Flume observations of enhanced fine-particle deposition to permeable sediment beds

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ABSTRACT: Predictions of the deposition rate of fine particles are integral to the study of the transport of many constituents, including contaminants and organic matter. Generally, fine-particle deposition rates are assumed to be equivalent to the suspension settling velocity. Deposition rates in excess of settling are considered enhanced. Flume observations of deposition were made using treatments that covered a wide range of flow, particle, and bed conditions. No enhancement was observed to impermeable boundaries. Specific treatments of sand bed experiments demonstrated large enhancements (up to eight times settling). For coarser sediment beds, little to no enhancement was observed. Previously identified mechanisms that could alter deposition rates, such as topography and aggregation, were dismissed using careful flow and particle size distribution measurements. Correlations between drag coefficient and deposition suggest that the mechanisms delivering additional particles to the sediment also reduce the effective drag of the bed on the flow. This is consistent with velocity slip at the sediment-water interface. Another trend evident in the data is a dependence on the ratio of the bed grain size to particle diameter. Small ratios were associated with large enhancements, consistent with the idea that filtration within the sediment could be retaining delivered particles. In concert, fluid incursions and bed filtration might be capable of increasing the particle flux to the bed. The observation of enhanced deposition to flat sediment beds reinforces the importance of permeable sediments to the transport of particles from the water column to the sediment bed.