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In situ measurements of solutes in aquatic systems

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Diffusive gradients in thin-films (DGT) has recently immerged as a versatile measurement technique for solutes in surface waters, including trace metal, phosphate and sulphide. It accumulates solutes continuously on a binding layer after they have diffused through a well-defined diffusive layer, usually consisting of a hydrogel. The device can be readily deployed in situ. The accumulated solute is measured later in the laboratory and used to calculate the in situ concentration in solution from Fick's laws of diffusion. The measurement is independent of pH and ionic strength of the water, requires no in situ calibration, can be corrected for temperature and is well characterised with respect to flow. The device continuously accumulates solutes during its in situ deployment, providing the time weighted average concentration in solution.

DGT can also be deployed directly in soils and sediments where it measures concentrations of solutes at the surface of the device, which can be related to solutes in porewaters and those able to be supplied dynamically from the solid phase. The theory for the interaction of the device with the soil or sediment system is fully developed and models are available for quantitative interpretation in terms of kinetic and partitioning parameters. Information can be obtained at different spatial scales, by slicing the binding gel at any desired resolution, from cm to mm, in one or two dimensions. By using beam techniques for the analysis, it is possible to obtain 2-D images of the concentrations of several solutes simultaneously at a higher spatial resolution of 100 microns, which is necessary for understanding chemical processes. The major use has been the measurements of Fe, Mn, sulphide and trace metals at redox gradients. Most applications have been in sediments, but in recent work solute concentration gradients have been measured in saturated surface soils and the hyporheic zone.