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Comparisons of Derived Metrics from Computed Tomography (CT) Scanned Images of Fluvial Sediment from Gravel-Bed Flume Experiments

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Uncertainty in bedload estimates for gravel bed rivers is largely driven by our inability to characterize arrangement, orientation and resultant forces of fluvial sediment in river beds. Water working of grains leads to structural differences between areas of the bed through particle sorting, packing, imbrication, mortaring and degree of bed armoring. In this study, non-destructive, micro-focus X-ray computed tomography (CT) imaging in 3D is used to visualize, quantify and assess the internal geometry of sections of a flume bed that have been extracted keeping their fabric intact. Flume experiments were conducted at 1:1 scaling of our prototype river. From the volume, center of mass, points of contact, and protrusion of individual grains derived from 3D scan data we estimate 3D static force properties at the grain-scale such as pivoting angles, buoyancy and gravity forces, and local grain exposure. Here metrics are derived for images from two flume experiments: one with a bed of coarse grains (>4mm) and the other where sand and clay were incorporated into the coarse flume bed. In addition to deriving force networks, comparison of metrics such as critical shear stress, pivot angles, grain distributions, principle axis orientation, and pore space over depth are made. This is the first time bed stability has been studied in 3D using CT scanned images of sediment from the bed surface to depths well into the subsurface. The derived metrics, inter-granular relationships and characterization of bed structures will lead to improved bedload estimates with reduced uncertainty, as well as improved understanding of relationships between sediment structure, grain size distribution and channel topography.