Name: Raleigh L. Martin, UCLA

Title: Controls on sediment tracer trapping in a granular bed

Abstract: Directly determining transport rates for coarse (diameter > 1 mm) sediment in rivers is extremely challenging, so recent years have seen the rapid expansion of tracer studies. These studies have revealed anomalous sediment tracer dispersion; however, the grain-scale processes involved are uncertain. Sediment motion consists of a series of steps and rests; because particles spend only a small fraction of time in motion, their long-term dispersion is governed by the distribution of waiting times, the times over which particles are trapped in the granular bed between movements. Here, we report on laboratory experiments that determine the origins and form of the tracer waiting time distribution. We tracked evolution of a bed of glass spheres, confined within a 2D channel and driven by steady fluid stress and particle flux. The bed exhibited stochastic fluctuations in elevation that are well described as an Ornstein-Uhlenbeck (O-U) process governed by two empirically-determined model parameters, a and b. The frequency of bed elevation change, a, increases linearly with imposed frequency of particle addition and is consistent with expectations of kinetic theory for sheared granular flows. The spatial range of bed elevation, b, likely controlled by intrinsic thresholds for particle entrainment and deposition, remains constant for all experiments. The asymptotic scaling of the waiting time distribution is similar to that inferred from gravel tracers in natural streams and reported values from tracers in avalanching rice piles. Thus, the O-U model may describe waiting time distributions for many disordered transport systems in which tracers experience burial and excavation.