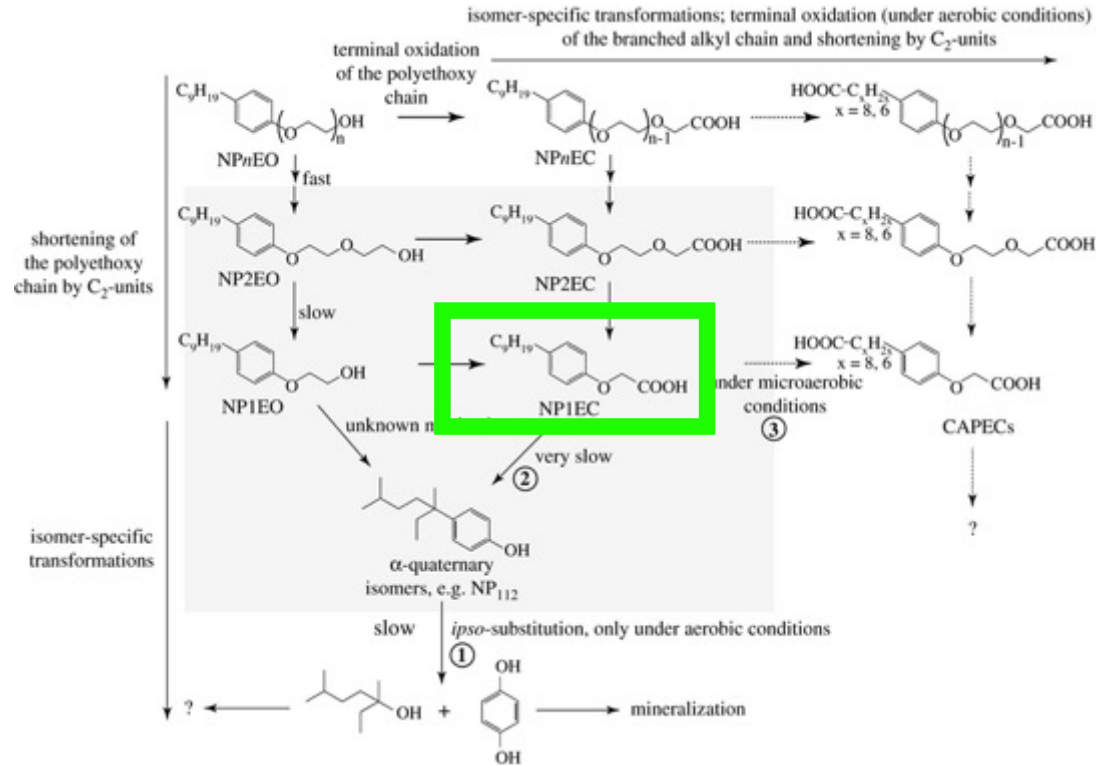
Hans-Peter
Kohler



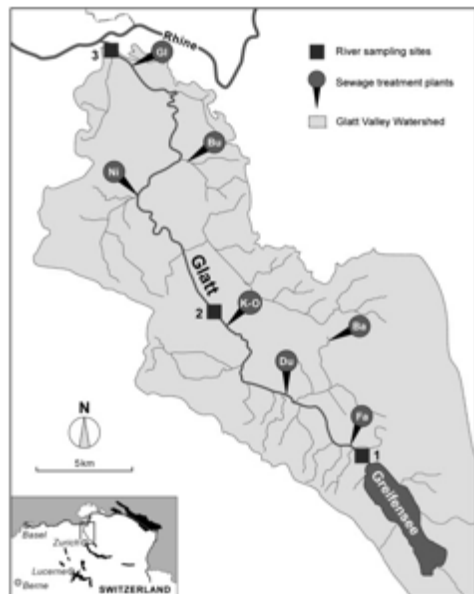
Frédéric Gabriel
2002-2007



Felix Wettstein
2003-2005

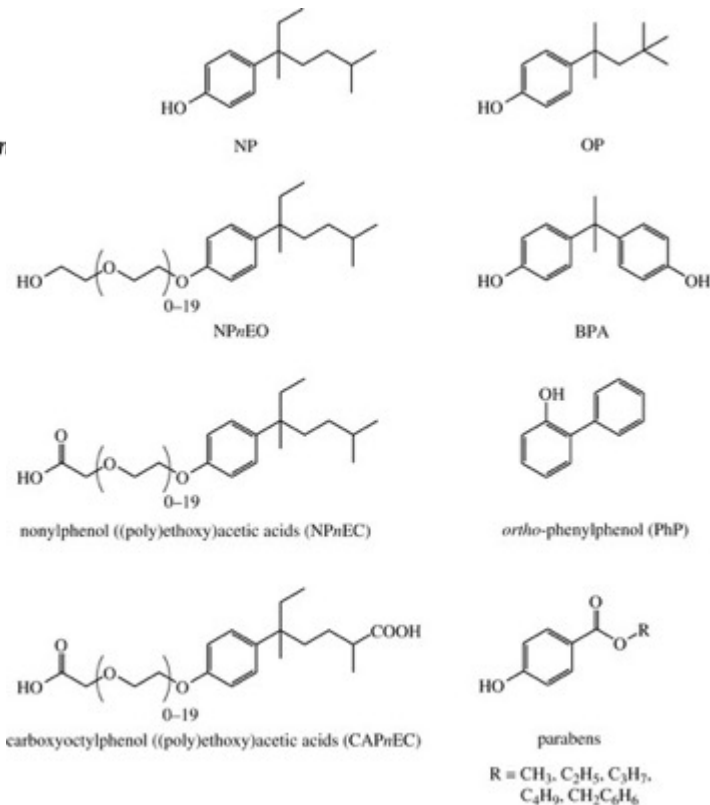


Mass balance of endocrine disruptors in a wastewater-river system is strongly influenced by water flow condition



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

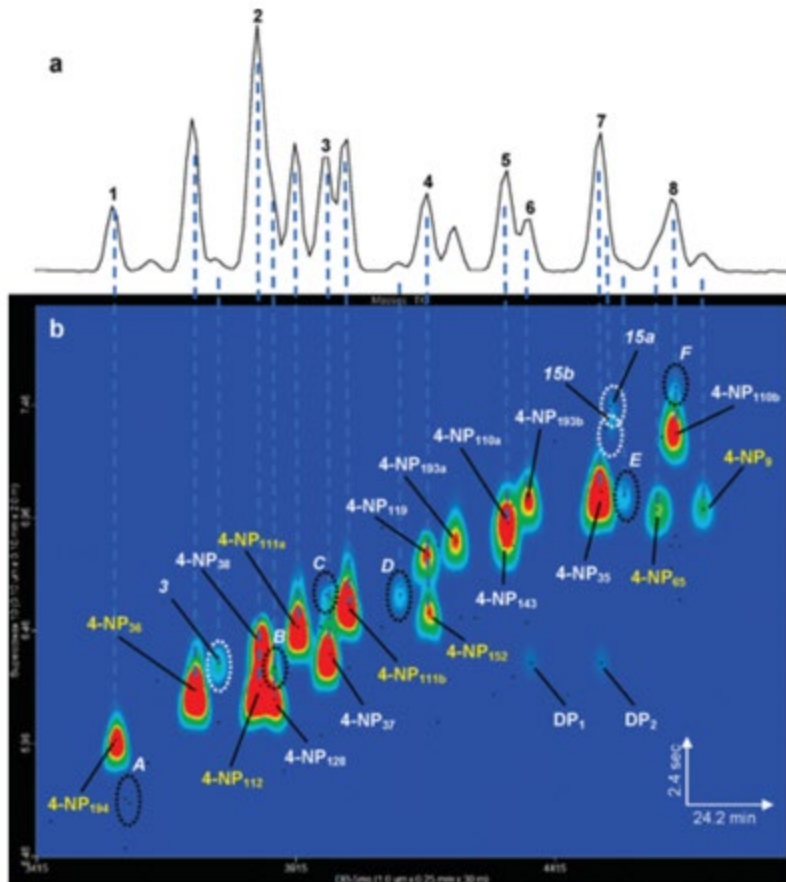
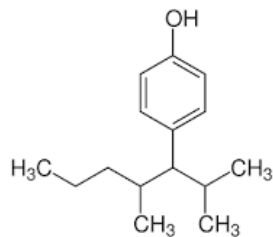
- solid-phase-extraction and LC-MS/MS techniques
- influents and effluents of wastewater treatment plants (WWTPs) and river water samples.
- mass flow analysis provided insight into the main sources and the fate of these contaminants during different weather conditions.

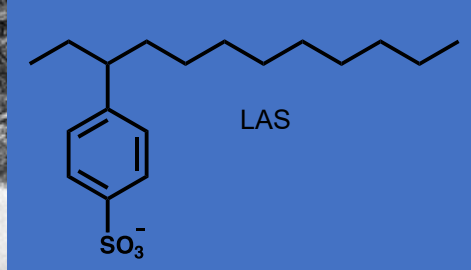
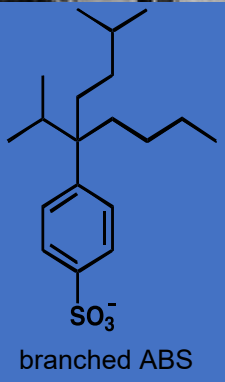




Isomer-Specific Determination of 4-Nonylphenols Using Comprehensive Two-Dimensional Gas Chromatography/Time-of-Flight Mass Spectrometry

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





Household detergent chemicals

- 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



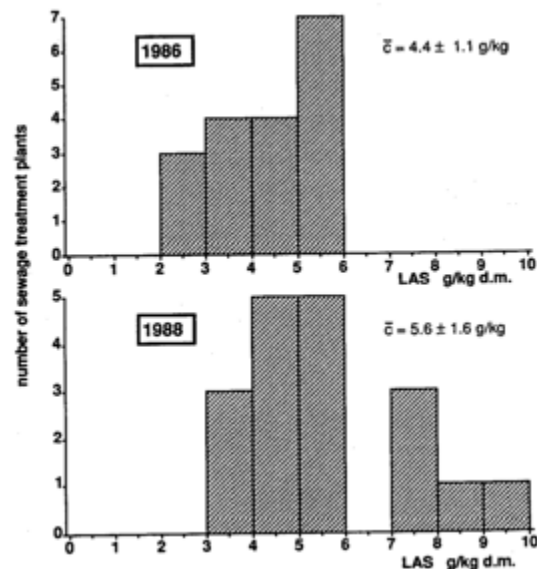
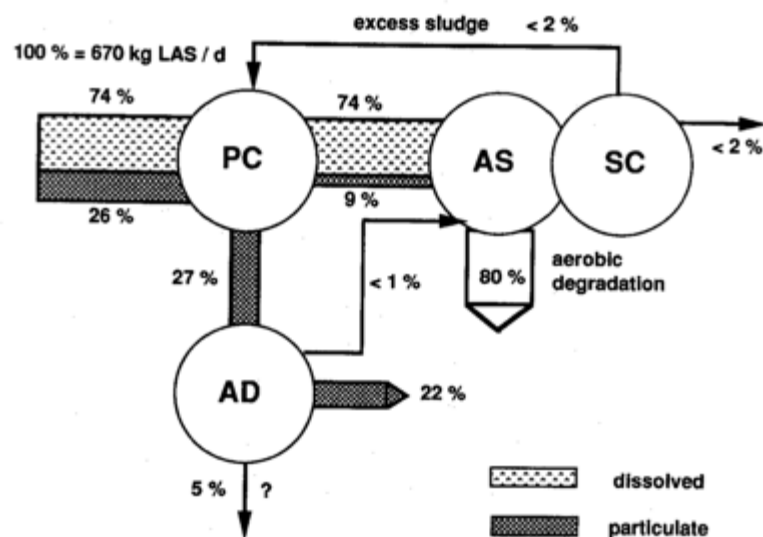
Pilar Fernandez
1992-1993



Antonio Marcomini
1985-1987

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

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





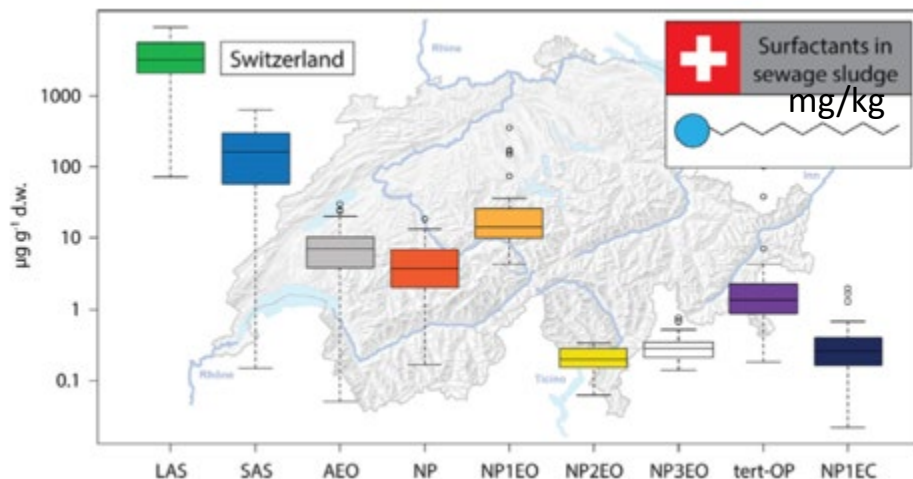
Lena Schinkel

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 ($\mu\text{g g}^{-1}$ 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.



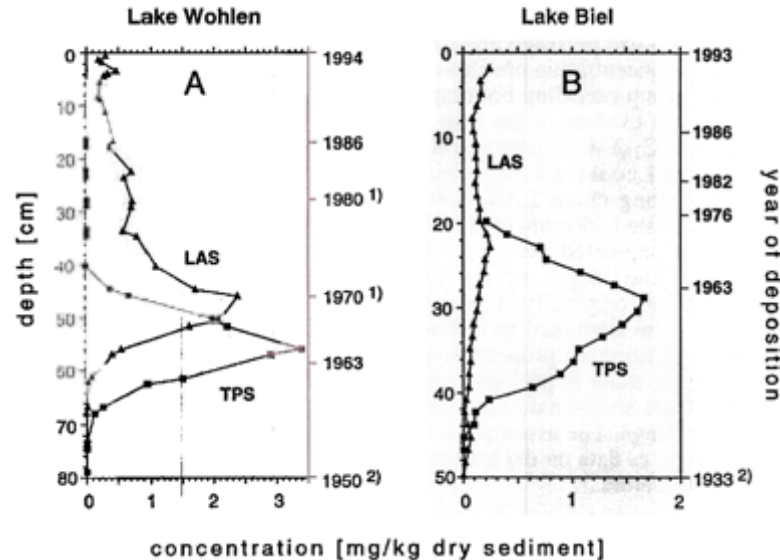
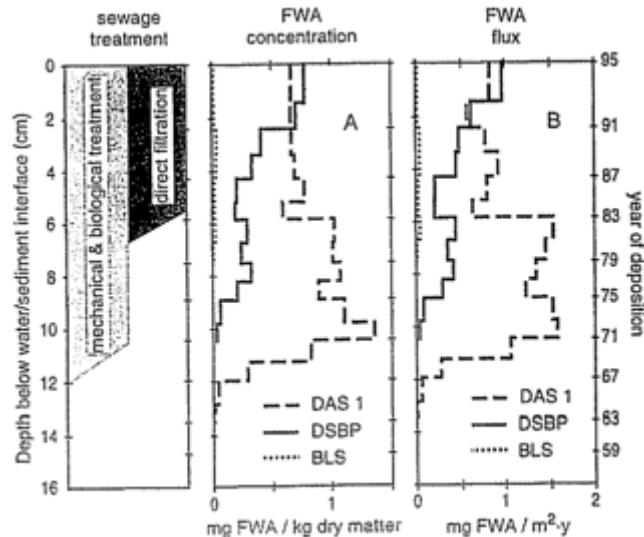
Thomas Poiger
1990-1994



Jean-Marc Stoll
1994-1997



René Reiser
1992-1997

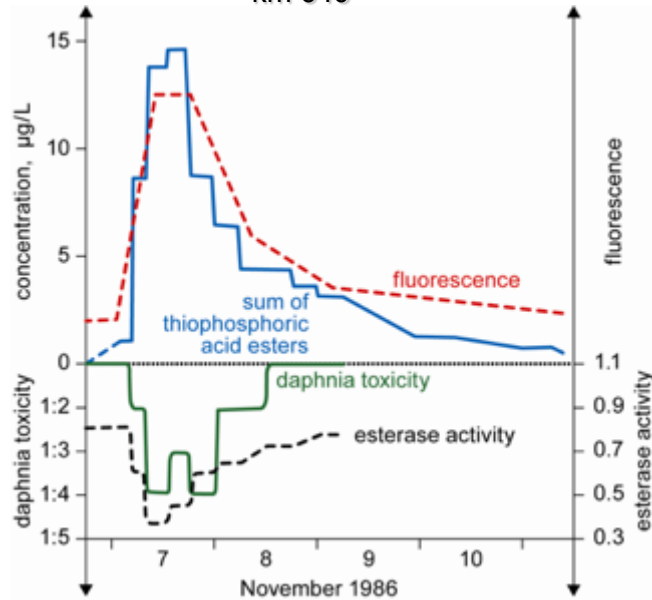


Schweizerhalle/Sandoz, 1986



The “Sandoz wave”

Bad Honnef
km 640



Giger, *ESPR* (2008)



Aus: „Die Zeit“, 14.11.1946



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. storeroom at Schweizerhalle, an industrial area near Basel, Switzerland, resulted in chemical contamination of the atmosphere and the surrounding Rhine. The Rhine River. The chemicals discharged into the Rhine caused massive kills of benthic organisms and fish (100-900 per 100 m² of riverbank) which was completely destroyed by the fire, contained pesticides (Table 1), solvents, dyes, and various raw and intermediate chemicals. More than 1300 metric tons of stored chemicals (1) was destroyed in the fire, but large quantities were introduced into the atmosphere. The fire burned for three hours 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 intense. The fire was called "one of the worst chemical spills ever" (4), the nature of the chemicals and the powerful self-cleaning mechanism of the river led to the predictions of a long-term "dead" Rhine unfished. The recovery of the Rhine from this accident is well underway, but the threat from chemical contamination still remains.



Chli Windgällen, 1993

René Reiser, Marc & Monika Suter



Franz Günter Kari

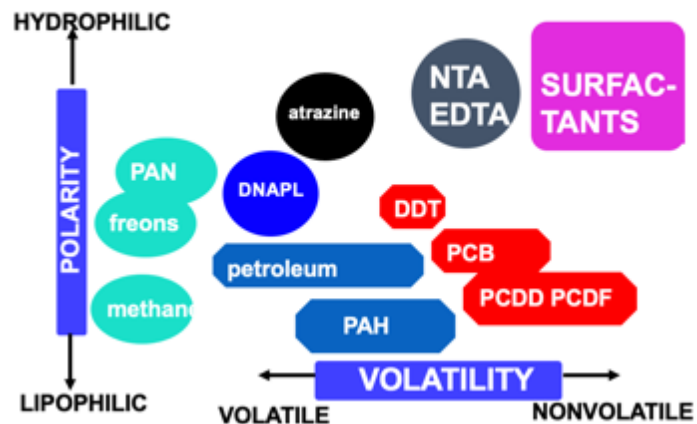
Alfredo Alder

Tom & Jennifer
Field

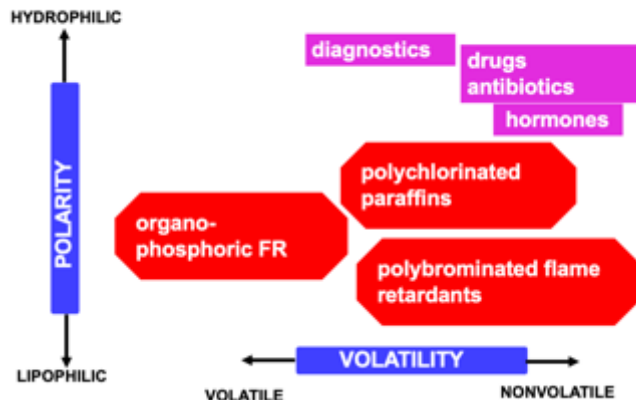
David Scheidegger

Erika Giger

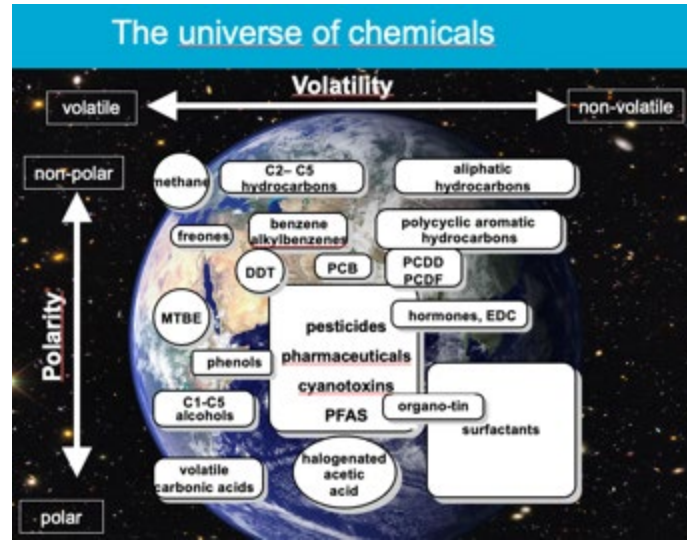
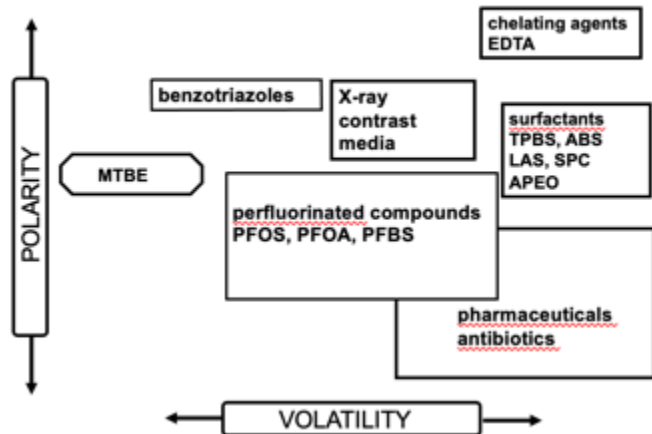
"Classic" organic contaminants



"Emerging" organic contaminants



Polar persistent organic pollutants



Heinz Singer
Euroanalysis
2023

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*

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

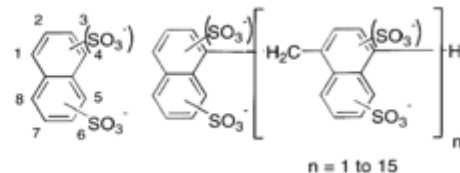


FIGURE 1. Chemical structures of the components of technical SNFC mixtures.

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



Beat Altenbach
1992-1996



Sabine Ruckstuhl
1998-2001



Sonja Riediker
1997-2002

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

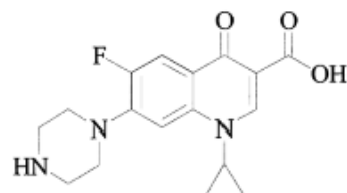
BENZENE- AND NAPHTHALENESULFONATES IN LEACHATES AND PLUMES OF LANDFILLS

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

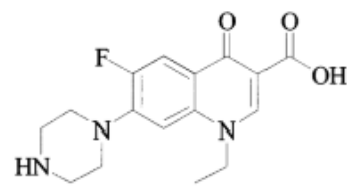
- EU research program **ANACAD**, *Analysis and Fate of Concrete Admixtures in Waste Water Treatment and in Natural Waters* 1997-2000
- International research program funded by Hewlett-Packard : **Rhine Basin Program**, *Aromatic Sulfonates* 1990-1998

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)



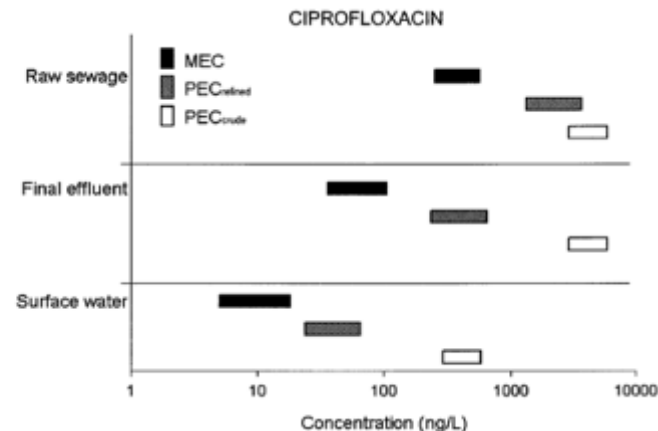
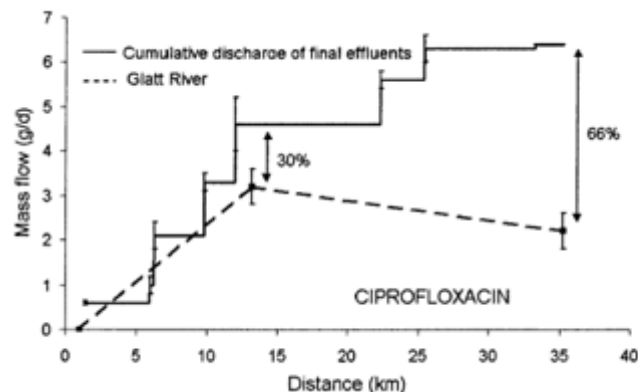
norfloxacin
(NOR)



Eva Golet
1997-2002

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

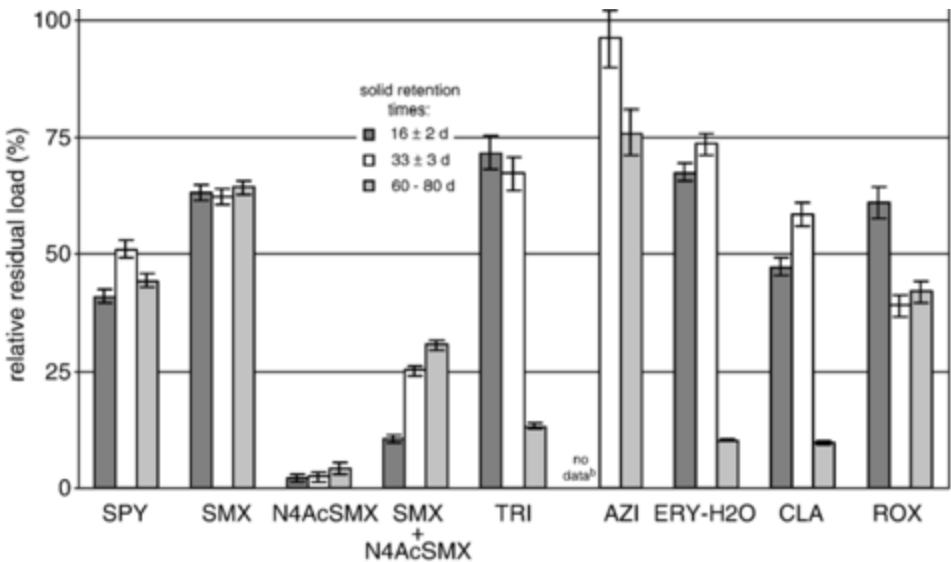


Fate of sulfonamides, macrolides, and trimethoprim in different wastewater treatment technologies

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



Anke Göbel
2001-2005



Hansruedi Siegrist



Adriano Joss



Christa McArdell
1996-2005

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

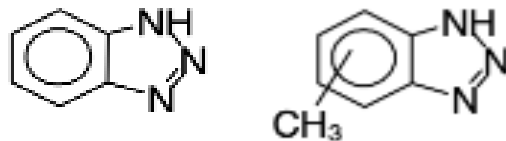
- **NRP 49** “Antibiotic resistance” 2001-2006
- EU Project “Assessment of technologies for the removal of pharmaceuticals and personal care products in sewage and drinking water facilities to improve the indirect potable water reuse” **POSEIDON** 2001-2004



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

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

Dimitra Voutsas
2004/5



Environ. Sci. Technol. 2006, 40, 7186–7192

Benzotriazole and Tolytriazole as Aquatic Contaminants. 1. Input and Occurrence in Rivers and Lakes[†]

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

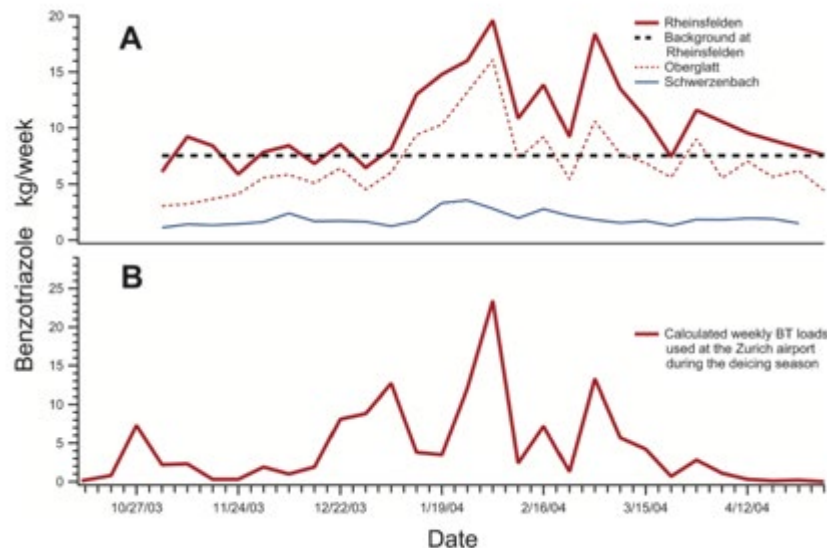
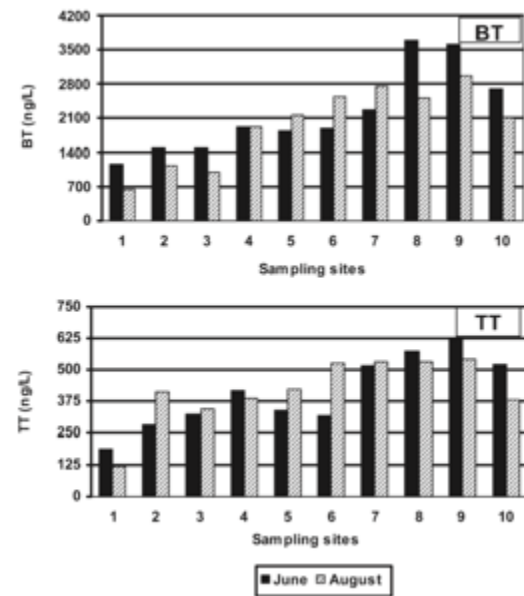


FIGURE 3. Benzotriazole mass flows in the Glatt River at Schwerzenbach, Oberglatt, and Rheinsfelden (A) and benzotriazole uses on Zurich airport (B).



Michael Berg Viet Pham Roland Schertenleib

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

VOL. 35, NO. 13, 2001

Chimia 57 (2003) 529–536

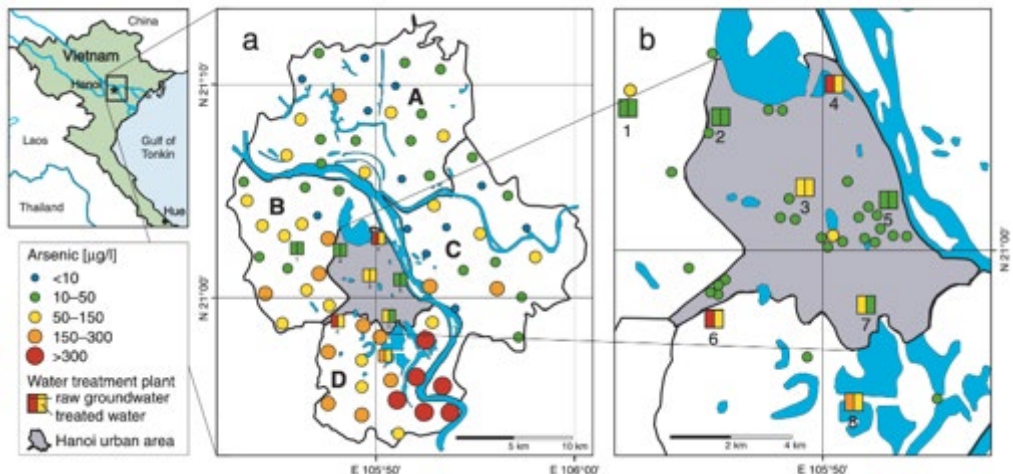
Environmental Analytical Research in Northern Vietnam – A Swiss-Vietnamese Cooperation Focusing on Arsenic and Organic Contaminants in Aquatic Environments and Drinking Water

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

Arsenic concentrations in the Hanoi area in September 1999



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 titration	[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			



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



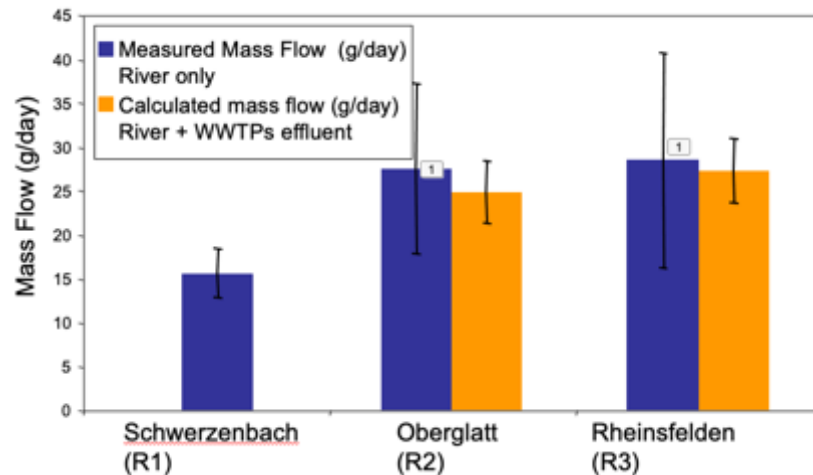
Jennifer Field



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



Hongwen Sun

Long-chain perfluorinated chemicals in digested sewage sludges in Switzerland

Hongwen Sun^a, Andreas C. Gerecke^b, Walter Giger^c, Alfredo C. Alder^{d,*}

Chemosphere 129 (2015) 62–73



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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 Voet¹

Eawag, Swiss Federal Institute of Aquatic Science and Technology, Überlandstrasse 133, CH-8600 Dübendorf, Switzerland

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 PFSA.
- Carpet and textile protection are most relevant for the emissions for PFCAs.
- Temporal trends between 2008 and 2011 show a decrease of PFOS levels.

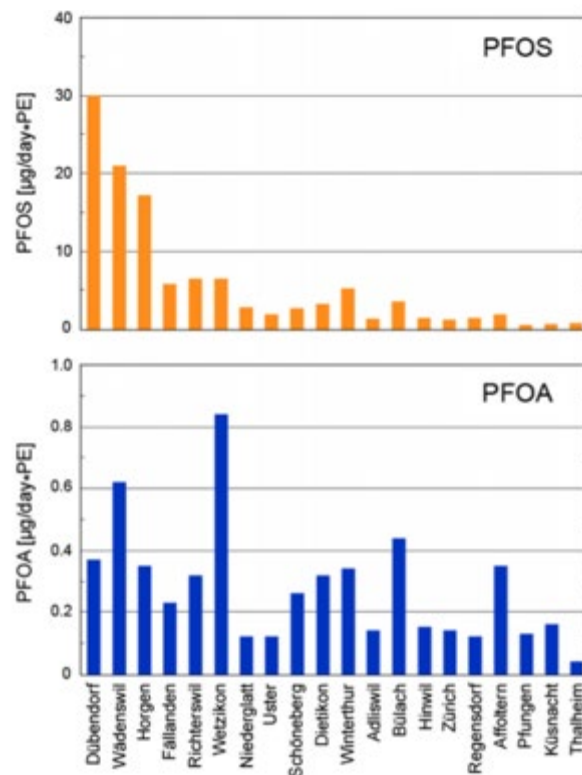
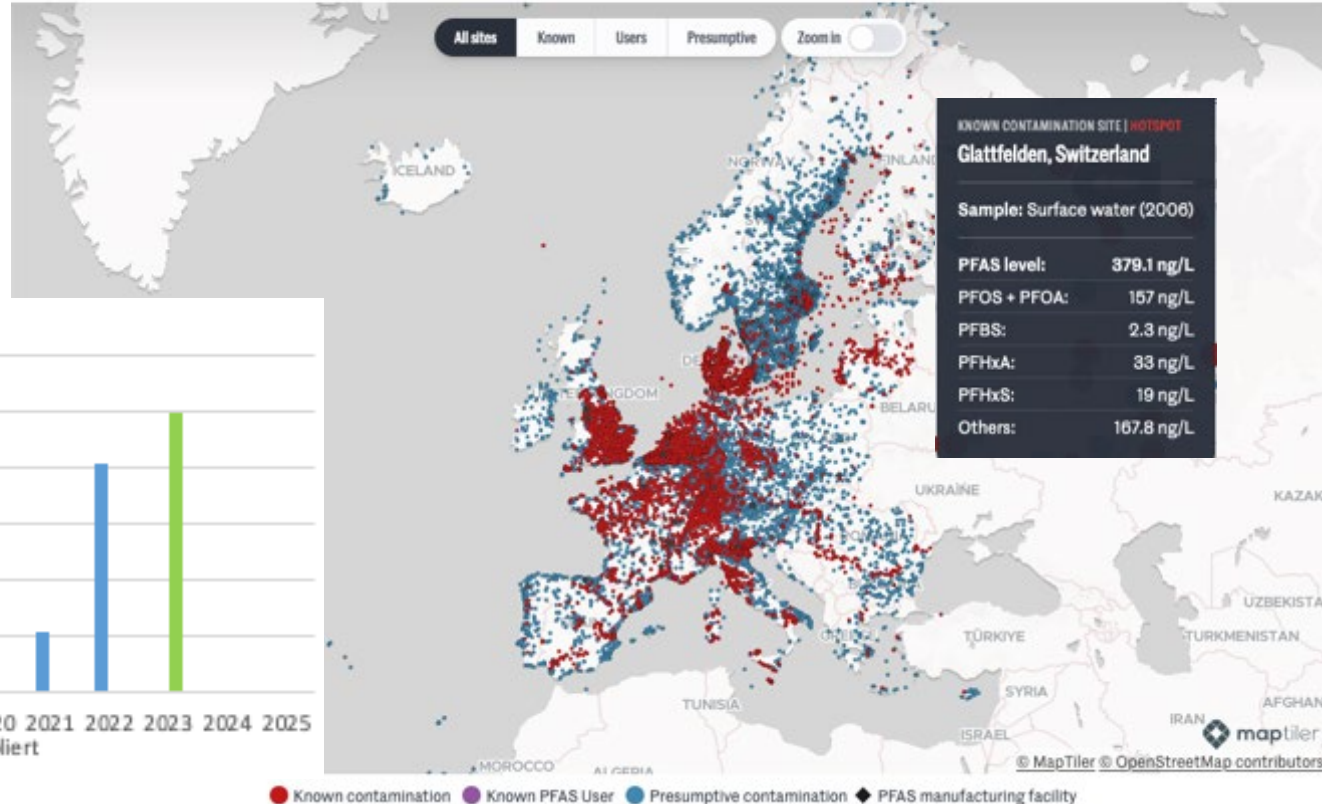


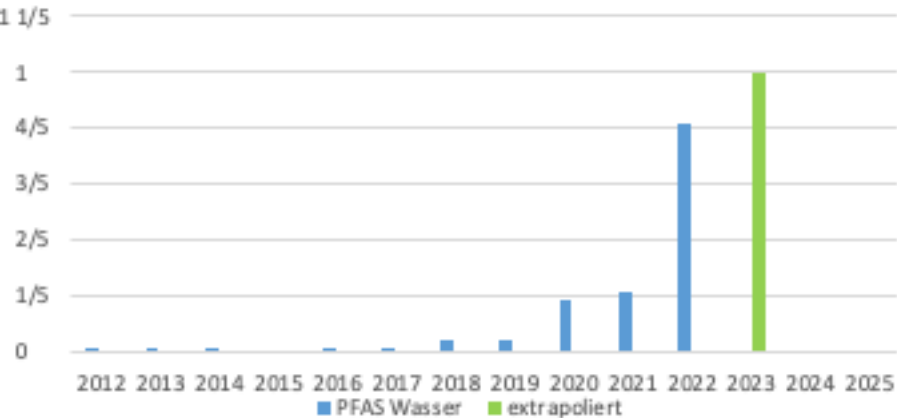
Fig. 5. Daily mass loads per population equivalents (PE) of PFOS and PFOA in digested sewage sludges from 20 WWTPs in Switzerland.

Forever Pollution Map, February 2023

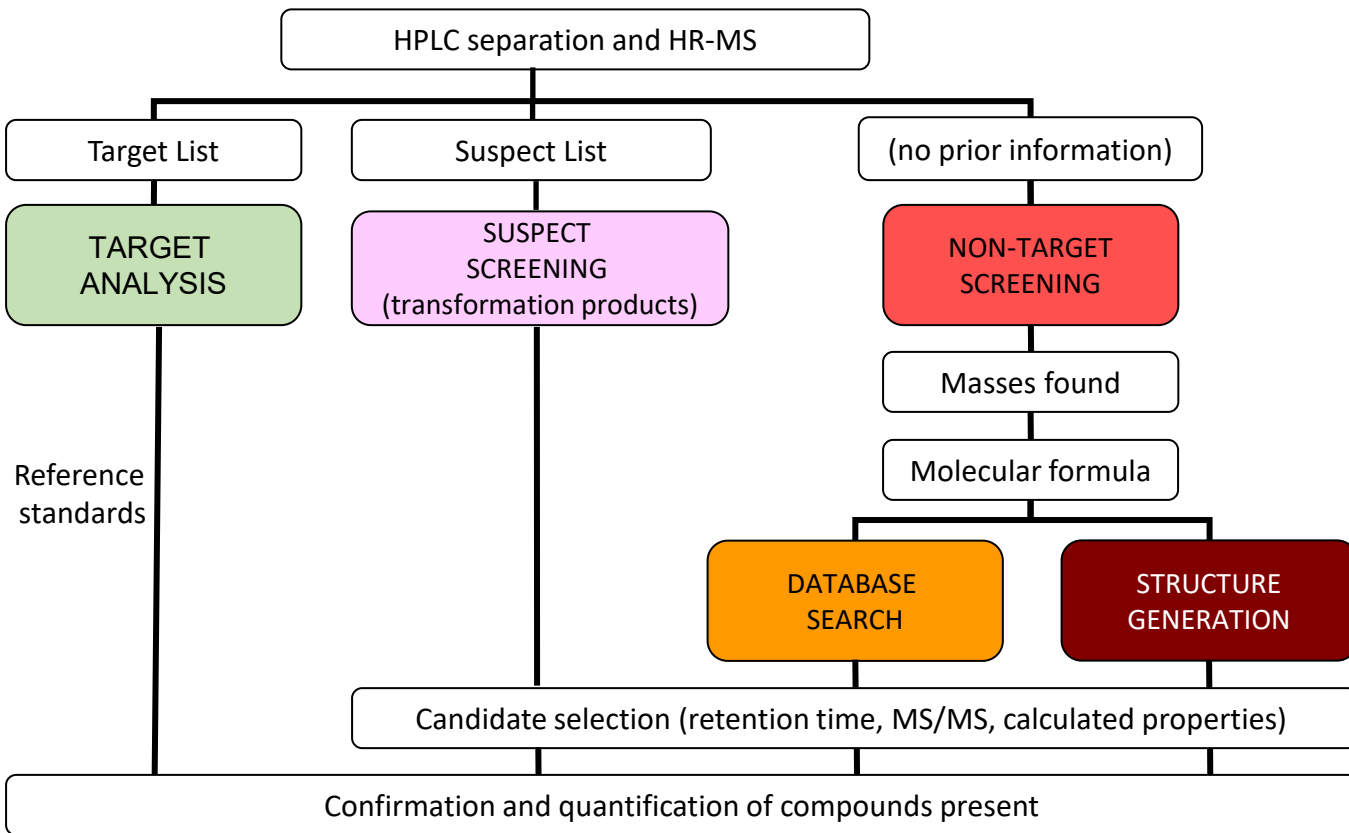
≡ Le Monde



Bachema
PFAS Determinations in water



Target, Suspect and Non-target analysis



*Aurea Chiaia, Eawag
and University of Bern*

*Juliane Hollender,
Heinz Singer, Eawag*

Number of compounds

Environmental mass spectrometry

Heinz Singer, Eawag, Euroanalysis 2023

TripleQuad QqQ

Sensitive **Target** analysis

Targets

**Toxic
non-polar
insecticides**

Lab

LL-GC-APCI

Targets

**Persistent polar
pesticide TPs**

Lab

VAC-IC-ESI

Orbitrap HRMS

Comprehensive **Non-Target** screening

Targets

**Illicit
drugs**

Transportable

MS2field

Suspects

**Cyano
toxins**

Lab

Online-SPE

Non-targets

**Industrial
chemicals**

Lab

SPE-LC

High resolution mass spectrometry

Juliane Hollender, Eawag, Anakon 2023

• Instrumentation

- high mass accuracy (< 0.001 Da)
- high mass resolution ($m/\Delta m > 40'000$)
- high sensitivity in fullscan mode
- chromatographic resolution
- soft ionization (ESI, APCI)

Data analysis /Databases

- compound databases



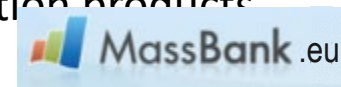
- suspect lists



- exposure relevant compounds
- predicted transformation products



- spectra libraries



- computational tools



CSI:FingerID

- 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

Mönch, 4099 m a.s.l.,
Bernese Oberland,
Switzerland

