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The effects of the vertical structure of a porous bed on hyporheic exchange

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Hyporheic exchange provides an important control on contaminant fluxes across the stream-subsurface interface. Several experimental studies have identified the dominant processes affecting hyporheic exchange. The surface layer, a few particle diameter thick, is affected by turbulent diffusion from the main flow, while deeper exchange is due to advective flow generated by pressure head variations at the stream/bed interface. This pressure head gradients are the result of the geometrical irregularities of the interface such as bends and bedforms. The structure of sediment beds is in turn a result of sediment transport processes acting at various time scales. Many structures of river beds develop as a vertical granulometric variation. Typical sorting processes like armoring and selective erosion and deposition produce layers having a thickness ranging from a few particle diameters to several meters. A layered bed structure has been constructed in a laboratory flume, both by laying sediments in layers and by allowing armoring to develop from a graded sediment mixture. The bed structure was measured using surface sampling procedures with appropriate area-to-volume conversion methods. Mass exchange between the stream and the bed was measured using tracers in a fully recirculated hydraulic system. Several combinations of armored and layered beds, either with flat beds or bedforms have been used.