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Evaluation of reaction rates in streambed sediments with seepage flow: a novel code

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Streambed interfaces represent hotspots for nutrient transformations because they host different microbial species which perform many heterotrophic and autotrophic reactions. The evaluation of these reaction rates is crucial to assess the fate of nutrients in riverine environments, and it is often performed through the analysis of concentrations from water samples collected along vertical profiles. The most commonly employed evaluation tool is the Profile code developed by Berg et al. (1998), which determines reaction rates by fitting observed concentrations to a diffusion-reaction equation that neglects the presence of water flow within sediments. However, hyporheic flow is extremely common in streambeds, where solute transport is often controlled by advection rather than diffusion. There is hence a pressing need to develop new methods that can be applied even to advection-dominated sediments. This contribution fills this gap by presenting a novel approach that extends the method proposed by Berg et al. (1998). This new approach includes the influence of vertical solute transport by upwelling or downwelling water, and it is this suited to the typical flow conditions of stream sediments. The code is applied to vertical profiles of dissolved oxygen from a laboratory flume designed to mimic the complex flow conditions of real streams. The results show that it is fundamental to consider water flow to obtain reliable estimates of reaction rates in streambeds.

Berg, P., N. Risgaard-Petersen, and S. Rysgaard, 1998, Interpretation of measured concentration profiles in the sediment porewater, Limnology and Oceanography, 43:1500-1510.