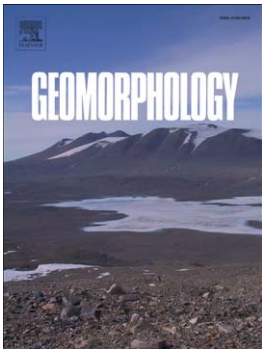

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The role of grain-size ratio in the mobility of mixed granular beds

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Abstract

The main goal of the study was to understand the effects of grain-size distribution on the stability of beds in the sand-silt range, which is a critical subject for the understanding of geomorphological processes in aquatic environments. Although theoretical models can explain the mobilization of a mixed bed, there is a clear lack in knowledge regarding the stabilizing effect of non-cohesive fine material. To connect existing findings, we analysed bed stability in relation to grain-size distribution in laboratory experiments. Erosion experiments in an annular flume were conducted using beds of different size compositions of spherical glass beads, i.e. a) the grain-size ratio $RD = D_{50,coarse}/D_{50,fine}$ (the relative size of coarse and fine grains; D_{50} = 39–367 µm) and b) the amount of fines. Several glass-bead combinations with unimodal and bimodal grain-size distributions (RD = 3.9, 5.8, and 9.4) and varying fine fractions (10–40 % dry weight) were subjected to increasing flow speeds (0.01-0.19 m s^{-1}). Using acoustic Doppler velocimetry (ADV) and optical backscatter, the flow profile in the vicinity of the bed surface, the changes in bed morphology, and the suspended sediment concentration (SSC) were measured. A new method was developed to evaluate the bed-level changes detected by the ADV as a proxy for the bed mobility. We found different modes of bed mobility depending on the grain-size ratio. For low grain-size ratios, an increase in the fine fraction (to 40 %) led to increased bed-level changes during the experiment and the mobilization of the mixed bed at the highest flow speed. For high ratios an increase in fine fraction (to 40 %) led to a decrease of bed-level