THE INITIATION OF GRAIN MOVEMENT BY WIND

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When air blows across the surface of dry, loose sand, a critical shear velocity (fluid threshold, U_{*t}) must be achieved to initiate motion. However, since most natural sediments consist of a range of grain sizes, fluid threshold for any sediment can not really be defined by a finite value but should be viewed as a threshold range which is a function of the mean size, sorting and packing of the sediment. In addition these textural parameters can indirectly affect various interparticle forces such as capillary water tension and electrostatic charges which tend to bend individual grains together, thereby increasing fluid threshold and decreasing the supply of grains to the air stream.

In order to investigate the initiation of particle movement by wind a series of wind tunnel tests was carried out on a range of screened sands and commercially available glass beads of differing mean sizes (range: 0.19mm to 0.77mm), sorting and shape characteristics. In addition, individual samples of the glass beads were mixed to produce rather poorly sorted bimodal distributions. In the wind tunnel tests a sensitive laser monitoring system was used in conjunction with a high speed counter to detect initial grain motion and to count individual grain movements. Test results suggest that when velocity is slowly increased over the sediment surface the smaller or more exposed grains are first entrained by the fluid drag of the air either in surface creep or in saltation. As velocity continues to rise, the larger or more protected grains may also be moved by fluid drag. On striking the surface saltating grains impart momentum to stationary grains thereby reducing the fluid drag necessary for entrainment (dynamic or impact threshold). As a result, there is a cascade effect in which a few grains of varying size, initially moving over a range of shear velocities (fluid threshold range) set in motion a rapidly increasing number of stationary grains. This transition occurs very rapidly and is affected by the sorting, packing and shape of the surface grains. The rapid progression from fluid to dynamic threshold, based on the number of grain movements, can be characterized by a hyperbolic function, the coefficients of which are directly related to the textural characteristics of the initial sediment. The data also indicate that predicted threshold values based on the modified Bagnold equation (Iversen et al, 1976) fall within the range of threshold values defined by the transition section of the grain movement/shear velocity plots. Moreover, the predicted values are very similar to the threshold values derived for the point of maximum inflection on the curves.