MS698–3: Sediment transport processes in coastal environments
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Problem Set 1: Due February 27th, 2003 by 2PM.

Problems are open book, open notes, and consultations with other students are allowed. Turn in your own work; printed out or handwritten on paper. Include enough details for partial credit.

1. *Grain Size Distribution*: Use the grain size distribution in the Table to:

   (a) Plot the histogram of the percent of each size class using ϕ-size vs. percent. Plot the cumulative percent in terms of ϕ-size on probability paper. See the class website for matlab tools to help with the probability plot.

   (b) Graphically determine from the cumulative distribution the values for each sample of ϕ_{84}, ϕ_{50}, ϕ_{16}, D_{84}, D_{50}, and D_{16}.

   (c) Estimate the mean size (in ϕ and mm), the mode, and standard deviation (in ϕ and as $\sqrt{D_{84}/D_{16}}$) of the distribution.

   (d) Characterize the sediment texture in terms of type (gravel, sandy, cobbles, etc.), and degree of sorting.

ϕ_{fine}	ϕ_{coarse}	ϕ_{nom}	fraction (%)
NA	10.0	10.50	0.03
10.0	9.0	9.50	0.10
9.0	8.0	8.50	0.12
8.0	7.0	7.50	0.11
7.0	6.0	6.50	0.10
6.0	5.0	5.50	0.09
5.0	4.0	4.50	0.10
4.0	3.0	3.50	5.07
3.0	2.0	2.50	63.14
2.0	1.0	1.50	25.98
1.0	0.0	0.50	2.39
0.0	-1.0	-0.50	0.71
-1.0	-2.0	-1.50	1.45
-2.0	-3.0	-2.50	0.60
-3.0	-4.0	-3.50	0
-4.0	-5.0	-4.50	0
-5.0	NA	-5.50	0

Table 1: Sediment bed size distributions from NJ Shelf location (site E: 25 m) Sample taken in April, 2000.

2. *Settling Velocity:* Estimate settling velocity for the D_{50} from question 1:

   (a) assuming it is quartz and naturally worn. Assume 10^o C water.

   (b) assuming that it is quartz, but very spherical and rounded. Assume 10^o C water.

   (c) assuming that it is **garnet**, and naturally worn (CSF=0.7, P=3.5), in 10^o C water.

   (d) find the settling velocity for this size sediment, naturally worn grains, in 10^o **air**.

3. *Bed Shear Stress and Roughness:*

   (a) For well sorted, planar beds of the following sizes and a boundary shear stress of $\tau_b = 1.5 dy/cm^2$, determine whether the flow is hydraulically smooth, transitional, or rough. Find the value of the hydraulic bottom roughness parameter (z_0) and the velocity 10cm above the bed, assuming that the flow is 10m deep.

      i. D=0.009 cm

      ii. D=0.14 cm

      iii. D=1.6 cm

   (b) Find the boundary stress on a planar bed of well sorted sediment 0.5mm in diameter (quartz density) if the velocity 2cm above the bed is 30cm/s and the flow is 10m deep. Express the answer in both cgs and SI(mks) units, i.e. dy/cm^2 and N/m^2.

4. *Critical Shear Stress:* Estimate the critical shear stress for D_{50} of the sediment from problem 1, assuming that it is on a well-sorted bed.

5. *Bedload Transport:* Consider a reasonably straight reach of a 2m deep, 20m wide channel of rectangular cross-section. The channel bed is composed of well sorted 1.0 mm sand ($\rho_s = 2.65 g/cm^3$) and the boundary shear stress is roughly $\tau_b = 25 dy/cm^2$. Estimate the volume discharge of sediment through a cross section of the channel using the following methods:

   (a) the Yalin bedload equation

   (b) the Meyer-Peter bedload equation

   (c) the Einstein bedload equation

   (d) the Bagnold bedload equation