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Tidally forced asymmetric pore water flow in intertidal coastal sediments

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Pore water exchange in shallow intertidal sediments is enhanced by tidally driven advective flow. This flow is a result of the asymmetric pressure distribution within the aquifer sediments during low tide. Accurate quantification is challenging in these systems because of the highly dynamic response of the pore waters to the ever changing hydraulic gradients generated by the tidal gauge. We therefore measured the pressure distribution along a tidal flat margin where pressure gradients are expected to be highest using direct-burial pressure transducers. A hydraulic numerical simulation of the tidal flat margin was set up that was capable of reproducing the pressure distribution within the sediment. The results show that pore waters directly discharge into the coastal waters during low tide releasing the complete pore water inventory of dissolved degradation products, trace metals and radium. The flux of mineralized carbon and nutrients out of the sediment is therefore much faster than in diffusion dominated open-marine systems. The flow also generates asymmetric patterns in pore water chemistry, such as strong increases in dissolved degradation products (dissolved inorganic carbon (DIC), ammonia or silica) with pore water age resulting from microbial degradation of organic matter. Pore water discharge amounts to 250 to 360 l per meter shore line per tide releasing, for example, between 24 to 34 moles of DIC each day. This process of pore water circulation in intertidal sediments is recognized as "biofiltration" of seawater, where redox sensitive species (Mo, U, Re) are trapped within the sediment and mobile pore water constituents mostly released from microbial degradation of organic matter are directly transported into the open waters.