

INITIATION OF MOTION TO ANTIDUNES: NEW VIDEOS OF THE STANDARD BEDFORM PROGRESSION FOR EDUCATORS

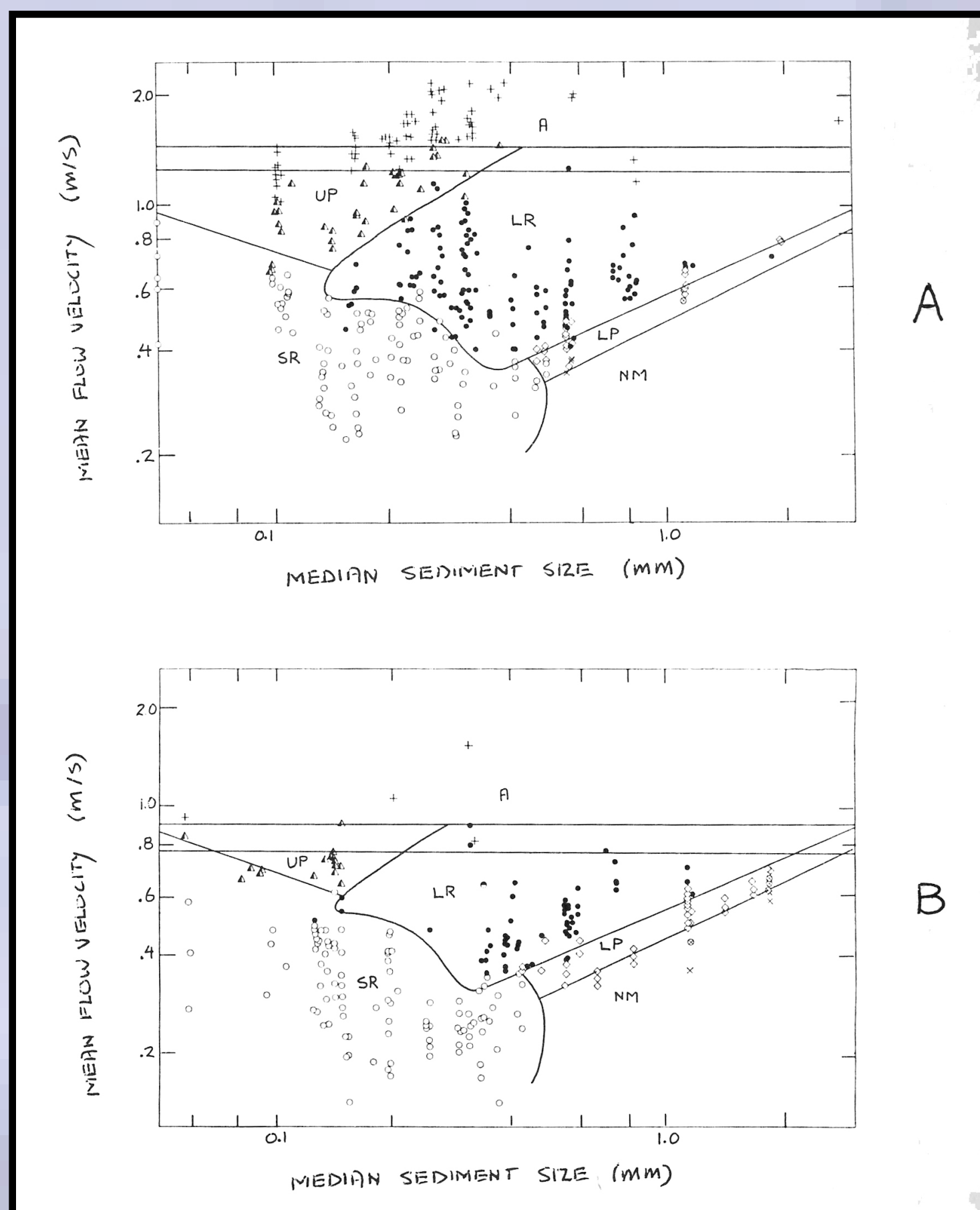
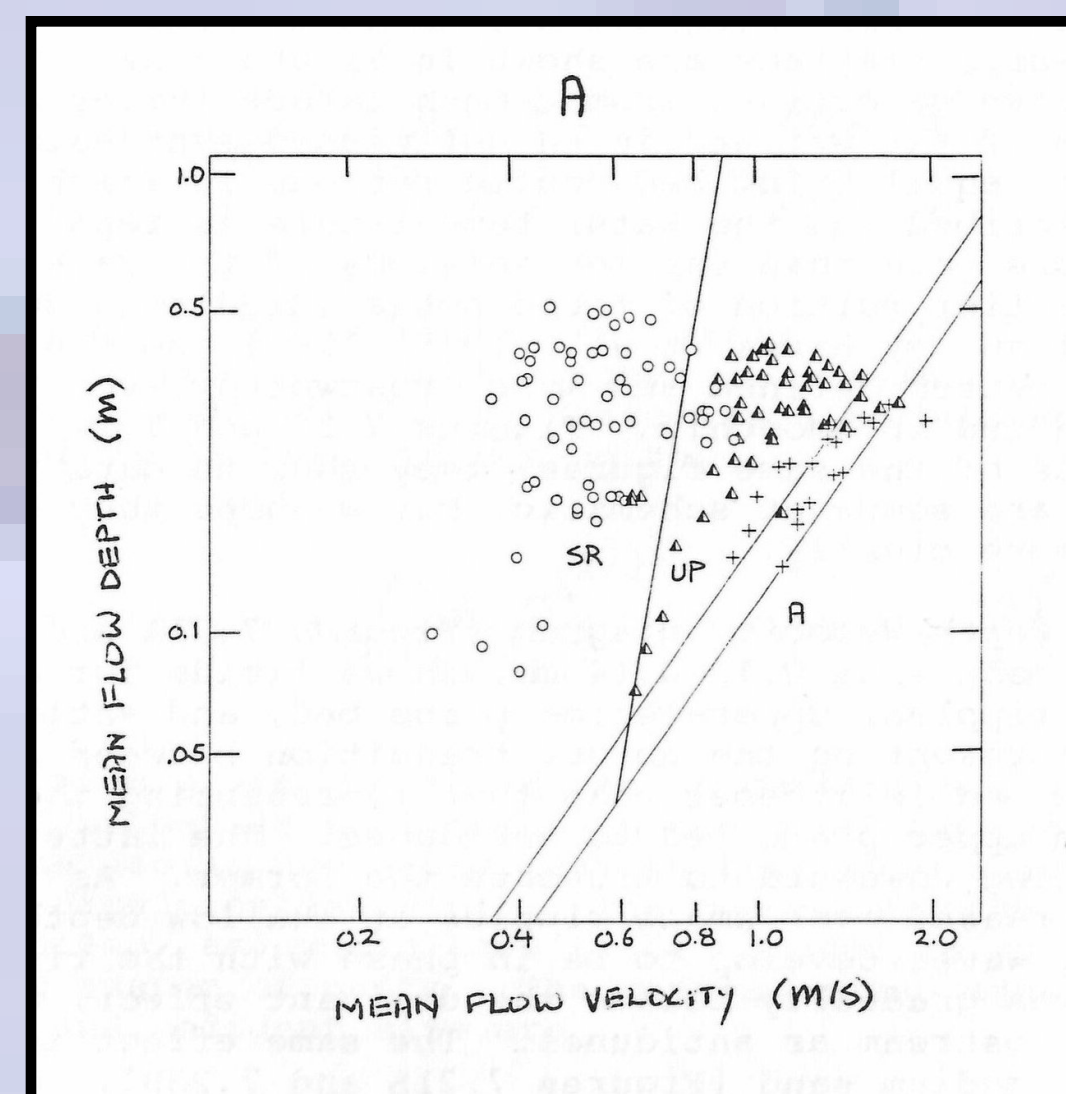
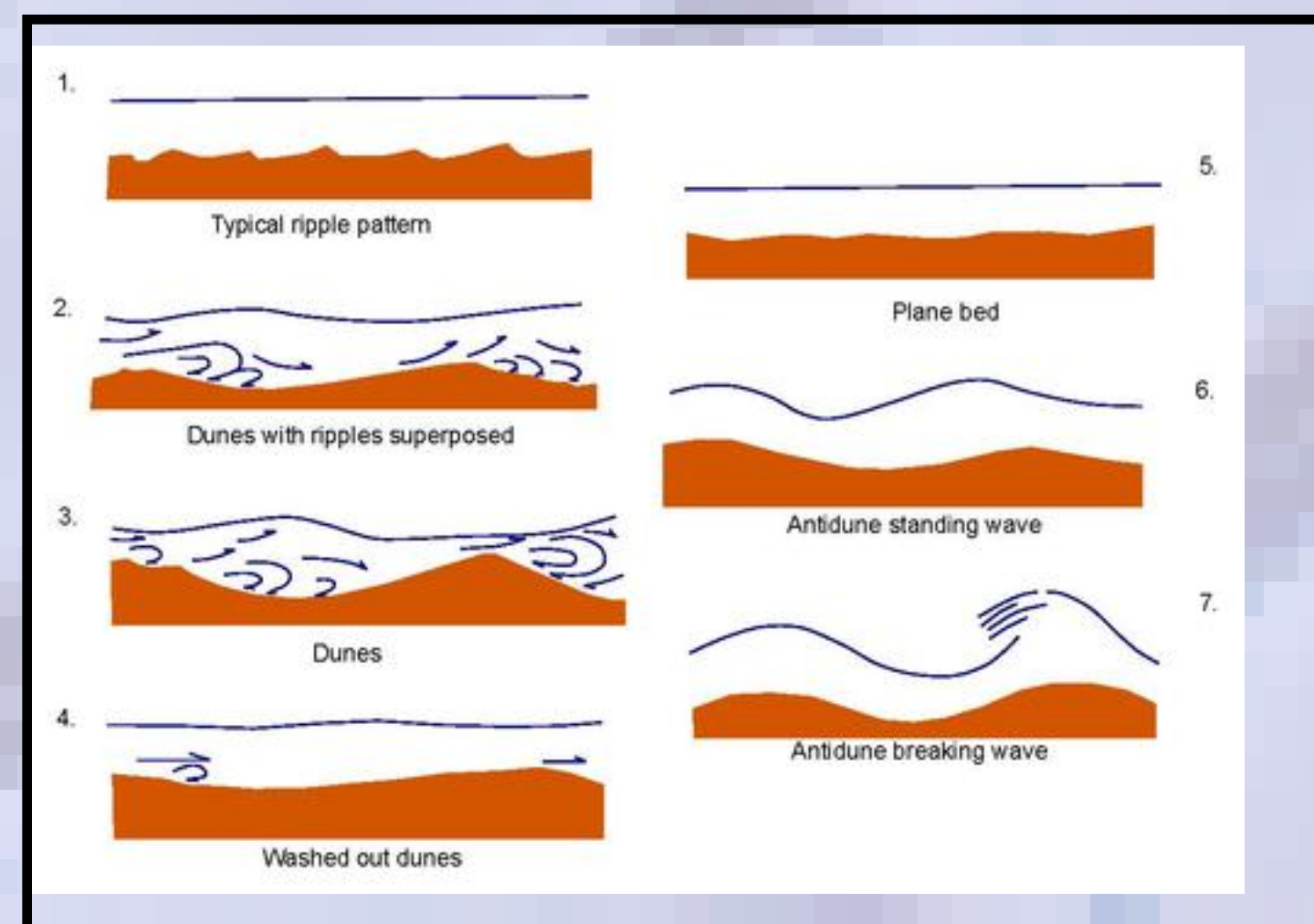
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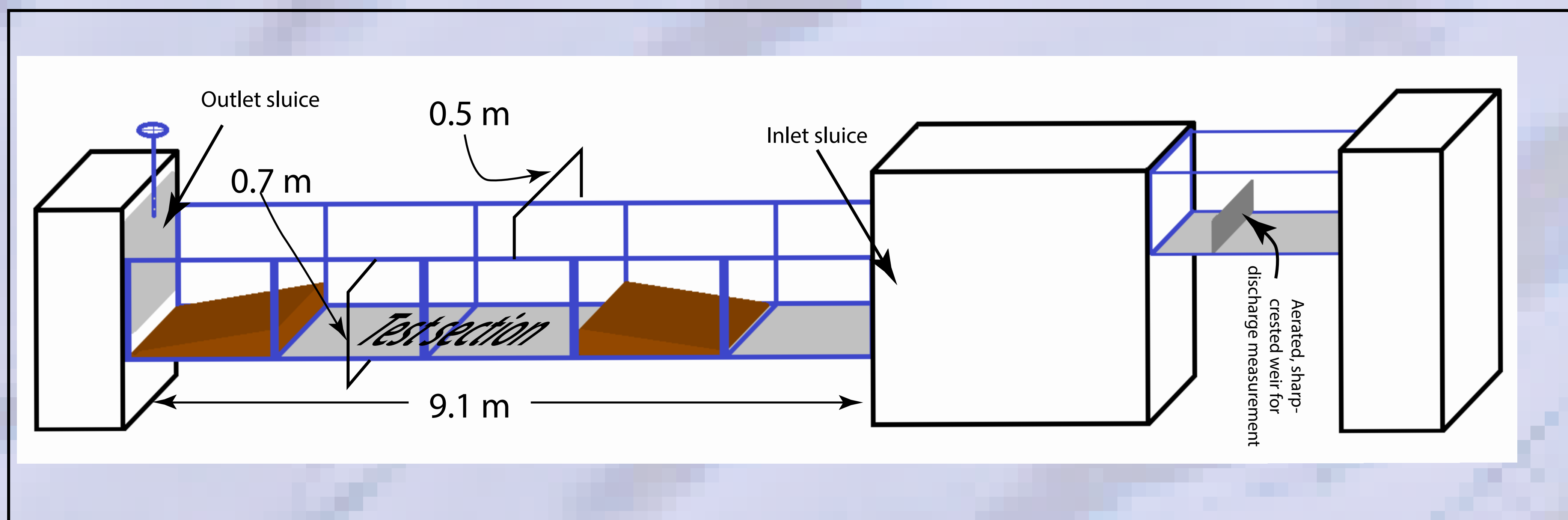
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INTRODUCTION



Bedforms and bed configurations are probably one of the most commonly-taught topics in sedimentology, stratigraphy, historical, even introductory geoscience courses. They are an appropriate gateway into a deeper understanding of the formation of stratification and lamination, paleocurrent analysis, and depositional systems analysis. Flume experiments that began with G.K. Gilbert in the early 20th century and culminated in the work from John Southard's lab at MIT in the 70s provided quantitative and qualitative data, in the form of bedform phase diagrams, that allowed geoscientists to place real constraints on flow conditions. After teaching sedimentology for 15 years and grubbing around the web for individual videos on bedforms, I decided it was time to make a video of the entire progression for all of us to use!

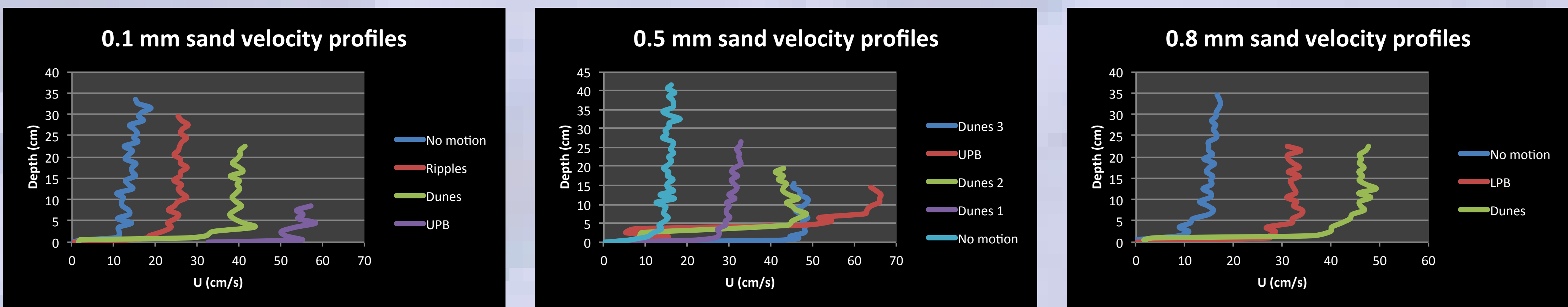
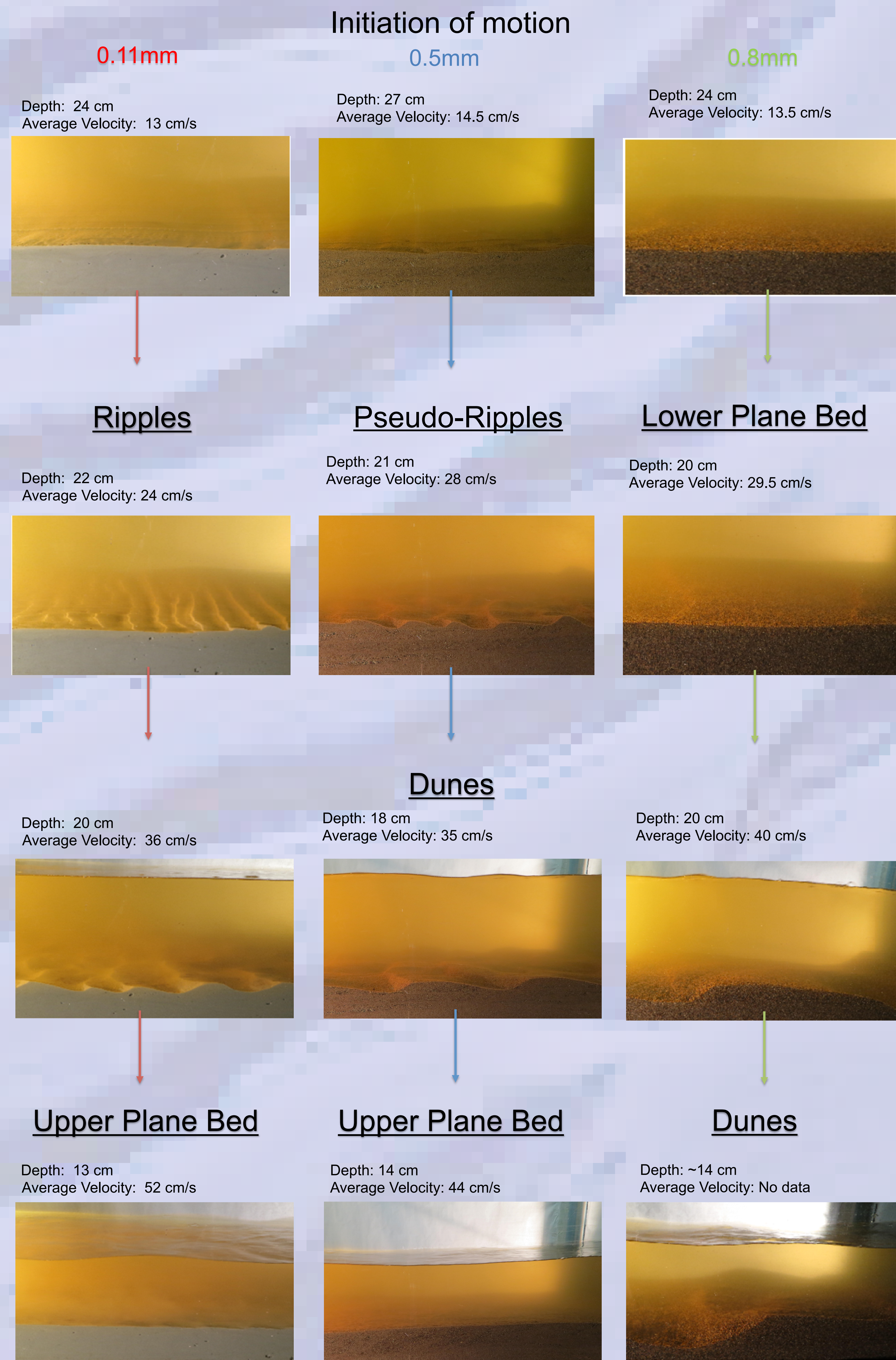
THE EXPERIMENTS



We used a fixed-bed, unidirectional flume at the St. Anthony Falls Laboratory (L=9.1 m, W=0.5 m, D=0.7 m) for our experiments. All experiments lacked sediment recirculation. For antidunes we used a smaller, tilting bed flume to achieve sufficiently high bed slopes. Our test section had inlet and outlet ramps and was ~3 m in length. Sand-sized sediment filled the space between the ramps. We conducted three sets of experiments for three grain sizes of bed sediment: 0.11, 0.5, and 0.8 mm D₅₀. We chose these sizes to capture the range of bed states that form under these grain size conditions. For each run we captured time lapse and realtime digital video through the sidewall, illuminated by an upstream-pointing submersible light. For each bed state we measured velocity profiles using a Sontek acoustic doppler velocimeter (ADV). This device provided the x, y, and z components of velocity as well.

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THE VIDEOS AND DATA



On the left are static images clipped from the videos. For each grain size we captured **real time standard video** and **time lapse video** of the entire run. Initiation of motion was captured for the coarsest grain size only (0.8 mm), mainly because it was difficult to see for the finer grain sizes. Antidunes were captured for the 0.5 mm sand size fraction only. We have created two videos:

- 1) A long version, with an extended introduction to the flume.
- 2) A short version that lacks this introduction.

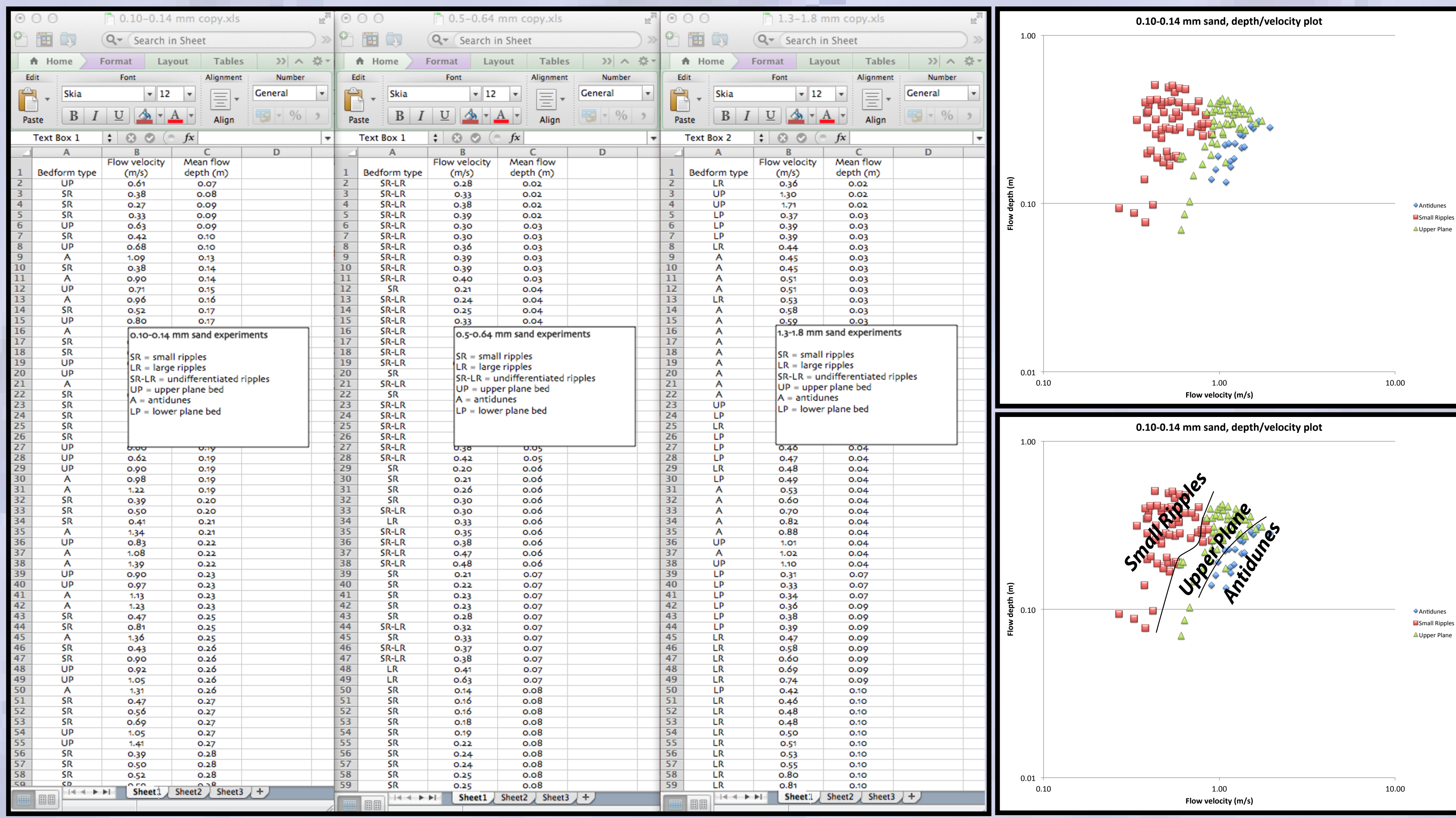
Representative velocity profiles were taken for each bed configuration (initiation of motion, ripples, lower plane bed, dunes, upper plane bed). We were unable to capture to velocity profile data for the antidune regime. We will provide raw and processed ADV probe data with the videos, so that students can examine variations in the x, y, and z components of velocity, calculate boundary shear stress using law of the wall equations, and see the conditions under which different bed states occur.

USING THE VIDEOS IN THE CLASSROOM

DERIVING BEDFORM PHASE DIAGRAMS:

After watching the videos here, students have the basis to use a larger data set to make their own bedform phase diagrams. Using Datathief software, we converted depth and velocity datapoints from figure 2 and others into Excel spreadsheets, one for each of the grain size ranges provided in Middleton and Southard (1983). The screenshot below is from these spreadsheets. Students then create diagrams like those on the right (below). This activity, including the Excel data files, is available at:

<http://serc.carleton.edu/NAGTWorkshops/sedimentary/activities/13667.html>



DOWNLOAD THE VIDEO AND SUPPORTING MATERIALS!!

You can download the full video and associated ADV velocity data by visiting the “Using Physical Models to Teach Sedimentary Geology” page at:

<http://serc.carleton.edu/NAGTWorkshops/sedimentary/models/index.html>

If you download the video and use it, please feel free to provide helpful feedback on it. We'd like to know how to make it more useful, clear, etc.

Acknowledgments

Our sincere thanks go out to Chris Paola, Sara Mielke, Chris Ellis, and Ben Erickson at the St. Anthony Falls Laboratory, University of Minnesota, for their scientific, engineering, and creative assistance. We also thank John Southard for inspiring this work and for being Paul's patron.