

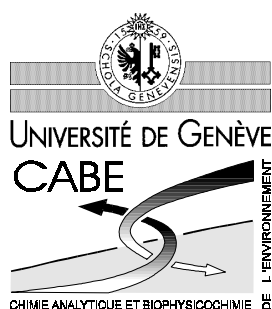
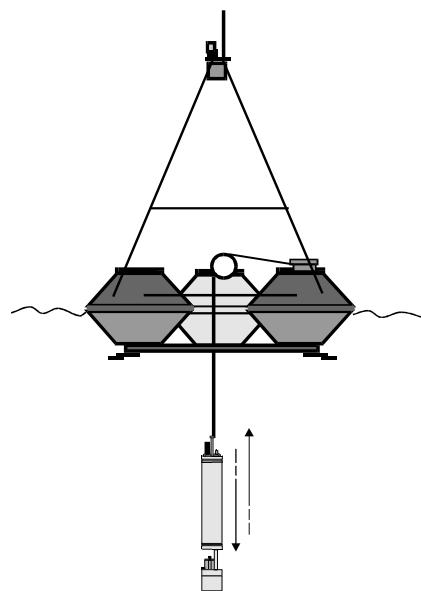
# Voltammetric In-situ Profiling system

**Introducing the only existing probe for trace compounds analysis at variable depth from the leader in Radio Buoy Profiling systems.**



## Check out these features !

- ☑ simultaneous trace metals analysis,
- ☑ possible extension to other compounds,
- ☑ original, long-term reliable gel protected microsensor,
- ☑ wide dynamic range (ng/l to mg/l),
- ☑ chemical speciation capability,
- ☑ easy combination with CTD, Oxygen, pH, redox sensors,
- ☑ flexibility of operation: spot or long-term monitoring,
- ☑ autonomous data analysis and transmission to land,
- ☑ profiling capability between 0 to 500 meter,
- ☑ advanced computer controlled analysis



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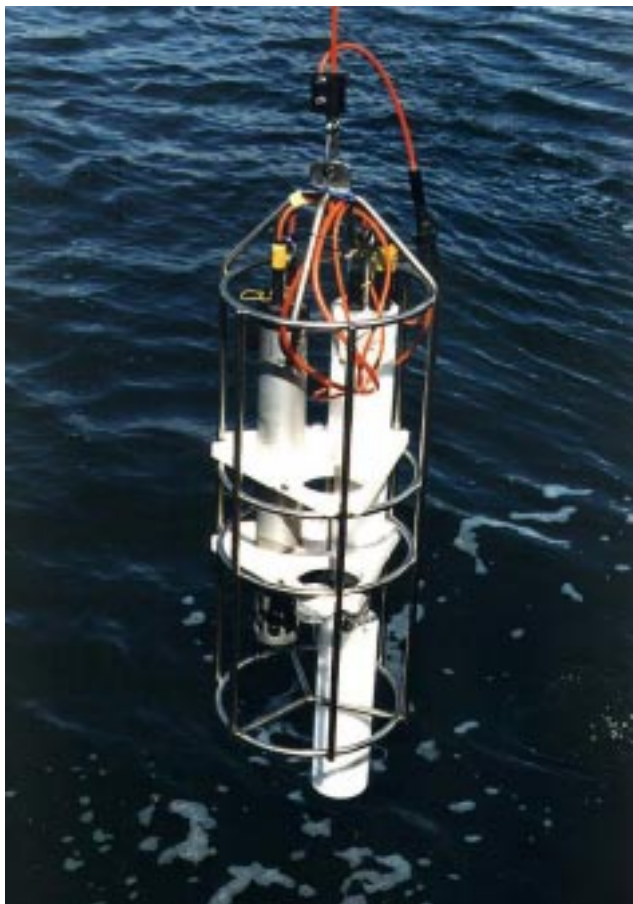
The CABB Group (Analytical and Biophysical Environmental Chemistry Group, University of Geneva) in collaboration with the Italian company IDRONAUT, has developed a voltammetric probe with which reproducible and reliable continuous monitoring can be performed. The **VIP system** includes both this voltammetric probe and the Idronaut OCEAN SEVEN 301 probe. It is usable in sea, fresh water, ground water down to 500 m as well as in treatment plants or water distribution network. It is controlled either by an operator from the surface, or automatically by a computer, when attached to a buoy. The submergible voltammetric probe is hung from the surface by means of a coaxial umbilical cable which powers the unit and transmits data by telemetry to the surface system.

The **VIP system**, when interfaced with an automatic Buoy Profiler, allows the whole water column (down to 500 m) to be automatically monitored for at least one week, at prefixed periods. It is configurable to routinely determine the concentration profiles in conditions chosen by the user (time period, depth resolution, etc.).

The **VOLTAMMETRIC PROBE** contains all the hardware and firmware necessary to manage the voltammetric measurements, the interfacing of the IDRONAUT OCEAN SEVEN 301 via an RS232C interface and the data transfer through telemetry to the surface deck unit or to the surface Buoy Profiler, if present.

The **VOLTAMMETRIC PROBE** allows measurement of i) Cu(II), Pb(II), Cd(II) and Zn(II) with a sensitivity greater than 100 pM and ii) of Mn(II), Fe(II) with a sensitivity of 0,1 µM. Analysis of other elements or organic compounds are foreseen. It permits metal speciation, i.e. it specifically determines the dissolved fraction of the trace metals (i.e. mobile metal species smaller than few nanometers), directly in-situ, without any sample handling, thus minimizing methodological artefacts. Additional determination of the total metal concentration permits calculation of the colloidal and particulate metal fraction by difference. This distinction is important for understanding the role and the fate of trace elements in a given aquatic system. Indeed, the dissolved fraction corresponds to the fraction easily assimilated by organisms while colloidal and particulate fractions play an important role in transport properties and residence time.

The **OCEAN SEVEN 301** probe allows measurement of the main chemical and physical parameters such as Depth, Temperature, Conductivity, Dissolved Oxygen, pH and Redox potential. Therefore, through these two measuring probes, in-situ voltammetric measurements of dissolved trace heavy metals are associated with other important chemical and physical characteristics of the sample. Additional probes for turbidity and fluorometry can also be integrated.



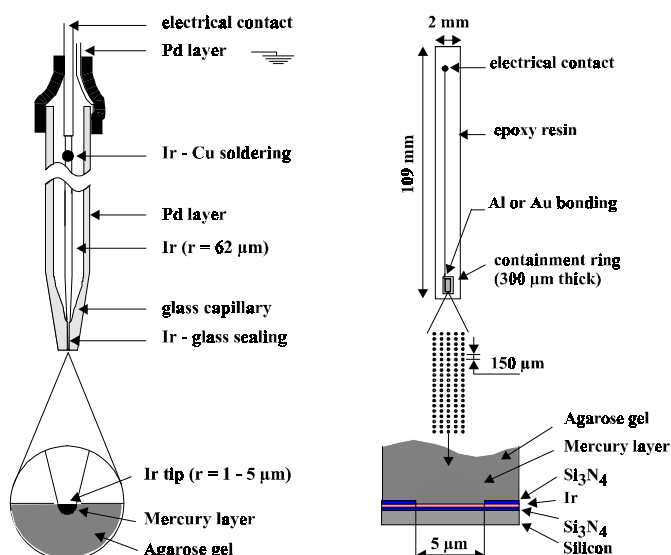
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## NOVEL VOLTAMMETRIC MICROSENSOR

The heart of a probe is its sensor. It measures a signal intensity, produced by the chemical reaction at its surface, which is proportional to the target elements. However, to perform automatic measurements over extended periods in complex media such as natural waters, most of the currently available sensors are not reliable nor sensitive enough for monitoring very low concentration of chemical compounds.

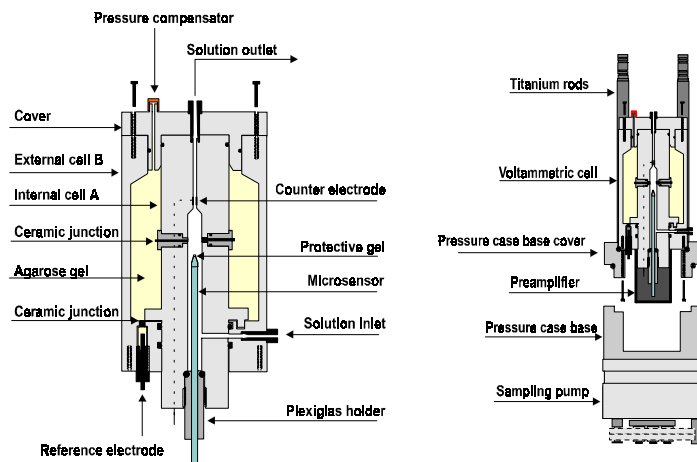
By optimising each production step and analytical procedure, the CABB Group, with the financial support of the Swiss National Foundation, has developed an electrochemical sensor satisfying the following criteria: robustness, versatility, reproducibility, stability and durability. **This sensor consists of an Iridium disk microelectrode of a few microns, sealed in a shielded glass capillary, coated or not with a mercury layer, and covered with a hydrophilic protective membrane.**

**The originality** of this invention is the combination of a separation method by dialysis process with a detection method (voltammetry using microelectrode) in the membrane miniaturized volume (mm<sup>3</sup>). In addition, the hydrophilic membrane prevents irreproducibility due to external variable convection and fouling of the microelectrode by adsorption of interfering compounds present in complex media such as waste waters, sediments, biological and industrial samples. Recently, IMT in collaboration with CABB, have developed a similar sensor using thin film technology on chips and photolithographic technique. These techniques allow mass production at low cost. The sensor consists of 5x20 interconnected Iridium microdisc electrodes having a diameter of 5 µm and a centre spacing of 150 µm surrounded of a 300 µm thick Epon SU8-8 containment ring for the hydrophilic protective membrane. The main advantage of this sensor is that it can be mass produced under well controlled conditions. Both sensor types have been successfully used for direct measurements of copper, lead, cadmium and zinc in trace level concentrations (concentrations <sup>3</sup> 0.005 µg/l) as well as of iron and manganese (concentrations <sup>3</sup> 10 µg/l) in freshwater (lakes, rivers).

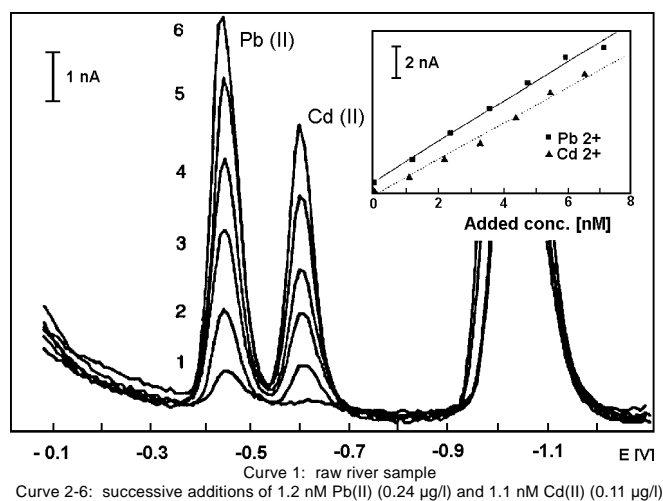


## THE VOLTAMMETRIC CELL

Both sensors are integrated in a flow-through voltammetric measurement cell with a platinum ring auxiliary electrode and a Ag/AgCl/KCl sat. gel reference electrode installed as dual bridge system with two ceramic junctions in contact with the solution. The second electrolyte reservoir (hydrophilic gel containing 1M NaNO<sub>3</sub>) of the reference electrode is placed all around the inner cell in order to shield both the working microelectrode and the counter electrode and, most important to allow pressure compensation. The cell is fixed on a pressure case base incorporating the preamplifier electronic board and the electrode connectors. Adaptation and connection of the voltammetric cell to the electronic housing is performed via two titanium rods.



Direct measurement and standard additions of Pb(II) and Cd(II) in Arve river sample.



**The VIP system is a no-compromise, state-of-the-art voltammeter to address the requirements of every environmental laboratory performing aquatic monitoring.**

The **complete VIP system** allows to perform continuous, in-situ, automatic profiling at prefixed periods. It consist of: a **submersible measurement system**, a **calibration deck unit**, a **surface deck unit**, a **701 Buoy profiler** and a **management software** running on IBM compatible PCs.

- The **submersible measurement system** is composed of the Voltammetric probe, an Ocean Seven 301 Probe and a peristaltic pump. The **VOLTAMMETRIC PROBE** contains all the hardware and firmware necessary to manage the voltammetric measurements, the interfacing of the OCEAN SEVEN 301 via an RS232C interface and the data transfer by telemetry, to the surface deck unit. The **OCEAN SEVEN 301** allows the measurement of other chemical and physical parameters such as Depth, Temperature, Conductivity, Dissolved Oxygen, pH and Redox potential. Optionally other sensors can be installed on the OCEAN SEVEN 301 probe. The OCEAN SEVEN 301 must be used during manual profiling in order to acquire depth data or to activate measurement at preselected depth.

- The **calibration deck unit**, which is connected to the submersible system before deployment, allows on-site probe maintenance and calibration operations, by means of a six position rotary valve and a peristaltic pump.

- The **surface deck unit** powers and interfaces by telemetry the measuring system with a Personal Computer. This unit converts serial, RS232C type signals (coming from a PC communication port), into telemetry signals (and vice versa) which flow superimposed on the measuring system power supply along the cable. The deck unit and the measuring system can be equipped with either ASK (up to 1500 meter cable length) or FSK (up to 10000 meter cable length) telemetry systems. The surface deck unit contains: a battery, a battery recharger, a power supply devices to power the VIP system and the transceiver used by the telemetry system. The internal rechargeable 12V lead battery allows more than one week of continuous operation without any external AC power.

- The **701 BUOY PROFILER** allows the unattended-automatic-profiling and monitoring of heavy metals trace analysis and other chemical and physical parameters in the water column at preset times.

- The **management software** allows the operator to manage all the functions required by the VIP system during each working activity. They are: voltammetric probe calibration and maintenance, measurements and profiling, automatic data retrieving, data processing and the support of the operator during each phase of the working activities.

## VOLTAMMETRIC PROBE SPECIFICATIONS

### ANALYTICAL

Measurable elements or compound:	Cu(II), Pb(II), Cd(II), Zn(II), Mn(II), Fe(II) extension to other elements or compounds is possible, metal speciation (see text)
Lowest detection limits:	50 pM (0.01ppb) (15 minutes deposition time) Cu(II), Pb(II), Cd(II), Zn(II)
Measurement range:	0.5nM to 500 nM (5 minutes deposition time) 0.1ppb to 100 ppb (5 minutes deposition time) Mn +Fe direct reduction mode concentrations <sup>3</sup> 0,1 µM

### OPERATIONAL

Measurement technique:	Anodic Stripping Voltammetry (Square Wave form)
pulse amplitude:	1 to 250 mV
step amplitude:	1 to 250 mV
pulse frequency:	1 , 1000 Hz (1ms to 1 s)
Hg film deposition technique:	constant potential
potential range:	± 2048 mV,
Hg film reoxidation technique:	linear potential scan
potential range:	± 2048 mV
scan rate:	from 1 mV/s to 1 V/s
Calibration:	automatic output of concentrations in ppb and/or nM

### ELECTRONIC

Power supply voltage:	10 , 30 V D.C, 100 mA @12 V 1.2 W
Memory	firmware: 256KWord Flash memories
	data: 1Mbyte non volatile RAM
Interfaces	RS232C: up to 38400 bps
	telemetry: FSK modulation, up to 4800 bps over cable 10000 meter long.
Compliance voltage:	± 8V @1 mA
Potential range:	± 2048 mV
Potential resolution:	± 250 µV
Current-measuring ranges:	from ± 1 pA to ± 30 µA
Minimum measured current:	0.1 pA
Data acquisition rate:	50 KHz (20 µs)

### MECHANICS

Dimensions:	length: 810 mm	weight: 6 kg (in air) - 3 kg (in water)
Pressure cylinder:	withstands up to 150 bar	
Material:	titanium, acetalic and acrylic plastics	

## CALIBRATION DECK UNIT SPECIFICATIONS

Allows laboratory and on-site conditioning and calibration operations. It incorporates the computer controlled six position rotary valve. The unit is provided with a holder containing (up to four) solution bottles; each bottle is equipped with cap, micro-filter and vent hole.

Dimensions: 130 x 260 x 340 mm. Weight: 1 kg.

## SURFACE DECK UNIT SPECIFICATIONS

The function of the PORTABLE DECK UNIT is to power and interface, by telemetry, the Voltammetric Probe with a portable Personal Computer. This unit contains a rechargeable lead battery (12V - 6.5 A/h) which allows about 35 hours of continuous operation even without external power (100, 110 or 220V AC, 50/60 Hz).

The PORTABLE DECK UNIT is provided with an adjustable power supply to power the Probe, an internal power supply to recharge the 12 V internal battery and a transceiver able to transform commands coming from the PC and data coming from the probe into an RS232C asynchronous transmission format, HALF-DUPLEX mode.

Dimensions: 275 x 250 x 75 mm. Weight: 4.5 kg.



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