topic X

How Does Sedimentation Occur?

Time Emphasis: 7 days

INVESTIGATION		A-1a	A-1b	A-1c	FE - #1	FE - #2	FE - #3	FE - #5
Time Emphasis (Periods)		1	1	1				
TOPIC OUTLINE								
A. Deposition								
A-1 Factors	*What Factors Affect the Deposition of Particles in a Medium?*							
A-1.1 Size	A-1.11	■			■		■	
	A-1.12	■			■		■	
	A-1.13	■				■	■	
A-1.2 Shape	A-1.21	■					■	■
A-1.3 Density	A-1.31	■					■	
A-1.4 Velocity	A-1.41		■	■		■	■	
	A-1.42		■			■	■	
	A-1.43		■	■				
	A-1.44							
B. Erosional-depositional system								
B-1 Characteristics	*What Are Some Characteristics of an Erosional - Depositional System?*							
B-1.1 Erosional depositional change	B-1.11		■					■
B-1.2 Dominant process	B-1.21		■					
B-1.3 Erosion-deposition interface	B-1.31		■				■	
B-1.4 Dynamic equilibrium	B-1.41		■					
B-1.5 Energy relationships	B-1.51			■				
	B-1.52			■				
	B-1.53							
	B-1.54							
PROCESS OF INQUIRY OBJECTIVES								
Mathematical Skill	PIO-1	■		■			■	
Measurement Skill	PIO-2	■		■			■	
Creating Models	PIO-3	■	■	■	■	■	■	■
Analysis of Error	PIO-4						■	
Data Collection & Organization	PIO-5	■		■			■	
TITLES		Deposition of Sediments	Stream Table	Density Currents	School Building & Grounds	Pit	Stream	Beach

Multimedia: Check Multimedia Section of Supplement for reference to this topic.

X-A-1a: DEPOSITION OF SEDIMENTS

QUESTION:

What factors affect the deposition of particles in a medium?

MATERIALS:

Plastic column (80 cm. long x 35 mm. inside diameter), cap or stopper, ring stand and clamp, sorted sediments (pebbles to fine silt...5 ml. of each size), screen sieves, unsorted sediments (100 ml.), watch or clock with second hand, water, graph paper.

SUGGESTED APPROACH:

1. Recommended groups of two students.

2. The apparatus is to be set up as suggested in student sheet.

3. Advanced Preparation: prepare five different sizes of sediment. Gravely sand will serve as an adequate unsorted material.

4. A brief prelaboratory discussion involving the prediction of the relationship between sediment size and settling time sets the stage for the investigation.

5. Have apparatus available,that could be used to find the density of the particles. Some of the students may want to investigate density as a variable.

6. Shape of grains could also be investigated as a variable.

7. One tube should be set up with a fine clay suspension where it can be left undisturbed for a few days to demonstrate the characteristics of a colloidal suspension.

PRECAUTIONS:

1. Make sure sediments are thoroughly sieved.

2. Caution the students to make sure that the hose and stopper are securely in position.

3. Caution the students to time the main body of the sediments. Some particles will settle almost immediately while others will remain in colloidal suspension.

4. Decide on a scale to depict the different sized particles.

TYPICAL RESULTS:

Students' graphs should show a decrease in settling time as the particle size increases (with a leveling off towards the larger particles). The graded bedding usually shows up very well in the tube.

MODIFICATIONS:

1. Simplified version:

   a) Supply the students with a large covered glass jar (i.e., mayonnaise jars), some sediments having mixed particle size and color.

b) Have students fill the jar 1/2 full with water; add about 150 ml. of sediments. Cover the jar and shake thoroughly. At the end of the shaking, allow the jar to stand quietly for about 5 minutes.

c) Have the students draw a diagram of what they observe.

d) Take a piece of rigid tubing (e.g., cork borer) and push straight through the layers of sediments. Using a solid rod that just fits inside the tube, carefully push the sediments out onto a piece of paper.

e) With a toothpick, smear small amounts of each kind of sediment on small glass squares. Place each glass square over millimeter graph paper and determine the particle size of each layer of sediments.

REFERENCES:

Investigating the Earth, pp. 292-293, Teacher's Guide, pp. 357-358.

X-A-1a: DEPOSITION OF SEDIMENTS

QUESTION:

What factors affect the deposition of particles in a medium?

INTRODUCTION:

The weathered material of the earth's surface may be eroded away and eventually deposited in the relatively quiet waters of ponds, lakes, or oceans. Unfortunately many of the processes of deposition go unnoticed by us because we are above and not under the surface of the waters. In this investigation you will be able to see, with the aid of a plastic tube, deposition taking place; study some factors which affect it; and observe the products of deposition.

OBJECTIVES:

When you have finished this investigation, you should be able to:

1. describe the factors that influence the deposition of sediment in a quiet body of water.

2. describe conditions under which you would expect graded bedding to be formed.

METHOD:

1. Set up the equipment as follows: attach a plastic column, in a vertical position, to a ring stand or some other supporting device. Make sure the bottom cap is tightly in place and the hose clamp is closed. Fill the tubes about 3/4 full of water.

2. Drop small amounts of each of the different sized sediment into the column and record the time each takes to reach the bottom. Repeat this three times for each size. Use the average time for the settling rate.

3. Make some type of comparative scale of the different particle sizes.

4. Construct a graph of the settling time versus grain size for each and draw inferences from the graph.

5. Empty the column, replace the stopper TIGHTLY, and fill the column HALF full with water. Drop a handful of the mixed sediment into the water and record your observations. After waiting several minutes, repeat this procedure once again.

6. After allowing a few minutes for settling, make some observations

concerning the nature of the sediment on the bottom of the column.

7. Develop a technique which will allow you to test the effect that density of particles has on the settling rate.

8. Investigate the effect of particle size on settling rates.

9. Make and record observations of the apparatus your teacher has set up to illustrate colloidal suspension.

QUESTIONS:

(A-1.11) 1. How does size affect the time in which particles settle when other factors are equal?

(A-1.12) 2. What was the pattern of motion of the finest particles in the sample as they settled? What rate of settling did you measure?

(A-1.13) 3. What is your description of the appearance of material which has accumulated on the bottom following the addition of the mixed sample to the quiet water.

(A-1.21) 4. What effect does the shape of a particle have on its settling rate when all other factors are equal.

(A-1.31) 5. What effect does the density of a particle have on its settling rate when all other factors are equal.

Easy (1)

X-A-1b: STREAM TABLE

QUESTION:

What factors affect the deposition of particles in a medium?

MATERIALS:

Stream table or tray, approximately 122 x 36 x 9 cm. with drain at one end, siphon tube with clamp, support to raise one end of tray, one bucket of soil, large overflow bucket, water.

SUGGESTED APPROACH:

1. Recommended student grouping (5-6).
2. It is best to set up the apparatus prior to class time.
3. A brief review of the concept of models might help to put the use of a stream table in perspective with the natural environment.
4. If there are sufficient numbers of stream tables available, a demonstration table may be set up and allowed to run for several days, thus more closely approximating the actual stream.
5. Relate observations to topics covered in Topic IX, as well as Topic X.
6. Relate to actual deltas on maps and aerial photographs.

PRECAUTIONS:

1. In a laboratory investigation such as this, the students should be allowed to pursue any reasonable approach to the study of stream deposition.
2. Due to increase in weight as the soil absorbs moisture, the middle of the stream table might buckle....support is needed.
3. The soil should be a fine washed sand or gravel. Organic matter will cause floating debris and will cloud the water to such an extent that the formation of the delta will be obscured. If difficulties arise such as the sand being washed away or the channel changing too rapidly, some fine clay may be added to the sand to stabilize it.

TYPICAL RESULTS:

The students should observe the following phenomenom during this investigation:

1. slope of the delta
2. stream meanders, deposition, and erosion
3. horizontal distribution of the sediments
4. deposition occurring in relatively quiet water

MODIFICATIONS:

1. If at all possible, go to an actual stream so that the students will be able to relate their model to the actual environment.
2. Sedimentation chambers may be constructed or purchased and may be used to illustrate the cross section of a delta.

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QUESTION:

What factors affect the deposition of particles in a medium?

INTRODUCTION:

Streams and rivers play an important role in the processes of erosion and deposition. In previous investigations, the factors which affect a stream's ability to erode have been studied. In this investigation you will see some of these factors in operation as well as observe how they affect the deposition of the eroded material in a model "lake."

OBJECTIVES:

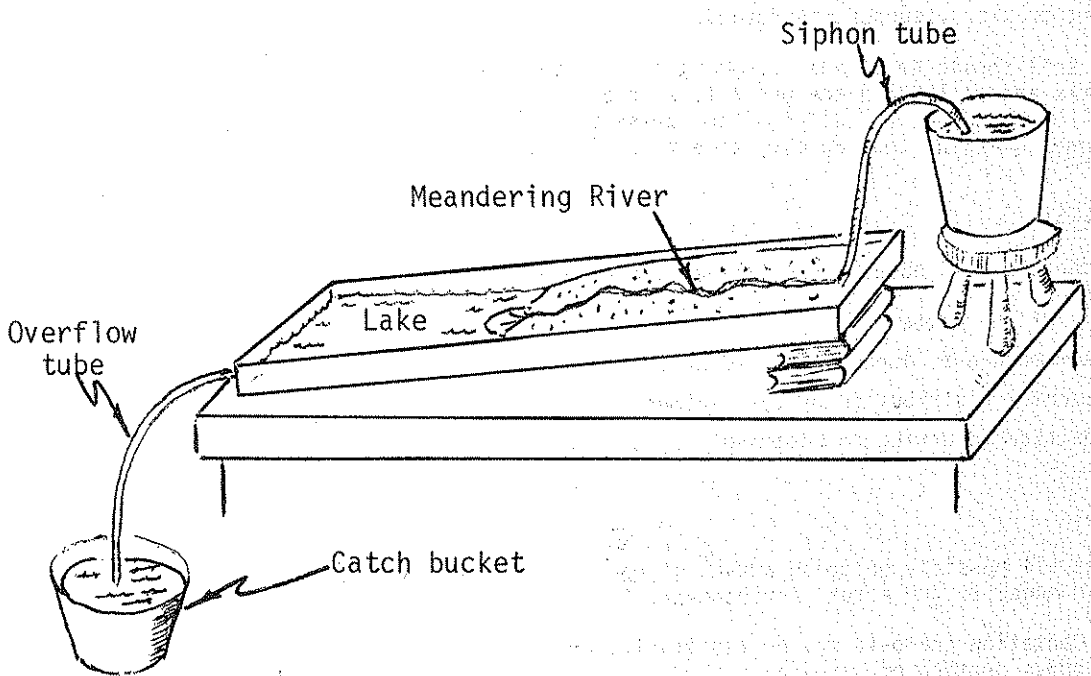
When you have finished this investigation, you should be able to:

1. describe the characteristics of a meandering stream, identifying areas of erosion and deposition.

2. describe the characteristics of a delta formation, including shape, structure, and kind of material of which it is composed.

METHOD:

1. Set up a stream table as illustrated in the diagram below:



2. Observe and record changes that occur on the land surface, lake, stream itself, and depositional features.

3. Modify the slope of the stream, making it steep near the head and less steep near the mouth. Observe particle erosion and deposition patterns that develop along the stream.

4. Float a small folded piece of paper downstream, or place a few drops of food coloring in the water at the upstream end. Observe its velocity in comparison to grains of sand moving in the stream bed. Which best represents the velocity of the water? Observe the path of the paper or the coloring. Where does it go in relation to the channel walls, and the lake?

5. Select at random four small equal areas of the stream table. Determine what process (erosion or deposition) is dominant in each area.

QUESTIONS:

(A-1.41) 1. As the velocity of the water decreased which particles were deposited first?

(A-1.42) 2. As the slope of your stream decreased, what happened to the velocity of the water flowing in the stream? Describe the horizontal sediment depositional pattern that resulted.

(A-1.43) 3. How does the velocity of particles being transported downstream compare to the velocity of the water transporting them?

(B-1.11) 4. What changes occurred in the total system as a result of the erosional and depositional processes?

(B-1.21) 5. What is your analysis of the process acting in the four selected areas?

(B-1.31) 6. From a plane view of the stream table, where can a boundary be drawn separating areas of erosion from areas where deposition is taking place?

(B-1.41) 7. In what areas on your stream table is it difficult for you to decide which is occurring, erosion or deposition? What is the possibility that both processes are occurring simultaneously?

Easy (1)

X-A-1c: DENSITY CURRENTS

QUESTION:

What factors affect the deposition of particles in a medium?

MATERIALS:

Two plastic or pyrex glass columns joined together, graduated cylinder (50 ml.), two small test tubes, two beakers, (100-250 ml.), grease pencil, timer or watch with second hand, fine sand (1 cubic centimeter), two ringstands, two swivel tube clamps, astrolabe, fine sand and clay (potter's clay from art department works well) mixture (100 grams), graph paper.

SUGGESTED APPROACH:

1. Advanced preparations:

   a. Prepare the two slurries to be used in the investigation:

      *#1 - one part fine sand and clay to two parts water

      *#2 - one part fine sand and clay to four parts water

      Label each slurry with the appropriate proportions.

   b. To save time, the apparatus may be set up prior to the students coming to class.

2. Have the students follow the directions on the student sheets and complete the investigation.

PRECAUTIONS:

1. Be sure the glass tubes used are not the breakable type.

2. The slope of the column should be between 10 and 15 degrees; lower slopes may be necessary if a shorter column is used.

3. Make sure all stoppers and clamps are tightly secured.

4. All slurries must be well agitated when density measurements are made and while being poured into the column.

5. Students should organize themselves so that each knows his responsibility before starting the investigation.

6. This model of a density current serves only to demonstrate what a density current is, but does not really illustrate how a real density current operates. A real density current can be triggered by a very small event such as a sea animal burrowing into the sand on a steep underwater slope. As loose sand begins to mix with the water, a density current forms and begins, slowly at first, to move down slope. As it continues, more sediments are stirred up and the current increases in density, and therefore in velocity, until a major density current able to transport coarse sediments far out to ocean basins is formed. When it reaches a broad, flat area on the ocean bottom, the decrease in slope begins to slow down the velocity of the current and eventually the sediments settle out in the quiet water.

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TYPICAL RESULTS:

In the past, this investigation has proved very effective in illustrating the concept of density currents and the important role they play in distributing large sediments on certain portions of the ocean floor.

MODIFICATIONS:

1. Position a plastic tube as described on the student sheet. Fill the tube 1/3 full with a dense solution of salt water. Add fresh water, being careful to maintain the interface between the two. Add a clay slurry and observe what happens when it reaches the salt-fresh water interface. This can be used as a demonstration after the above investigation is completed.

REFERENCES:

Sand, Scientific American (reprint) by P.H.H. Kuenen.

X-A-1c: DENSITY CURRENTS

QUESTION:

What factors affect the deposition of particles in a medium?

INTRODUCTION:

Geologists have found coarse sediments on the ocean floor far from shore but near the mouths of submarine canyons. They have attributed these sediments to "density currents" coming from the continental shelf. In this investigation you will have an opportunity to create a model of a density current and seek an answer to the question, "Could density currents actually carry these coarse sediments that far out to sea?"

OBJECTIVES:

When you finish this investigation, you should be able to:

1. explain the probable mode of transport and deposition for the coarse grained sediments found in the deep ocean basins.

METHOD:

1. Position the plastic tube at an angle of 10 - 15 degrees with the table top. Make sure it is adequately supported and that the bottom cap is on tight. Fill the tube with water (this can be done using a bucket of water and siphon). Make sure you leave enough room in the tube to allow three test tubes of water to be added without spilling over.

2. Prepare slurry #1, unless your teacher has already done so. Either measure or estimate its density and record it. Stir the slurry until it is well mixed and then fill a test tube 1/2 full with it. Shake the test tube well and quickly pour its contents into the plastic tube of water. Mark the distance the slurry travels in 5 second intervals (use a grease pencil and mark directly on the plastic tube). Measure these distances and record them. Examine and record your observations of the materials that settle along the bottom.

3. Empty the contents of the tube; rinse with clear water; replace the bottom cap tightly, and repeat the procedure with slurry #2.

4. Prepare a graph showing the relationship between relative density of the slurry and average velocity of the density current.

QUESTIONS:

1. What is the order by density of the two slurries and tap water?

2. How do you account for the differences in densities?

3. What variations did you notice in the rate of movement of slurry #1?

4. What variations did you notice for slurry #2?

(A-1.43) 5. From your graph, what is the relationship between the densities of the two slurries and their average velocities?

6. If you had an infinitely long tube, which slurry would travel the farthest in a given time? Why?

(A-1.41) 7. Your investigation differed from a real density current in one very important way. A real density current moves over an ocean bottom containing loose sediment, as a result, it stirs up these sediments and the current increases in density as it moves. Did your density current increase as it moved down the tube? If the density of a real density current increases as it continues along its path, what would happen to its velocity? What would happen to the amount of sediment being carried? What would finally act to slow this down and eventually let the sediments settle to the bottom again? Which particles would settle out first?

8. If you were to vary the angle of the tube from 15 to 12 to 9 to 6 degrees and use slurry #1, what would a graph of angle of slope versus average velocity look like? (Draw a rough sketch.)

9. From your graphs and observations, do you think that density currents are the cause of the coarse sediments on the ocean floor? Explain.

(B-1.51) 10. What are the energy characteristics of a density current in motion? Where did the energy originate?

(B-1.52) 11. When the energy of the system is depleted, what will happen to the sediment?