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Macroform and microform-induced change in redox-sensitive chemistries of river channel surface sediments

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In-stream geomorphological features such as riffle-pool sequences (macroforms) can produce steep hydraulic gradients which induce flow in and out of the riverbed – hyporheic exchange flow (HEF). The acceleration of flow over channel obstacles such as large cobbles and boulders (microforms) can create variation in surface-subsurface pressure gradients and generation of HEF. HEF in shallow surface sediments affect the transformation of redox-sensitive chemical forms and, therefore, the attenuation or release of nutrients in river systems. Here, we examine the relationship between stream geomorphological environment (microform and macroform) and concentration profiles of redox-sensitive species (nitrate, sulphate, iron, manganese) in shallow (15cm) subsurface sediments. In-situ passive samplers (diffusive equilibrium in thin films – DET) are used to obtain biogeochemical data from armoured environments at fine scale (cm) depth resolution where there is strong upwelling. The probes were deployed in a 50m reach of the River Eden, Cumbria, UK, during baseflow conditions. The experimental setup allowed for the assessment of differences in redox-sensitive chemistries between a riffle and pool environment and between smooth and rough bed surfaces in the pool. The passive sensing basis of the DET methodology provided a means for investigating how HEF systems generated at two different geomorphological scales influence the concentration and spatial patterns of redox-sensitive species. DET's capability of measuring at high spatial resolution allowed the extent of hyporheic mixing to be targeted, even though it is often limited to the top few centimetres of sediment.