# Laboratory experiments to predict evolution of sediment size distributions by abrasion and fragmentation in transport

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Sediment particles carry information about the hillslope settings where they are created and the fluvial environments they traverse on their journey through the channel network to depositional zones. Information about upstream tectonic, climatic, geologic, and geomorphic conditions are encoded in the distributions of particle sizes, shapes, and rock types, and in the degree of chemical weathering. However, some information is lost due to abrasion and fragmentation of particles in transport. These processes reduce the size and alter the shape of individual particles, and thus transform the distributions of particle attributes. Despite the importance of particle wear in modulating the signals of upstream conditions contained in sedimentary deposits, many fundamental knowledge gaps remain. Here I report the results of a suite of laboratory experiments designed to enable prediction of particle wear rates, and shape evolution, in specific field settings, based on knowledge of rock strength, rates of energy expenditure in transport, and the initial particle size distribution. Facilities and methods include a set of 4 rotating drums, ranging in size from 0.2 to 4.0 meter diameter, vertically-oriented abrasion mills, and free-fall particle drops. Rock strength was measured by the Brazilian tensile splitting test, and particle shape and angularity were quantified from photographs. Particle size distributions were measured by weighing individual clasts and by sieving. Experiments reveal that abrasion rates scale with the inverse square of rock tensile strength, where strength varies with rock type and with degree of chemical weathering within a single rock type. Wear rates are not substantially influenced by the presence of particles of differing strength, contrary to a commonly-held assumption. Production rate of fine particles (<2 mm) in the drum experiments scales as a power function of the rate of energy expenditure, a result that can be used to extrapolate to field settings where intensity of particle motion can be estimated. Wear rates decline as particles become less angular, at rates that correlate with cumulative travel distance and mass loss. This result enables estimation of both initial particle size and distance from source using measurements of particle angularity and rock strength, but only for particles that have not yet reached a stable surface morphology. Fragmentation during high energy collisions can reset particle angularity, and by creating new coarse particles (>2mm), can transform particle size distributions. Particle drop experiments quantify how fragmentation probability varies with impact energy for a given rock type. Fragment sizes collapse to a single non-dimensional particle size distribution. I illustrate how these experimental results can be used in field settings to distinguish the effects of particle wear from size-selective transport in downstream fining of river bed material, and to infer the initial size of sediments supplied to channels by upstream hillslopes.

Keywords: Sediment, Abrasion, Fragmentation, Experiment, Particle Size Distribution

 