

ESM series samplers – Exposmeter Metals for sediments series samplers

A passive, integrative tool for measuring
metal concentrations in water

ESM series samplers based on DGT (Diffusive Gradient Thin Films) technology. ESM series samplers measures directly the mean flux of labile species of metals to the device during the deployment. This can be interpreted directly as the mean concentration of labile metal at the interface between the device surface and the sediment, during the deployment. For the situation where supply from soil particles to solution is rapid, this interfacial concentration is the same as the concentration of metal in bulk pore-water.

ESM series samplers can be deployed in undisturbed sediments. It will then provide information related to the local structure and heterogeneity. For deep water ESM series samplers can be deployed into retrieved sediment cores or a submersible lander can enable in situ deployment.



ESM series sampler

Different binding agents with selectivity for different substances can be deployed. A binding agent is immobilized in a thin layer of hydrogel (binding-gel). It is separated from solution by an ion permeable hydrogel layer (diffusive gel) of thickness Δ_g . Between the diffusive gel and the bulk solution there is a diffusive boundary layer

(DBL), of thickness δ where transport of ions is solely by molecular diffusion. Within a few minutes of immersion, a steady state linear concentration gradient is established between the solution and the resin gel.

In practice the EGM series samplers are deployed for a fixed time, t (s). On retrieval the binding-gel layer is peeled off and the mass of the accumulated ions in this layer is measured. The mass can be measured directly in the binding-gel layer by drying it and using a beam technique such as laser ablation ICP-MS. More commonly, ions in the binding-layer are eluted with a known volume of solution (1 or 2M HNO₃ in the case of metals bound to Chelex resin). The concentration of ions in the eluent is then measured by any suitable analytical technique after appropriate dilution.

Concentration in the bulk solution can be calculated from the known values of Δ_g , D and A , the measured deployment time, t , and accumulated mass, M .

$$C = M\Delta_g / DtA$$

where D is the diffusion coefficient ($\text{cm}^2 \text{s}^{-1}$),

A is area of the exposed diffusive layer, (cm^2)

Δ_g is thickness of hydrogel layer (diffusive gel), cm

ESM series samplers distinguish between species both kinetically (according to their lability) and by size (whether they can pass through the diffusive gel layer). By using different gel compositions it is possible to effectively measure inorganic and organically complexed metal species separately in situ.

ESM – Exposmeter metals for sediments Metals (Cd, Co, Ni, Cu, Zn, Pb, Fe, Mn, Al)

Binding agent: Chelex resin immobilised in a thin layer of hydrogel Diffusive gel: ion permeable hydrogel layer (polyacrylamide)

Size: plastic assembly - 25 cm x 4 cm, exposure window - 15 cm x 2 cm



ESM-P – Exposmeter phosphorus for sediments

Binding agent: Iron oxide immobilised in a thin layer of hydrogel Diffusive gel: ion permeable hydrogel layer (polyacrylamide)

Size: plastic assembly - 25 cm x 4 cm, exposure window - 15 cm x 2 cm

ESM-As – Exposmeter arsenic for sediments

Binding agent: iron oxide immobilised on thin layer of hydrogel Diffusive gel: ion permeable hydrogel layer (polyacrylamide)

Size: plastic assembly - 25 cm x 4 cm, exposure window - 15 cm x 2 cm

ESM-Hg – Exposmeter mercury for sediments

Binding agent: Spheron-Thiol resin immobilised in a thin layer of hydrogel Diffusive gel: ion permeable hydrogel layer (agarose gel)

Size: plastic assembly - 25 cm x 4 cm, exposure window - 15 cm x 2 cm