Graded Bedding

Description of the Activity

This activity introduces students to the concept of sorting materials in different mediums and the sedimentary feature called graded bedding. Students will discover that water is a good medium to separate and sort particles, and that particles behave differently in water than in air.

Reason for Doing the Activity

An underlying principle of geology is that processes affecting Earth today have occurred in the past. It is the basis for understanding how features that we see in the rock record were formed. By understanding how sedimentary features form today, geologists are better able to interpret and reconstruct many of Earth's past environments. Graded bedding is one such feature that is commonly seen in a host of today's active sedimentary environments, as well as in the sedimentary rocks of past environments. It is a feature that is very useful in reconstructing how the sediment grains were transported, the age relationships of different layers, and what the environment was like when the sediments were deposited.

Many science texts and lab manuals have activities that simulate the formation of graded beds by shaking liter size water bottles containing different size particles. However, this procedure simply does not work as the bottle size containers creates too much turbulence, and the trip to the bottom of the bottle is too short for particles to differentially settle into a graded bed.

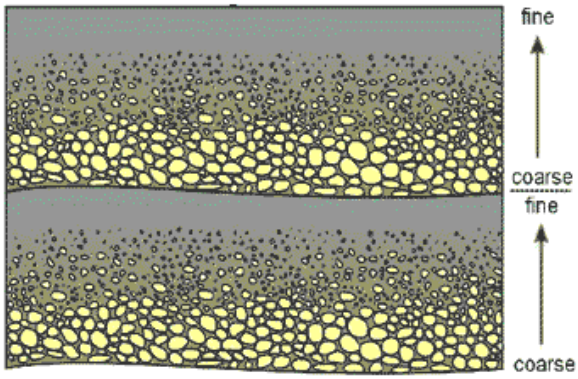
Background

Unlike the way in which different-sized particles fall in air (at essentially the same rate), particles in water settle at different rates depending on size and, to a lesser extent, density and shape. Large particles tend to settle out first, and the smallest particles settle last. As long as there is any turbulence, clay-sized particles will be kept aloft in the water column, making the water *turbid.* Clay particles settle so slowly that once they enter a stream or river they can be carried for great distances, even when flow velocities are low. Larger particles, such as coarse sand, gravel, and boulders, are rolled or bounced along the bed of the stream only during times of high flow velocities. As a water current diminishes (in response to a lowering of the slope of the stream (the stream *grade*) or when the stream flows into a quiet body of water such as a pond, a lake, or ocean), it progressively loses the ability to transport material. Sediment is then deposited in the form of a "graded bed" with layers of coarse material deposited first and finer grains deposited later. These layers can range from a few millimeters to several meters in thickness.

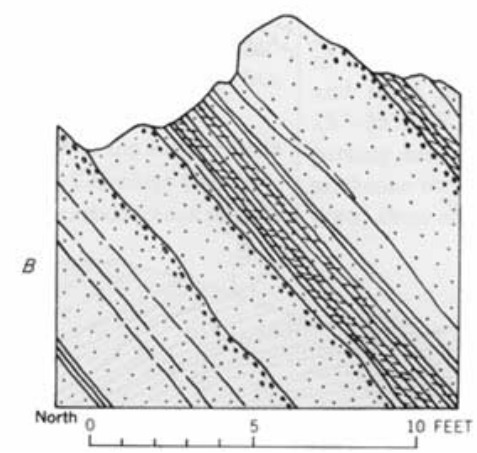
Graded bedding is a sediment deposit characterized by coarse sediments at its base, which grade upward into progressively finer ones. Graded bedding is usually explained as the result of a large amount of mixed sediment being discharged into quiet water. Flood waters carrying a pulse of sediment into a lake, an underwater landslide on the continental slope pouring onto the deep sea floor, or a tsunami washing over a beach into a lagoon would be processes capable of producing graded bedding. Particles falling in air would all fall at the

Background (cont.)

same rate, but in water the coarsest particles fall to the bottom first, followed by smaller and smaller particles. It is usually a reliable indicator of the top and bottom of a bed, which is useful in studying strongly tilted rocks.



Example of how graded bedding was used to interpret "which end is up."



Sketch of outcrop showing overturned beds as indicated by graded bedding. Drawing by H. W. Ferguson and Philip B. King. From U.S. Geological Survey Bulletin 587 Geology of the Great Smokey Mountains National Park, Tennessee and North Carolina (2006).

Graded bedding in sedimentary rocks of King George IV Lake area, central Newfoundland. It shows the progressive decrease in grain size from the bottom to the top of the bed. (Photo courtesy of the Geological Survey, Government of Newfoundland and Labrador - Canada)

Water's ability to sort sediment according to size provides an effective means by which the constituents of sediment can be analyzed.

Particle and Sieve Sizes*

Sand	Geological Size Range (2.00-0.05 mm)	Soil Science Range (2-.02 mm)
Coarse Sand (Sieve #4-#10/10-35)	2.00-0.5 mm	4.75-2.4 mm
Medium Sand (Sieve #10-#40/35-60)	.5-0.125 mm	2.4-.42 mm
Fine Sand (Sieve #40-#/60-230)	0.125-0.062 mm	0.42-0.07 mm
Silt	0.05-0.002 mm	0.02-0.002 mm
Clay	<0.002 mm	<.002 mm

* Sieve sizes originated as a description of a mesh woven by so many threads per inch. The higher the sieve size, the greater the number of threads per inch. Note that size range varies somewhat according to professional organization. Geological size range is from the United States Geological Survey. Soil Science size range is from the Unified Soil Science Classification.

Grade Level

Secondary School \Middle School (depth of interpretation and analyses of results can be adjusted accordingly.)

Amount of Time Needed for this Activity

No more than one class period (some previous collection and set-up time also required)

Materials

Needed for each student group

Two 4ft. transparent plastic columns, sealed at one end with a plug. (You can purchase a fluorescent bulb tube guards for $3 each and drain plugs for $2 each at a hardware store) [Note: Both this activity on graded bedding and the, *What's in my Soil* activity use 4' transparent plastic fluorescent bulb covers as separation columns.]

2 cups construction sand or sand and gravel mixture (washed)

1 scoop, 1 ¼ cup (This can be a bottle top with a cap. With the cap removed, it becomes a funnel.)

Squeeze bottle for washing down sides (May be a laboratory bottle or a clean bottle used for dishwashing detergent.)

Paper cups or other containers for holding soil

6 cups water

Ring stand or other support for columns

Plastic cups are good containers for these activities.

Getting Ready

- It is important that the sand or sand-gravel mixture produces visible layers. Ring stands are ideal to keep the columns upright, but if they are not available, use masking or duct tape to secure the columns to any stable object such as the side of a desk, table, chair, or wall. It is advisable to stand the tubes in a bucket or other container where they will not be moved once activities begin.

- Sand can be coarse construction grade sand and gravel (available at building supply or hardware stores). Be aware that although students will get good sorting results, if the material is not washed, a cloud of fine clay particles may remain at the top of the column and will not settle out on the first day. So either wash the gravel and sand material prior to doing the activity or plan to let the column set up overnight to illustrate that clay particles take much more time to settle.

- Before presenting this activity to students in class, test the column with water to ensure a tight fit. This activity is best done in a classroom without carpeting on the floor; however, think of the occasional flood as part of the water cycle and part of doing science! Have a mop handy, just in case!

Focus attention on the following:

- The ability of water to sort particles into layers in a way that does not occur in air.

- The *pattern* of sorting and settling. Particles grade from large-size (coarse) particles on the bottom to small-size (fine) particles on the top. Each graded layer represents one depositional event.

- The patterns that occur every time the procedure was repeated. If the material was thoroughly mixed, the ratio of course to fine should have remained constant every time the mixture was poured into the column.

Procedures

1. Use a ring stand to support a column, or tape the column to a desk or chair.

2. Pour 1 cup of sand/gravel mixture into column.

3. Observe and discuss what happens as the mixture falls through the air and then settles on the bottom.

4. Repeat steps 2 and 3 three more times.

5. Pour 6 cups of water into the second column.

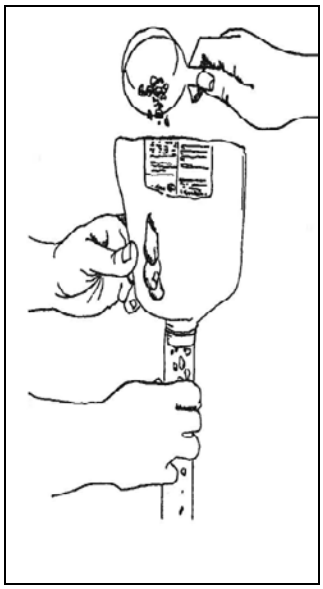
6. Pour ¼ cup sand/gravel mix into second column.

7. Observe and discuss what happens as the mixture falls through the water and then settles on the bottom.

8. Repeat steps 6 and 7 three more times. Simply rotate the column.

Activity Sheet A: Sorting and Separating-Procedure and Analysis

In this activity, you will observe how particles sort and settle in air and water.



Materials for each group

Activity Sheet 2-2: Sorting and Separating-Procedure and Analysis

2 4-foot transparent, plastic columns, sealed at one end

1 ¼ -cup scoop

1 bottle-top funnel

2 cups construction sand or sand-and-gravel mixture

6 cups water

Ring stand or other support for soil columns

1. Use a ring stand to support a column, or tape the column to a desk or chair.

2. Pour 1 cup of sand/gravel mixture into column.

3. Observe and discuss what happens as the mixture falls through the air and then settles on the bottom.

4. Repeat steps 2 and 3 three more times.

5. Pour 6 cups of water into the second column.

6. Pour ¼ cup sand/gravel mix into second column.

7. Observe and discuss what happens as the mixture falls through the water and then settles on the bottom.

8. Repeat steps 6 and 7 three more times.

9. Now answer the following questions:

• What difference did you notice between how the sand-and-gravel mix fell through the air and how it fell through water?

• What differences did you notice between the mixture that settled at the bottom of the tube containing air and the mixture that settled at the bottom of the tube containing water?