LAB 10

Lab Handout

Lab 10. Deposition of Sediments: How Can We Explain the Deposition of Sediments in Water?

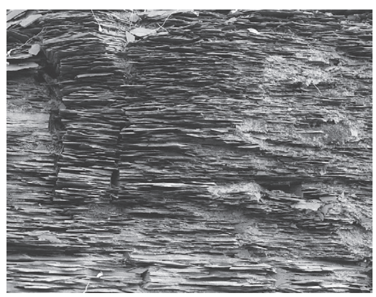
Introduction

People use sedimentary rocks such as siltstone, shale, and sandstone (see Figure L10.1) for many different purposes. Siltstone, for example, is used to build homes and walls or for decorations. Shale is used to make cement, terra-cotta pots, bricks, and roof tiles. Sandstone is another sedimentary rock that is used as a building material. It is used to create floor tiles and decorative walls in homes or businesses and to create monuments and roads. Sandstone is also used as a sharpening stone for knives.

FIGURE L10.1

Some examples of sedimentary rock

Siltstone



Shale

Sandstone

The material that makes up siltstone, shale, and sandstone comes from other rocks that have weathered over time. These rocks are therefore called *clastic sedimentary rocks*. As a rock weathers, it is broken into smaller pieces or sediments. These sediments are then carried to other places by wind, liquid water, or glacial ice. The sediments eventually settle out of the air or water and accumulate at a specific location. This process is called *deposition,* and it results in layers of different types of sediment. These layers of sediment then turn into a rock through a process called *lithification*.

Sediments go through compaction and cementation during lithification. *Compaction* happens when the individual pieces of sediment in a layer are forced together because of the combined weight of all the sediment in layers above them. *Cementation* happens when the dissolved minerals between the pieces of sediment dry. These minerals then bind the other pieces of sediment together and harden—much like cement mix does after water is added to it. The sediments that are cemented together to create a sedimentary rock often come from all different kinds of rocks, and therefore have different physical properties.

Geologists, as a result, classify clastic sedimentary rocks based on the types of sediment found within them.

Sedimentary rocks, such as those shown in Figure L10.1, consist of layers of different types of sediments because different types of sediments fall through a fluid, such as water, at different rates. The rate at which a sediment falls through a fluid is called its *settling velocity.* The settling velocity of a sediment, like its texture, density, or color, is a unique physical property of that sediment. When a sediment has a settling velocity that is lower than the stream flow velocity of a river, that sediment will be carried downstream. When a sediment has a settling velocity that is higher than the stream flow velocity of a river, that sediment will sink to the bottom of the river and not move farther downstream. The stream velocity of a river at different locations, as a result, will determine where different types of sediments will accumulate and what types of sedimentary rocks will form at different locations.

TABLE L10.1

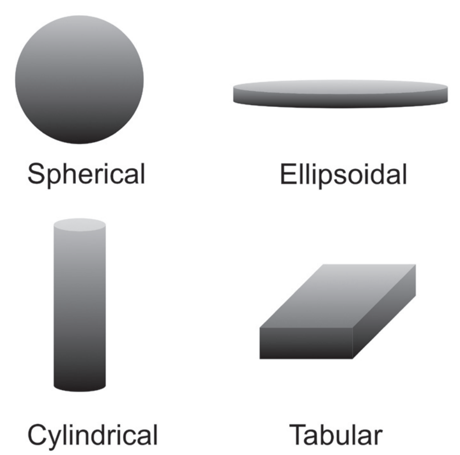
Modified Wentworth scale for classifying particles by size

Name	Particle size (mm)
Pebble	> 4
Granule	3.9–2.0
Very coarse sand	1.9–1.0
Coarse sand	0.9–0.5
Medium sand	0.49–0.25
Fine sand	0.24–0.125
Very fine sand	0.124–0.0625
Silt	0.0624–0.002
Clay	< 0.002

It is important for geologists to understand how the different characteristics of a sediment affects its settling velocity because this physical property helps them explain how sediments move from one location to another and allows them to predict where different types of sediments will accumulate over time. Geologists can also learn more about environmental conditions of the past if they understand the factors that affect the deposition of sediments when they examine the nature and location of different types of sedimentary rock.

FIGURE L10.2

The various shapes of a sediment particle



A sediment has many different physical properties that may or may not affect its settling velocity; these properties include particle size, shape, and density. Sediment particles can range in size from clay that is less than to 0.002 mm in diameter to large pebbles that can be well over 4 mm in diameter. Geologists often use a specific scale, such as the Wentworth scale (see Table L10.1), to classify or describe the particle size of a sediment. Shape is another physical property of a sediment, and geologists often classify or describe the shape of a sediment particle using the terms shown in Figure L10.2. Finally, the density of a sediment is defined as its mass per unit volume.

In this investigation, you will have an opportunity to figure out how these three physical properties affect the settling velocity of a sediment. You will then use this information to develop a conceptual model that explains how sediments will settle in water. A conceptual model like this is useful because it allows people to not only understand why sedimentary rocks consist of layers of different materials but also predict the order of the layers that will be found in different kinds of sedimentary rocks.

Your Task

You will be given several different sediments. You will then explore how each type of sediment settles in a column of water over time. Your goal is to use what you know about cause-and-effect relationships and structure and function to design and carry out an investigation that will enable you to develop a conceptual model that explains how particle size, density, and shape affects the settling rate of a sediment in water. Once you have created your conceptual model, you will return these sediments to your teacher. He or she will then give you one or two sediment mixtures. You will use the sediment mixtures to test, and if needed, revise your model. Your model, if valid or acceptable, should allow you to predict how the different types of sediments found in each mixture will accumulate at the bottom of a column of water over time.

The guiding question of this investigation is, ***How can we explain the deposition of sediments in water?***

Materials

You may use any of the following materials during your investigation:

Sediments of different sizes
- Gravel
- Coarse sand
- Medium sand
- Fine sand

Sediments of different shapes
- 4 Pieces of modeling clay (each 2 g)

Sediments of different densities
- Glass beads (4 mm)
- Plastic beads (4 mm)
- Ball bearings (4 mm)

Sediment mixtures for testing the model
- Mixture A
- Mixture B

Consumable
- Water

Equipment
- Safety glasses or goggles (required)
- Chemical-resistant apron (required)
- Gloves (required)
- Clear plastic tube
- Rubber stopper
- Beaker (500 ml)
- Beaker (50 ml)
- Funnel
- Duct tape
- Meterstick
- Bucket
- Electronic or triple beam balance
- Stopwatches

Safety Precautions

Follow all normal lab safety rules. In addition, take the following safety precautions:

- Wear sanitized indirectly vented chemical-splash goggles and chemical-resistant aprons and gloves throughout the entire investigation (which includes setup and cleanup).
- Handle all glassware with care.
- Immediately wipe up any spilled water and pick up any spilled beads, ball bearings, or other materials that can cause a slip, trip, or fall hazard.
- Wash hands with soap and water when done collecting the data and after completing the lab.

Investigation Proposal Required? ☐ Yes ☐ No

Getting Started

You will need to design and carry out at least three different experiments to determine how the structure of a sediment affects the rate at which it will fall through a column of water. These experiments are necessary because you will need to answer three specific questions before you can develop an answer to the guiding question for this lab:

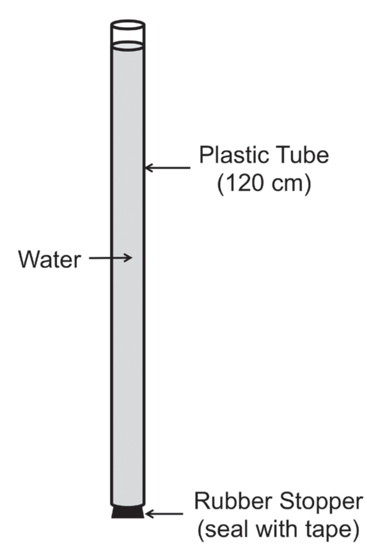
- How does particle size affect the time it takes a sediment to fall through a column of water?
- How does particle density affect the time it takes a sediment to fall through a column of water?
- How does particle shape affect the time it takes a sediment to fall through a column of water?

You can create a water column, such as the one shown in Figure L10.3, using a large plastic tube and a rubber stopper. Before you create your water column, it will be important for you to determine what type of data you need to collect, how you will collect the data, and how you will analyze the data for each experiment, because each experiment is slightly different.

To determine *what type of data you need to collect*, think about the following questions:

- What conditions need to be satisfied to establish a cause-and-effect relationship?
- How will you determine when a particular sediment type has settled?
- How will you determine how long it takes for a sediment to fall through a column of water?
- What information will you need to calculate the density of a particle?

FIGURE L10.3
A water column



- When will you need to make these measurements or observations?

To determine *how you will collect the data,* think about the following questions:

- What will serve as your independent variable and dependent variable for each experiment?
- How will you vary the independent variable during each experiment?
- What will you do to hold the other variables constant during each experiment?
- What types of comparisons will you need to make?
- What measurement scale or scales should you use to collect data?
- What will you do to reduce error in your measurements?
- How will you keep track of and organize the data you collect?

To determine *how you will analyze the data,* think about the following questions:

- What calculations will you need to make?
- How could you use mathematics to describe a relationship between variables?
- How could you use mathematics to document a difference between groups or conditions?
- What types of patterns might you look for as you analyze your data?
- What type of table or graph could you create to help make sense of your data?

Once you have finished collecting data, your group can develop a conceptual model that explains the deposition of sediments in water. For your conceptual model to be complete, it must be able to explain how the structure of different sediments relates to how different types of sediments will move through water. It must also include information about the stream flow velocity of a body of water such as a river or lake. The stream flow velocity is how fast the water is moving in a specific direction. The stream flow velocity of water in a water column is zero, but in a river it can reach velocities of 25 km/h. Finally, and perhaps most important, you should be able to use your model to predict the order in which different types of sediments will settle at the bottom of a column of water. This type of conceptual model is useful because it enables people to understand where and when different types of sediments will accumulate over time.

The last step in your investigation will be to generate the evidence that you need to convince others that the conceptual model you developed based on your experiments is valid or acceptable. To accomplish this goal, you can use your model to predict how the different sediments in a mixture will settle in a column of water after a set amount of time. If you are able to use your conceptual model to make accurate predictions about how the different sediments in a mixture will move through the water relative to each other, then you should be able to convince others that your model is valid or acceptable.

Connections to the Nature of Scientific Knowledge and Scientific Inquiry

As you work through your investigation, be sure to think about

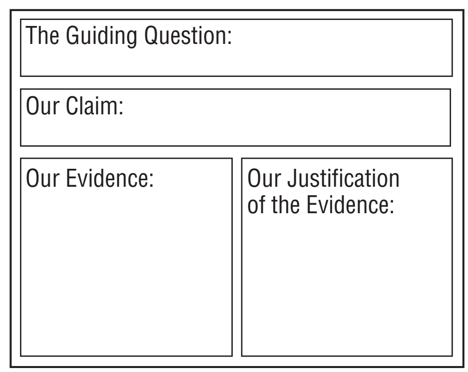
- the use of models as as tools for reasoning about natural phenomena, and
- the nature and role of experiments in science.

Initial Argument

Once your group has finished collecting and analyzing your data, your group will need to develop an initial argument. Your initial argument needs to include a claim, evidence to support your claim, and a justification of the evidence. The *claim* is your group's answer to the guiding question. The *evidence* is an analysis and interpretation of your data. Finally, the *justification* of the evidence is why your group thinks the evidence matters. The justification of the evidence is important because scientists can use different kinds of evidence to support their claims. Your group will create your initial argument on a whiteboard. Your whiteboard should include all the information shown in Figure L10.4.

FIGURE L10.4

Argument presentation on a whiteboard



Argumentation Session

The argumentation session allows all of the groups to share their arguments. One or two members of each group will stay at the lab station to share that group's argument, while the other members of the group go to the other lab stations to listen to and critique the other arguments. This is similar to what scientists do when they propose, support, evaluate, and refine new ideas during a poster session at a conference. If you are presenting your group's argument, your goal is to share your ideas and answer questions. You should also keep a record of the critiques and suggestions made by your classmates so you can use this feedback to make your initial argument stronger. You can keep track of specific critiques and suggestions for improvement that your classmates mention in the space below.

Critiques of our initial argument and suggestions for improvement:

If you are critiquing your classmates' arguments, your goal is to look for mistakes in their arguments and offer suggestions for improvement so these mistakes can be fixed. You should look for ways to make your initial argument stronger by looking for things that the other groups did well. You can keep track of interesting ideas that you see and hear during the argumentation in the space below. You can also use this space to keep track of any questions that you will need to discuss with your team.

Interesting ideas from other groups or questions to take back to my group:

Once the argumentation session is complete, you will have a chance to meet with your group and revise your initial argument. Your group might need to gather more data or design a way to test one or more alternative claims as part of this process. Remember, your goal at this stage of the investigation is to develop the best argument possible.

Report

Once you have completed your research, you will need to prepare an *investigation report* that consists of three sections. Each section should provide an answer for the following questions:

1. What question were you trying to answer and why?
2. What did you do to answer your question and why?
3. What is your argument?

Your report should answer these questions in two pages or less. You should write your report using a word processing application (such as Word, Pages, or Google Docs), if possible, to make it easier for you to edit and revise it later. You should embed any diagrams, figures, or tables into the document. Be sure to write in a persuasive style; you are trying to convince others that your claim is acceptable or valid.