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Response of a Channel with Alternate Bars to a Decrease in Supply of Mixed-Size Bedload: A Flume Experiment

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Dietrich et al. (Nature, 1989) demonstrated an increase in bed-surface armoring in response to decreases in rate of feed of a sand-gravel mixture into an experimental channel. Although their case was one of steady uniform flow, they observed that armoring did not increase uniformly, but instead, a central zone of finer surface particles and intensive bedload transport was preserved as feed rate was reduced. We repeated their experiment for a 2-D case in which the formation of alternate bars was induced. Froude-modeled hydraulic conditions were created in a 0.3x7.5m flume filled and fed with a sand-gravel mixture (D50=1.4mm; 0.35<D<8mm). After a series of six stationary alternate bars were formed under equilibrium sediment transport, feed rate was reduced in two steps to one-third and one-tenth the initial rate as discharge was held constant. Output particle size initially decreased but later equalled input size as sediment transport re-equilibrated. Degree of armoring expressed as the ratio of median grain size of the entire wetted bed surface to that of the sediment increased from 1.6 to 2.0 to 2.6. The zone of intensive bedload transport decreased from 49% to 32% to 19% of the flume width and retreated from bar heads and flow margins. After the first reduction in feed rate, the channel incised by twice the mean water depth. on average, as fine fractions were winnowed from the bed surface. Although incision was only moderate, it was sufficient to cause distal bar surfaces to emerge as terrace-like features. The channel did not incise significantly after the second feed-rate reduction. The primary response to reduced supply of bedload of a constant grain size under a nearly constant boundary shear stress, therefore, was an increase in bed armoring as the mobile zone of the bed became limited to a narrow central corridor.