

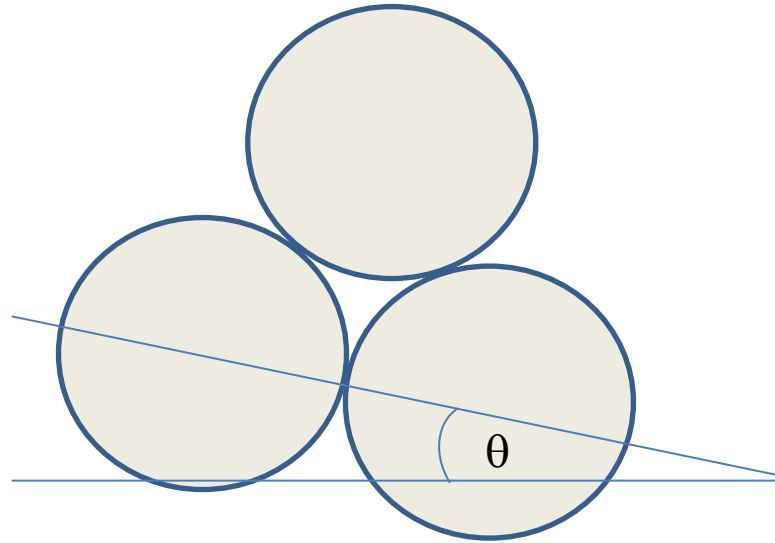
“Dry” Motion



“Dry” Motion

Angle of Repose:

Granular Geometry of Slope



What balance of forces create:

1) a static friction angle

2) a dynamic friction angle

Fluid Motion

Properties and Parameters of Fluids Relevant to Sediment Transport

ρ	Density	[kg/m ³]	g	Gravity	[m/s ²]
ν	Viscosity	[m ² /s]	U	Velocity	[m/s]
H	Depth	[m]			

Dimensionless Scales of Fluid Motion

$$Re = \frac{UH}{\nu} \quad \text{Balance of Inertial Scale to Viscous Scale}$$

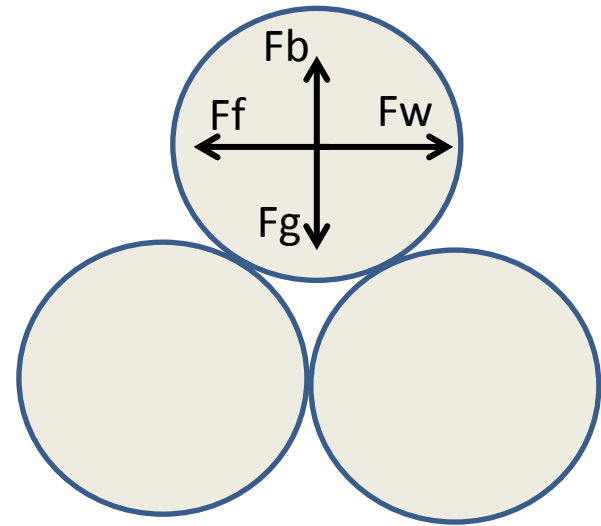
$$Fr = \frac{U}{\sqrt{gH}} \quad \text{Balance of Kinetic \& Potential Energy Scales}$$

Flow	ρ	ν	g	H	U	Re	Fr
Air	10 ⁰	10 ⁻⁸		?	10 ¹	>>10 ³	?
Water	10 ³	10 ⁻⁶	10 ¹	10 ⁰	10 ⁰	10 ⁶	10 ⁻¹
Ice	10 ³	10 ⁷		10 ³	10 ⁻⁷	10 ¹¹	10 ⁻⁹

Fluid Motion

Q: How is force applied to sediment by fluid?

Force balance on a single grain



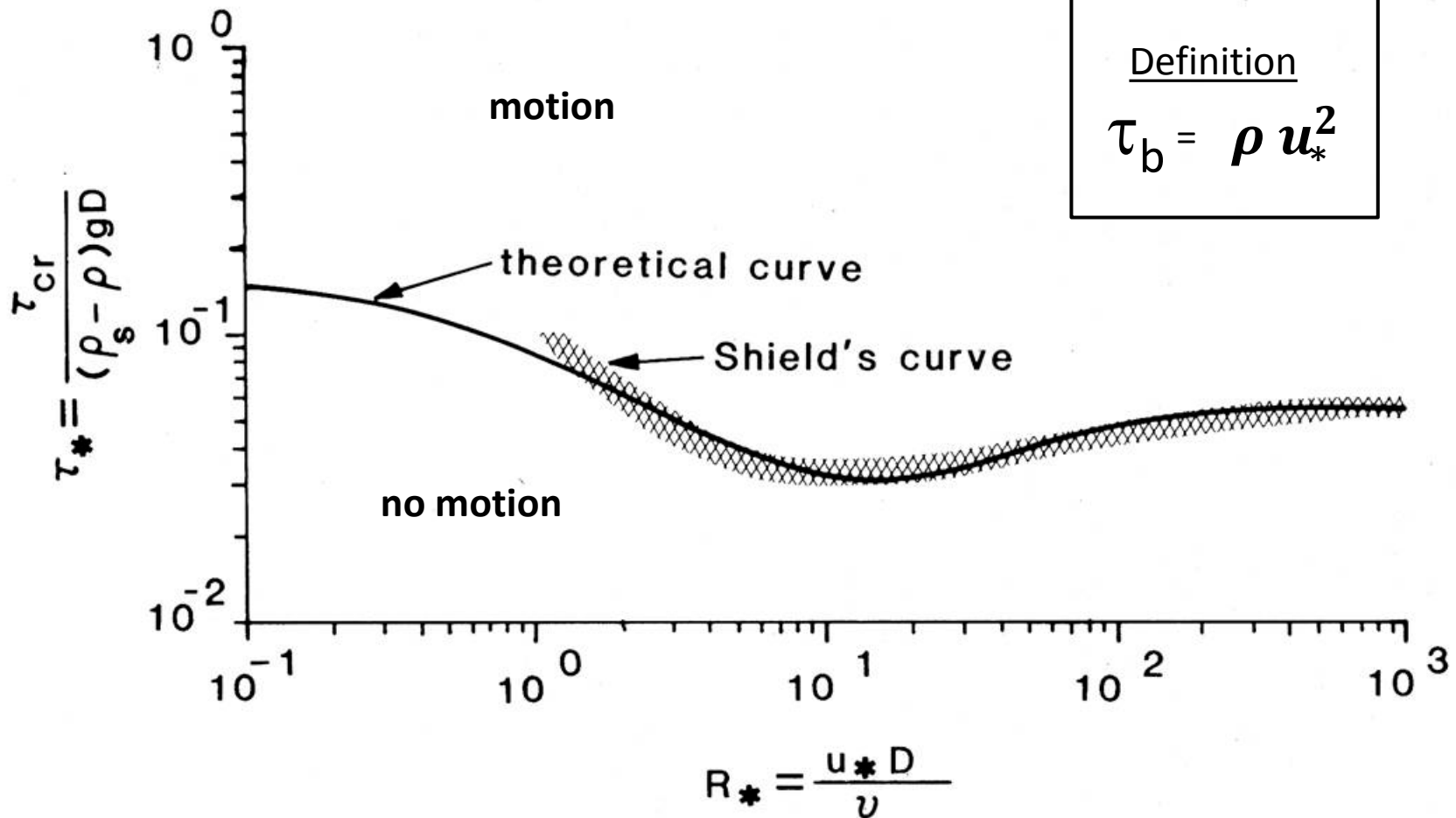
Force balance for an entire bed (shear stress)

$$\tau_b = \frac{\text{Force}}{\text{Area}} = f(\text{vertical velocity gradient near the bed})$$

$$\tau_b = \rho g H S \quad \text{in a river- with some caveats...}$$

Fluid Motion

Q: How & when do fluids move sediment?



Fluid Motion

Rouse Number, the ratio of fall velocity, w_s , and shear velocity, u_* determine style of transport

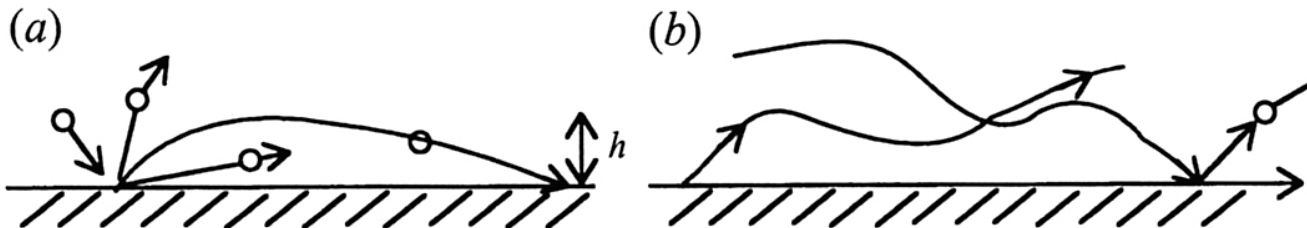
$$p = \frac{w_s}{u_*}$$

Bedload = saltation, rolling, sliding

Criteria: $\tau_b > \tau_{cr}$ (from Shields curve)

$$\frac{w_s}{u_*} > 3$$

K. Nishimura and J. C. R. Hunt



Fluid Motion

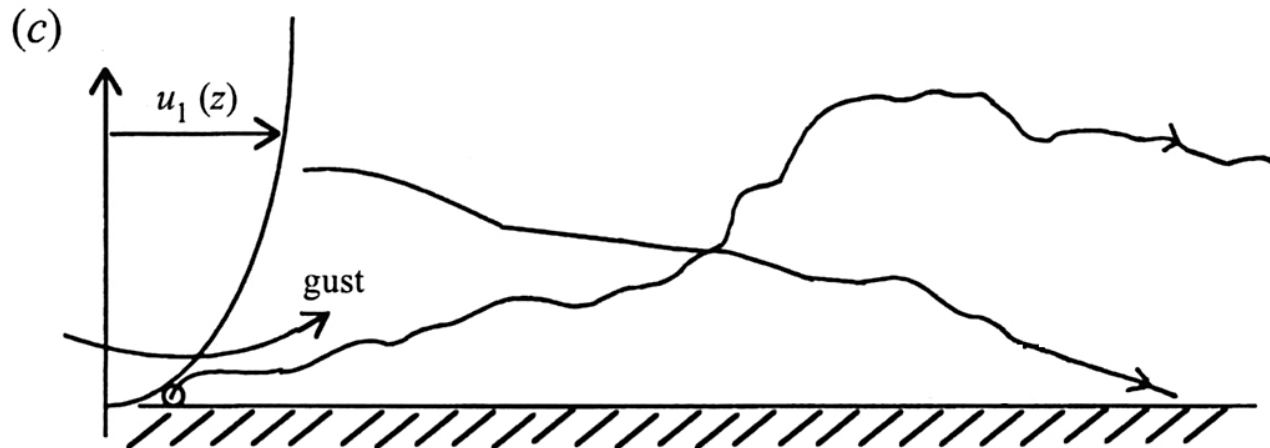
Rouse Number, the ratio of fall velocity, w_s , and shear velocity, u_* determine style of transport

$$p = \frac{w_s}{u_*}$$

Suspension = flights of particles in occasional contact with bed

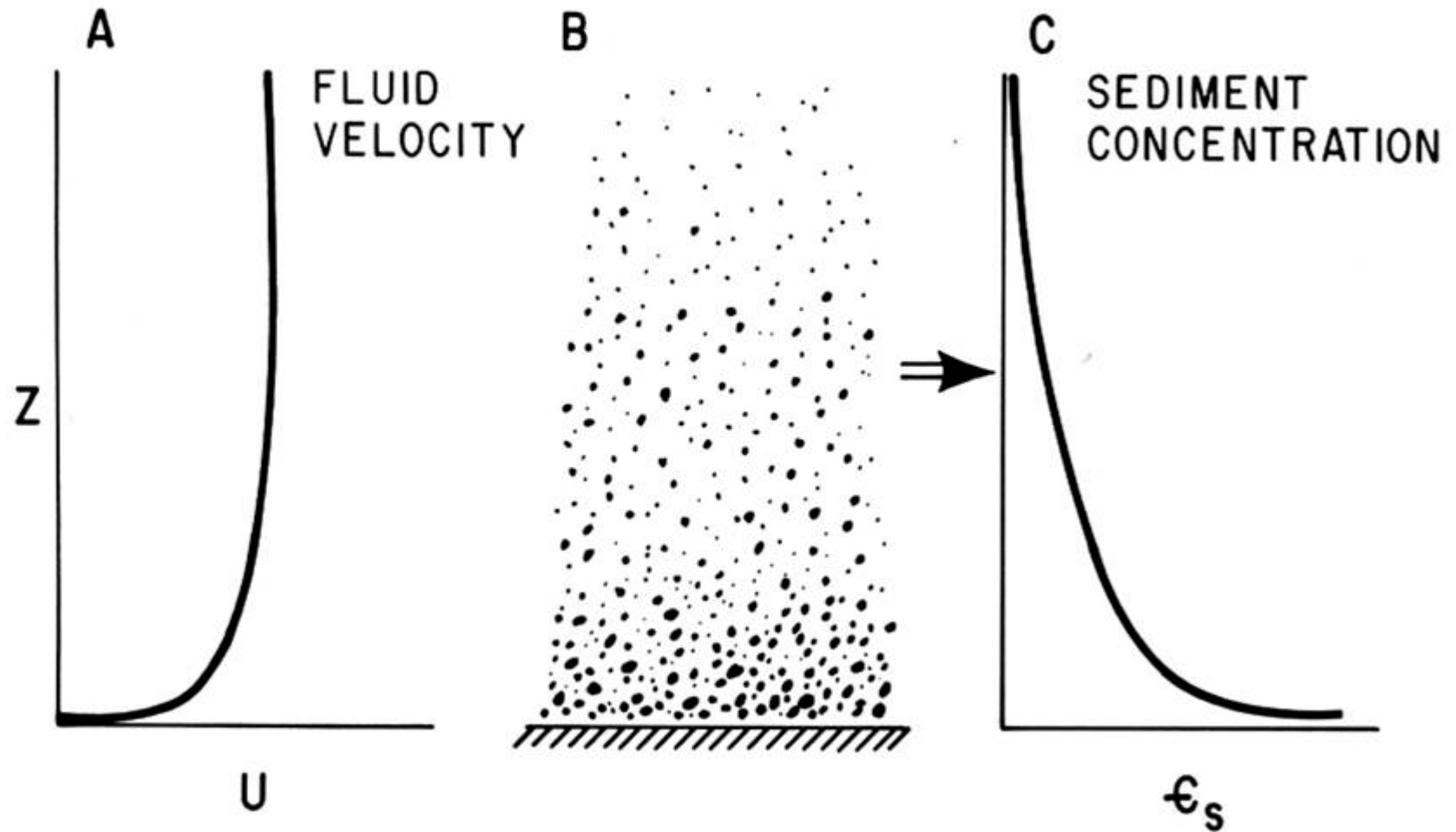
Criteria: $\tau_b > \tau_{cr}$ (from Shields curve)

$$\frac{w_s}{u_*} < 1$$



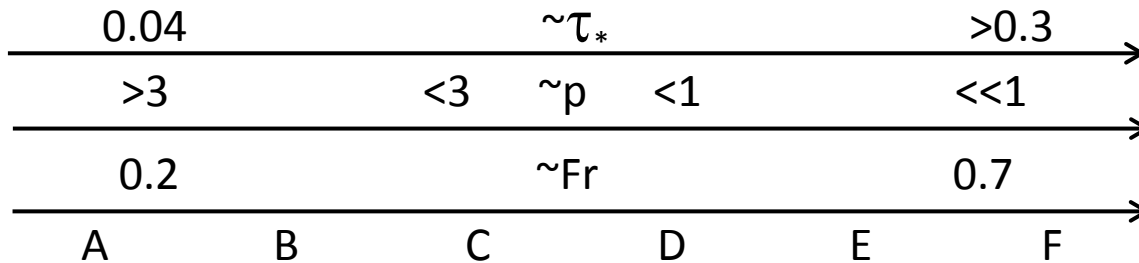
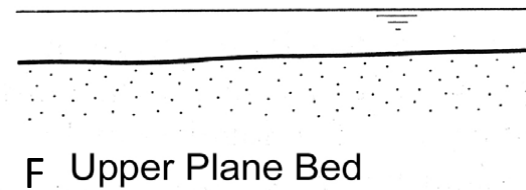
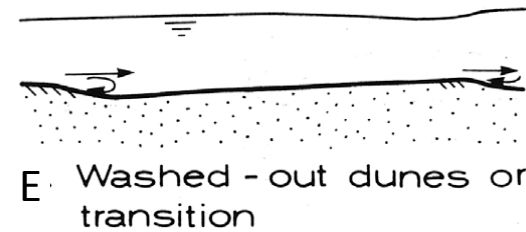
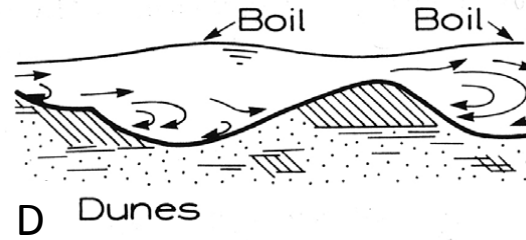
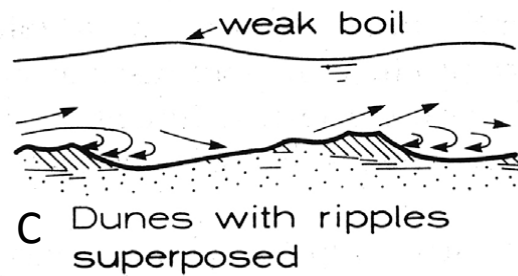
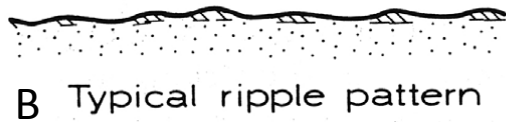
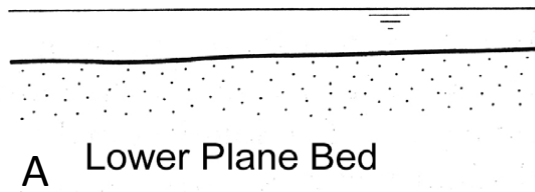
Fluid Motion

Typical vertical profiles in a river for velocity & concentration



Fluid Motion

Typical fluvial bedforms



Definitions: Bedform topography

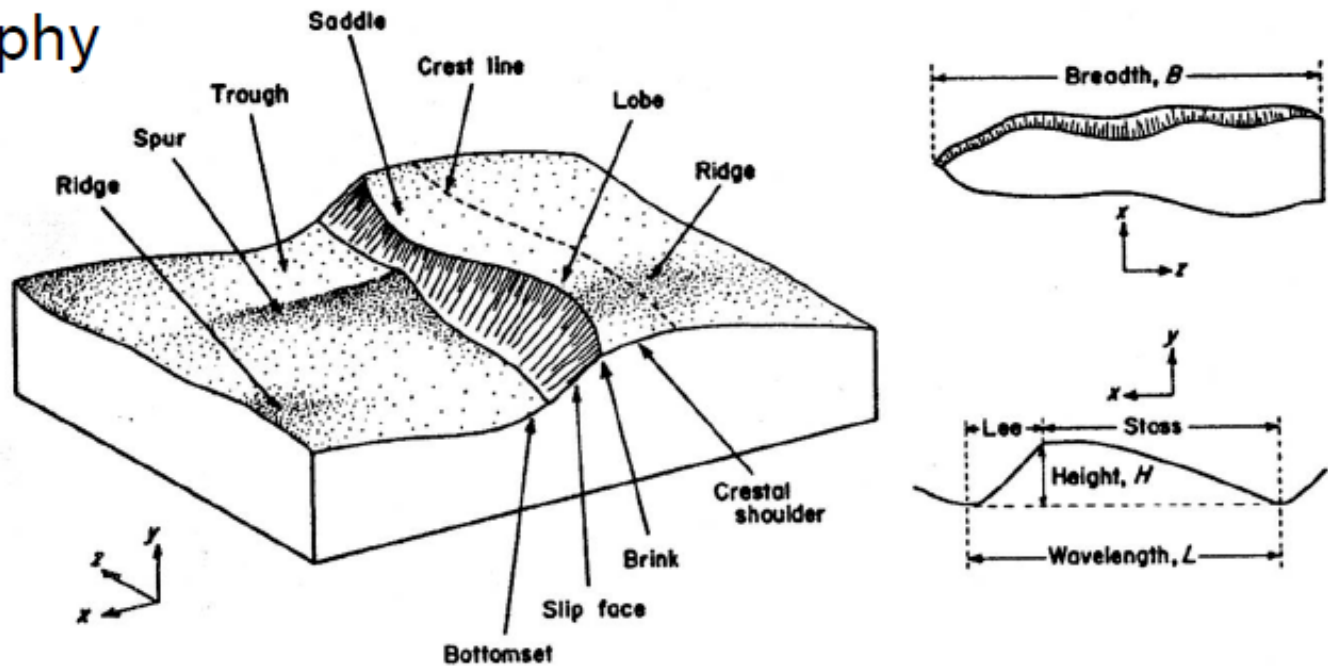
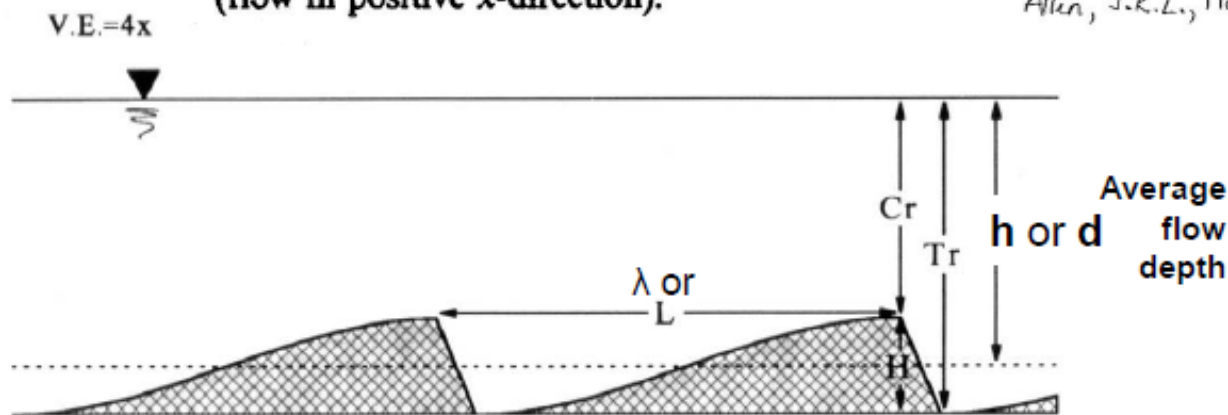


Fig. 8-2. Schematic representation of the chief morphological features of transverse bedforms (flow in positive x -direction).
 Allen, J.R.L., 1982, *Sedimentary Structures*, vol.1



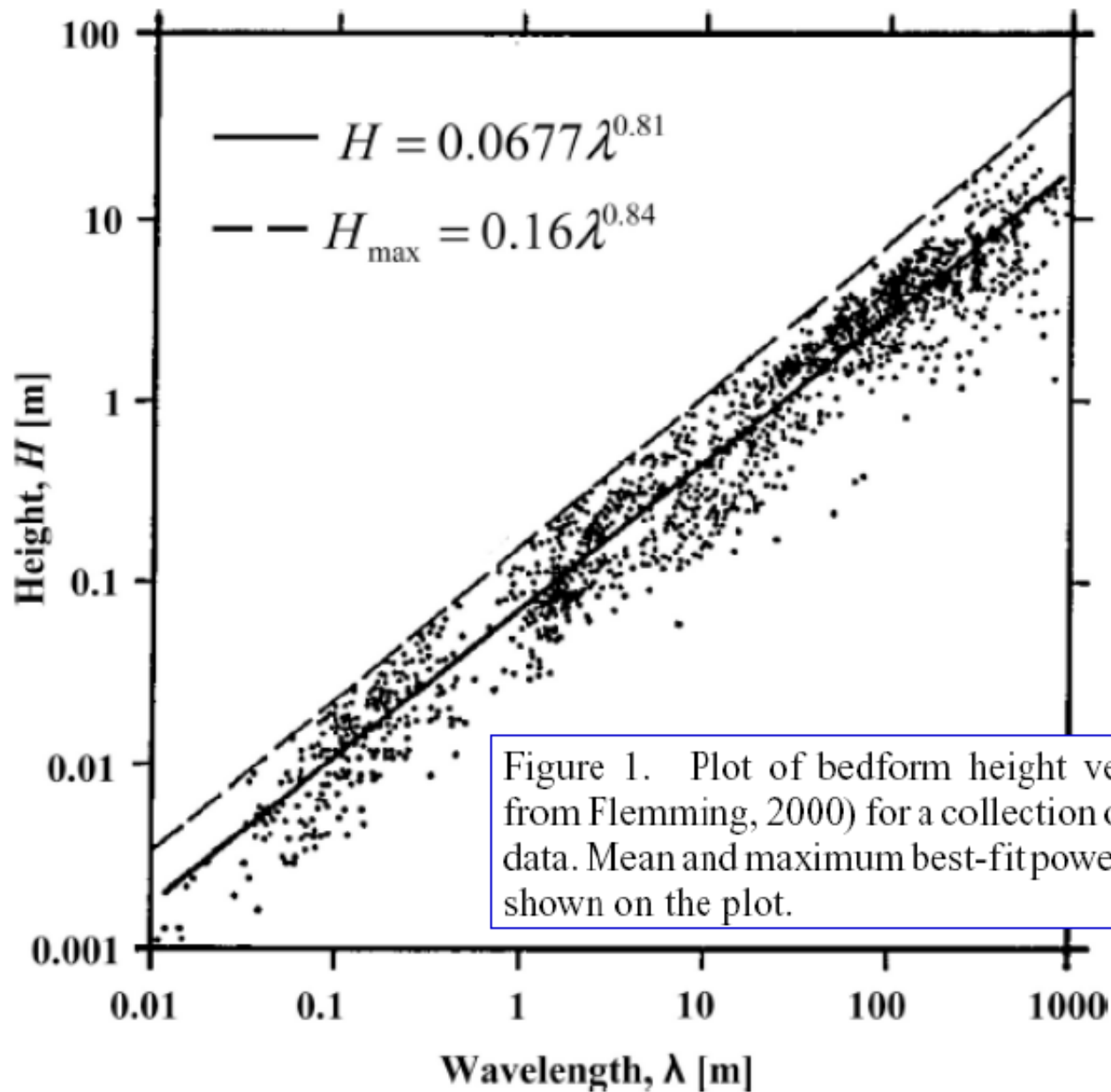
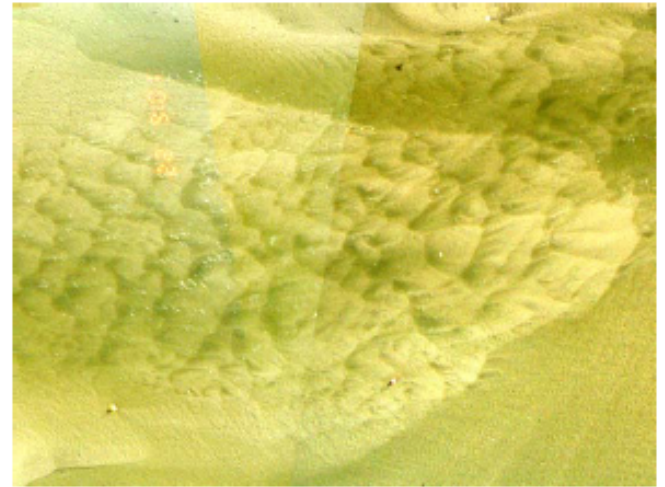


Figure 1. Plot of bedform height versus length (adapted from Flemming, 2000) for a collection of field and laboratory data. Mean and maximum best-fit power law relationships are shown on the plot.

Transport of sediment typically results in the spontaneous development of trains of repetitive bed topography at a number of scales. The two basic types are: 1) bedforms; and 2) bar forms.



Bedforms:

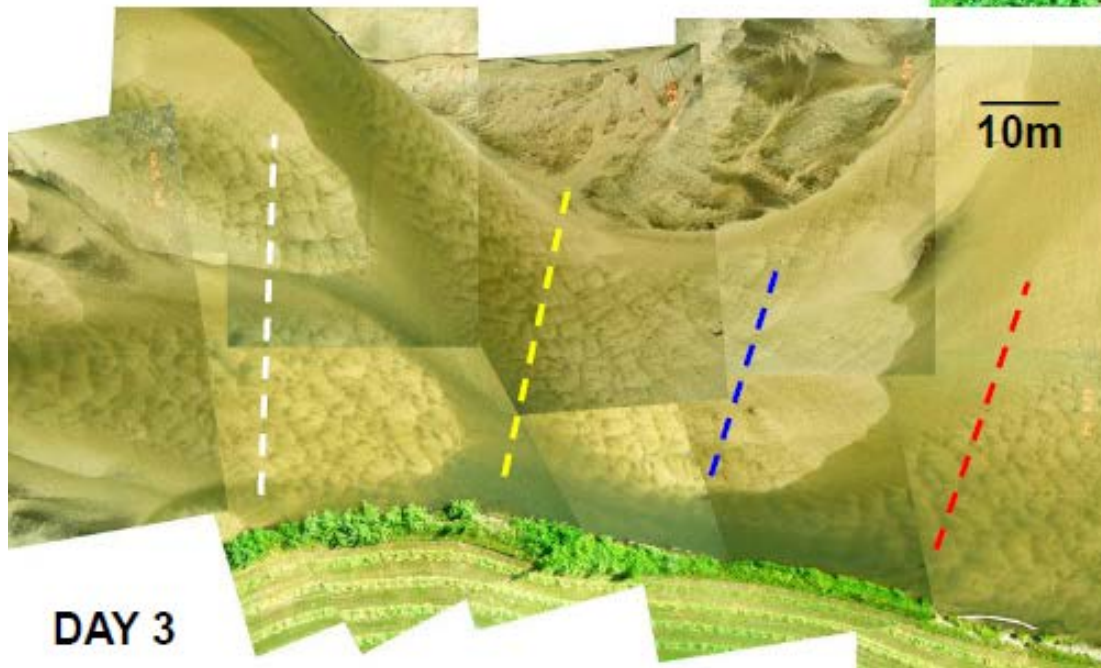
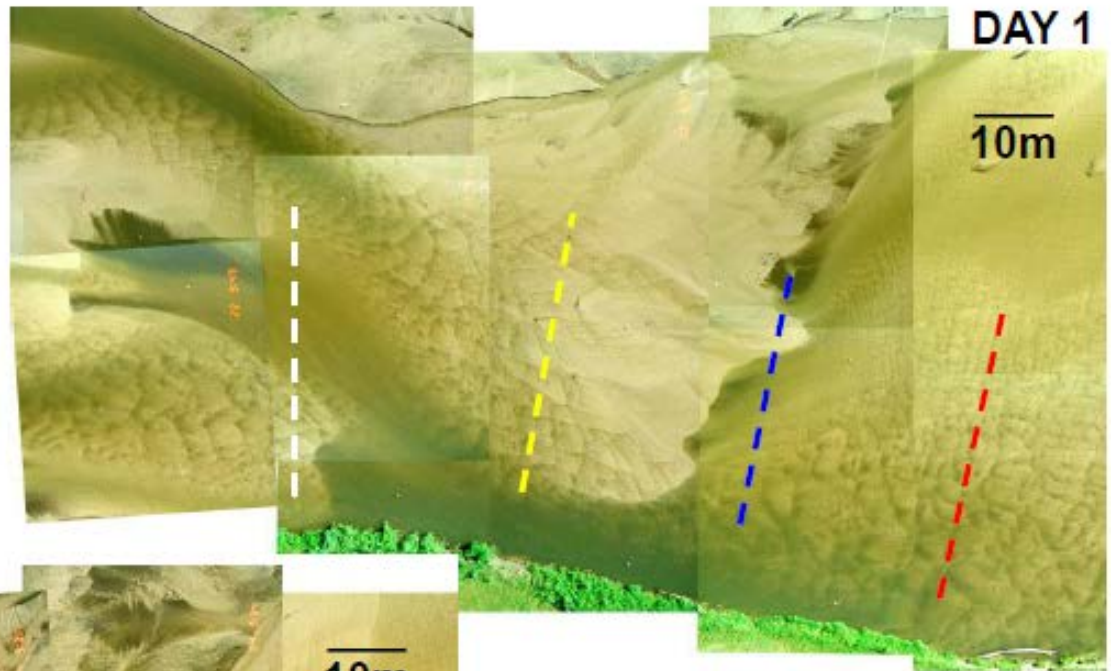
Scale of topography: Limited to a fraction of the flow depth.

Bar forms:

Scale of topography: Bar forms can grow to the water surface and have lengths that are scaled by channel width.

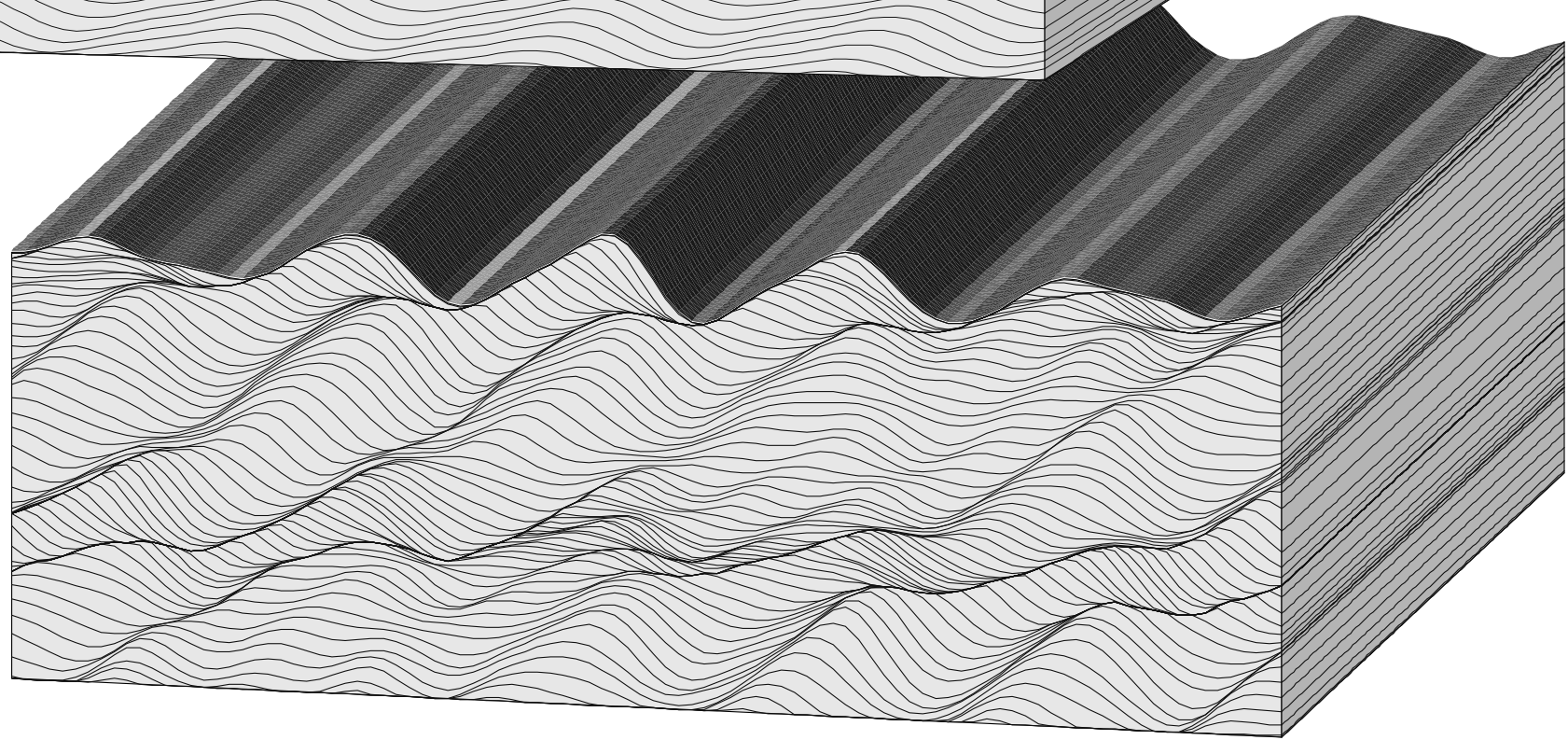
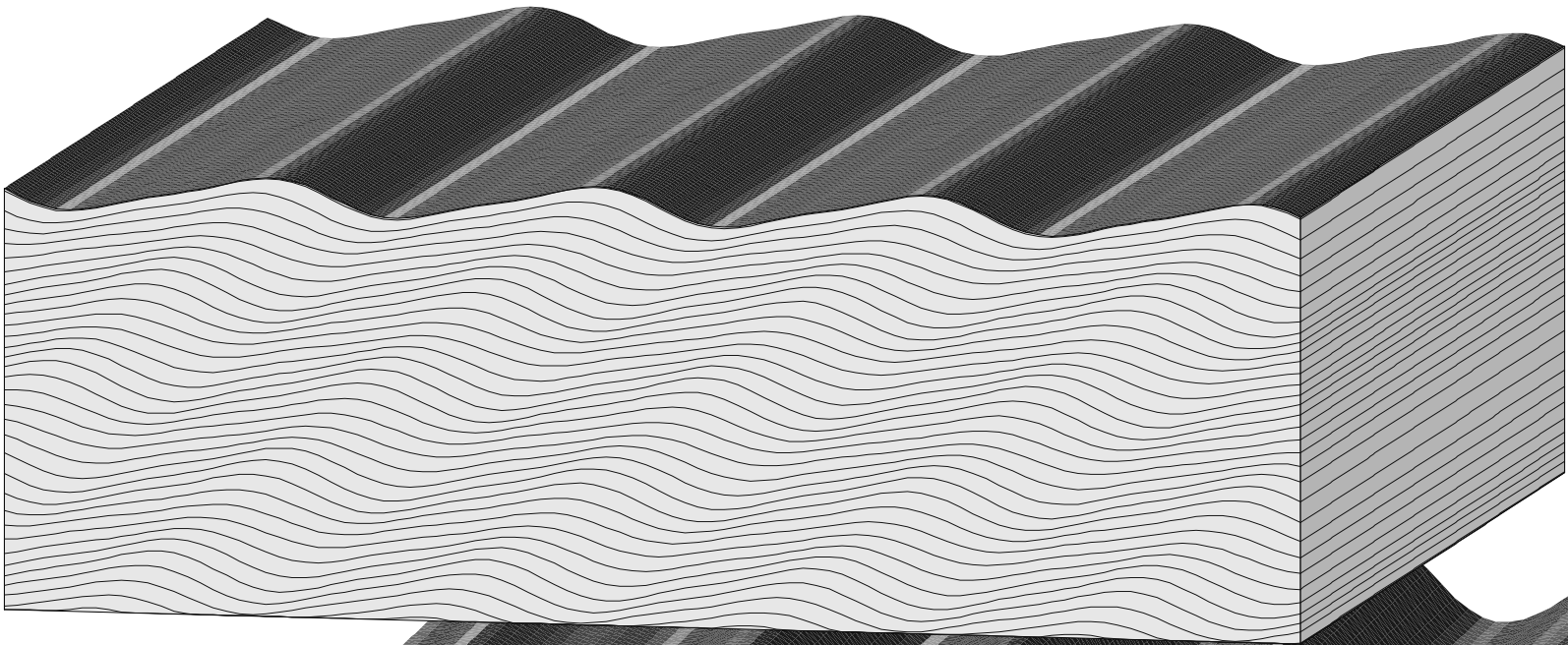
Aerial photography records interactions between dunes and bars.

Dashed lines mark the same locations in each photo mosaic.



Crest-lines of dunes move about 2.5m/hr.

Crest-lines of bars move about 10m/day.



Stratification from Bedform or Bar form?



Stratification from Bedform or Bar form?

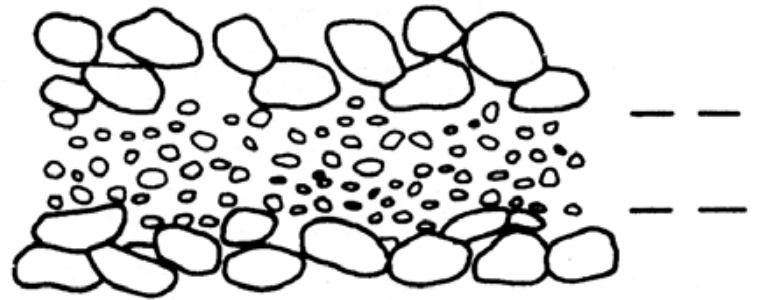


Graded Beds

Composition



Size



Shape



Orientation



Bioturbation → Ichnofossils

Burrowing

Surface Locomotion

Feeding

Anchoring

Thalassinoides

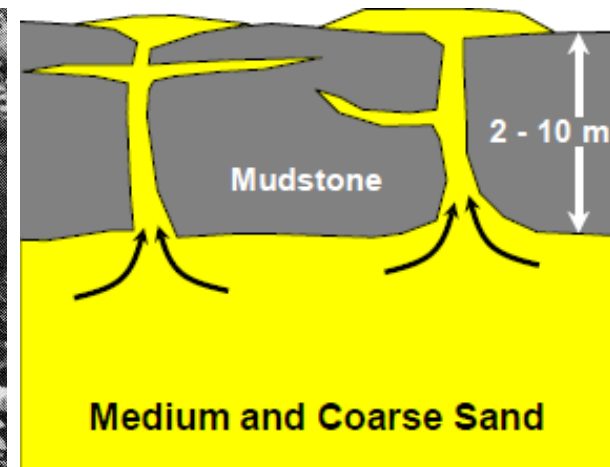


Soft-Sediment Deformation →

Load Structure



Liquefaction

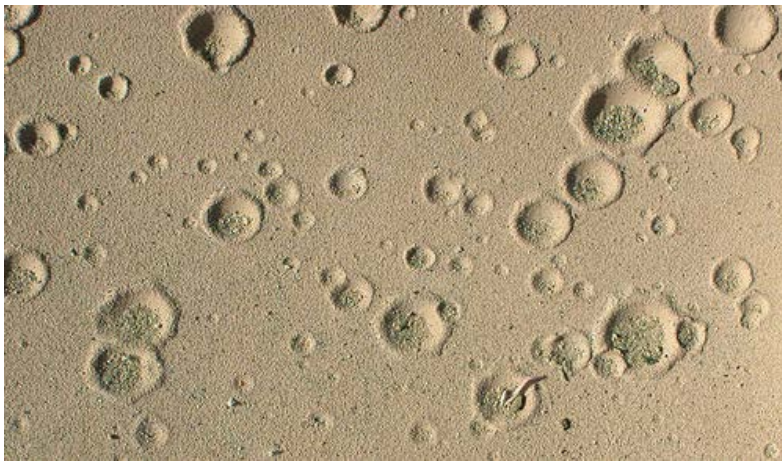


Other Deformation →

Cracking



Splashing



Sole Marks

