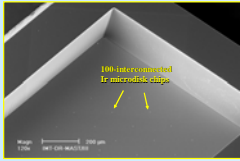


IN SITU AUTOMATED MONITORING OF TRACE METAL SPECIATION IN AQUATIC SYSTEMS IN RELATION WITH THE BIOGEOCHEMICAL PROCESSES

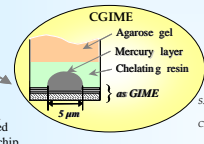
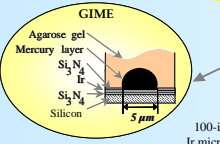
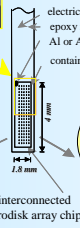
μ-Sensor Technology

Gel integrated Hg-plated Ir-based voltammetric microsensor arrays allowing direct measurements of specific metal species or group of metal species in complex media

(FNS and EU projects: CABE-University of Geneva + IMT-University of Neuchâtel)



Development Validation



Role and Fate of Trace Metals in Aquatic Ecosystems ?

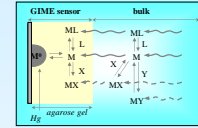


Ecotoxicity ?
 Reactivity ?
 Spreading ?

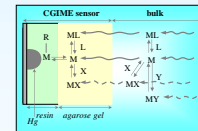
J. Bufflé*, M.-L. Tercier-Waeber, Trends in Analytical Chemistry 24 (2005) 172-191.
 S. Noël, M.-L. Tercier-Waeber*, J. Bufflé, O. Cuenat, M. Koudelka-Hep, Electroanalysis, 18 (2006) 2061-2069.
 Tercier-Waeber*, J. Bufflé, Anal. Chem. 66 (1994) 3670-3678
 C. Belmont-Hébert, M.-L. Tercier*, J. Bufflé, G.C. Fancabris, M. Koudelka-Hep, Anal. Chem. 70 (1998) 2949

μ-Sensors Measurement Principle and Feature

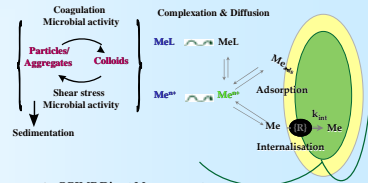
GIME voltammetric microsensor: micro-integrated analytical system coupling separation, electrochemical pre-concentration and detection



CGIME voltammetric microsensor: micro-integrated analytical system coupling separation, chemical and electrochemical pre-concentration, electrochemical detection



- GIME Direct Measurements:
 - detection of **dynamic metal species** (free Me ions + small and mobile ML complexes with size of few nm)
 - Me species potentially bio-available
- GIME Measurements in Pretreated Samples:
 - total extractable metal Me concentrations
 - collaboration with the term of transport properties and residence time



- CGIME Direct Measurements:
 - detection of **free Me ions**
 - Me species linked to bio-uptake

In situ Monitoring Systems

Submersible probes for in situ « real-time » measurements of specific metal species or group of metal species coupled to master variables (EU projects: Idronaut Srl-Milan + CABE-University of Geneva)

First generation: The VIP System

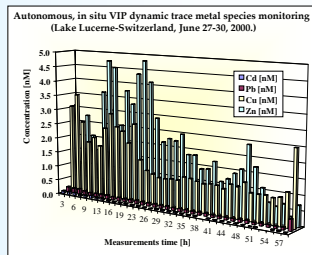


Voltaammetric In situ Profiling system

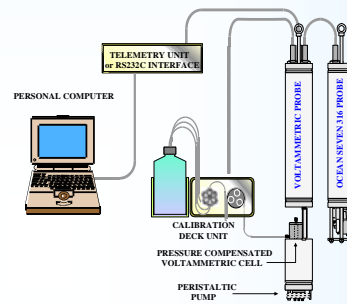
In situ monitoring of the dynamic fractions of Cu(II), Pb(II), Cd(II), Zn(II) at the ppt level and Mn(II), Fe(II) at ppb level using a GIME sensor

VIP users: worldwide academic/governmental institutes and private companies

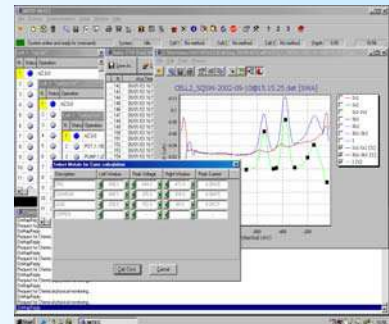
CABE-CH; EAWAG-CH; Plymouth Marine Laboratory-UK; Lancaster Environmental Science Dept-UK; Institute of Marine Sciences-I; Analytical and Marine Laboratory-S; INRS-Canada; California State University-USA; Seismic Appl. Beijing-China; Iranian National Center for Oceanography-Iran; Magistrato Alle Acque Venezia-I; T&T S.p.a-I; Seismic Asia Pacific LTD - Australia; MariCal Ltd - USA



VIP schematic diagram and details of its main components



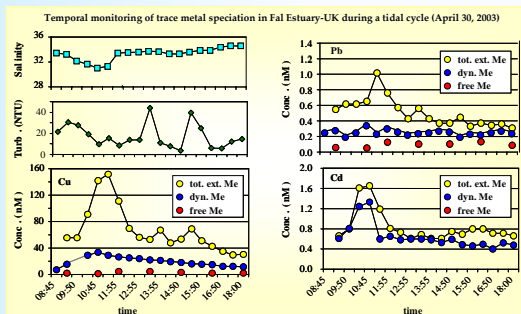
VIP - Windows Management Program



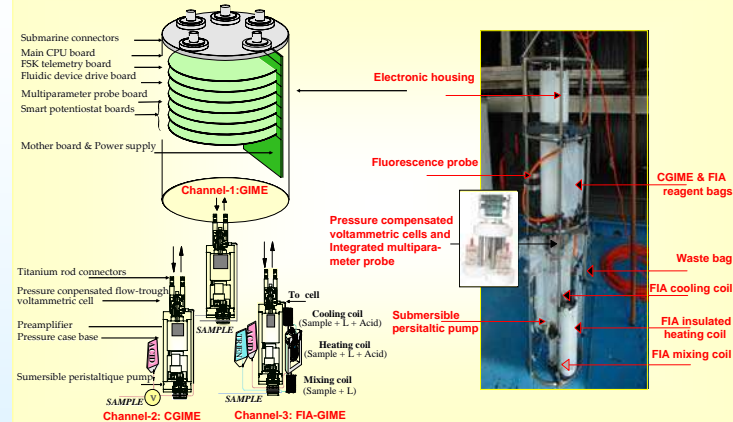
Second generation: The MPCP

Multi Physical-Chemical Profiler

In situ simultaneous monitoring of 4 specific fractions (speciation) of Cu(II), Pb(II), Cd(II) at the ppt level (free Me ions, dynamic Me species, colloidal/particulate Me species, total extractable Me conc.) and master variables (p, T, O₂, conductivity, salinity, turbidity, chlorophyll a)



The Multi-Physical Chemical Profiler (MPCP) and details of its main components



Reliable remote monitoring systems for environmental studies and pollution control

Advantages of remote submersible probes:

- Rapid detection of pollutant input
- Minimization of the large number of artifacts (sampling and sample handling)
- Minimization of the overall cost of data collection
- Accumulation of detailed spatial and temporal data
- Development, optimisation of environmental models
- Measurements in locations difficult to access (boreholes, deep lakes and oceans)



Applications



MPCP applications:

- Gullmar Fjord-Sweden: Monitoring of trace metal speciation in relation with bio-geochemical processes (IMTEC EU project 2002)
- Estuaries-SW UK: Temporal evolution of trace metal speciation and master variables in microtidal estuaries (IMTEC EU project - 2003)
- Venice Lagoon & northern Adriatic coastal area-I: Remote in situ monitoring of trace metal speciation and master bio-physicochemical variables (IMTEC EU project - 2003)
- Po estuary & its coastal plume-I: Spatial evolution of trace metal speciation and bio-physicochemical parameters (IMTEC EU project - Adriatic cruises: 2002, 2003, 2004)
- Lake Lemán-CH: Trace element regulation and removal by algal blooms in the surface water of Lake Lemán. (Projet Franco-Suisse TERRAB 2006; Forel, INRA-Thonon, CABE)
- Riou-Mort & Lot rivers-Fr: Monitoring of spatial and temporal evolution of specific trace metal species and master variables in aquatic systems affected by chronic polymetallic pollution. (ECODIS EU project : 2007-2008)

Detailed spatial and temporal data bank on trace metal speciation and bio-physicochemical parameters
 Development/optimisation of predictive environmental models
 Evolution of aquatic ecosystems and of long term impact of heavy Me