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How to interpret porewater profiles from permeable sediment?

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Permeable sediments of the coastal North Sea are of great interest as they combine a high substrate availability with and an intensive hydrodynamic forcing by waves and tidal currents. This setting leads to high exchange rates between sediment and water column due to pressure-driven porewater advection and thereby to high benthic turnover rates of oxygen, nutrients, and organic matter. However, the estimation of exchange rates is challenging since traditional methods of flux measurements such as chamber incubations or fitting of molecular diffusion models to porewater profiles are often inappropriate to estimate the effect of advective porewater exchange on benthic fluxes of e.g. oxygen or nitrate.
An emerging method is the employment of Elliott's advection model (Elliott & Brooks 1997) for the interpretation of porewater concentration profiles. A disadvantage of Elliott's model is its demand for additional non-trivial parameters. Especially the horizontal pressure gradient and the actual porewater velocity as two crucial parameters are difficult to measure in-situ and are thus usually derived from an empirical model (Elliott & Brooks 1997, Ahmerkamp et al. 2017, Neumann et al. 2017) increasing the uncertainty of the flux estimates.
In an attempt to reduce this uncertainty of permeable sediment flux estimates, we sampled sediment and porewater from the Elbe Estuary in Germany. Our samples comprised permeable and impermeable sediment along the estuarine salinity gradient, and we have analyzed a multitude of porewater and sediment parameters (nutrients, redox metals, pH, total alkalinity, sulfides and sulfate, and additional dissolved elements). We demonstrate how the comprehensive ensemble of the porewater and sediment profiles contributes to the reduction of uncertainty of benthic fluxes derived by means of Elliott's porewater advection model.