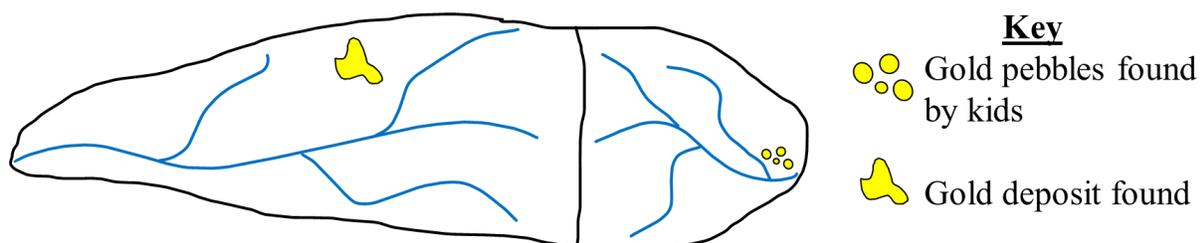


Drainage Divide Laboratory Guide

One afternoon some kids fishing at their favorite fishing spot noticed that some of the pebbles along the bank of the river seemed to have gold in them. They were excited about this and wondered if there were rock formations upstream that had gold deposits. In their spare time the kids started to search upstream for gold in rocks but did not find anything. One night they showed the pebbles to one of the kid's fathers who worked for a large construction company. He took the pebbles to work and was able to get his company to invest some resources into looking for possible gold deposits. The company was able to cover a much larger area upstream using jeeps, airplanes and sophisticated equipment. But alas---they never found any evidence of gold deposits in the hills that the river drained. Years later, a geomorphologist (a scientist who studies the processes that shape rivers and mountains on the surface of earth) heard of this story and went to look for these gold deposits. Unlike the people who had been involved in the first exploration, the geomorphologist was familiar with the process of **drainage divide migration**, and by using her knowledge she managed to find a layer of bedrock with rich gold deposits. Interestingly, she did not find these deposits in the area that drains the stream where the pebbles were found. Instead she found the gold deposits in an area that drains to a different stream on the other side of the ridge. In the assignment below you will learn about the process of **drainage divide migration**, and how it helped the geomorphologist to find the gold deposits.



1. Introduction

The area from which all rainfall flows to a stream is called the drainage basin, or catchment area, of that stream. For example, the total area that drains to the mouth of the Mississippi River constitutes its

drainage basin. The boundary between neighboring drainage basins is typically located along a ridge and is called a drainage divide. This is because it divides that landscape into different drainage basins. Rain drops that fall on opposite sides of a drainage divide will flow into different drainage basins. Although drainage divides may appear immobile, they can actually move through time in a process called divide migration. Divide migration occurs when the erosion on one side of the divide is more intense compared to the other side. Over long time scales, the migration of divides can meaningfully change the area of drainage basins, and therefore the discharge of the rivers that drain them, as well as the quantities of sediments and nutrients that are carried by these rivers. This lab will explore the mechanisms of divide migration.

2. Materials

- Cardboard cereal box
- Scissors
- 3 cups of rice
- Pencil
- Tape
- Tablespoon
- 1 cup measuring cup
- Ruler
- Thumbtack
- Funnel
- Bean
- Printed and cut out “slope guide” and “funnel guide” (found in additional materials section)

3. Procedure

Part A: Setting up the Experiment

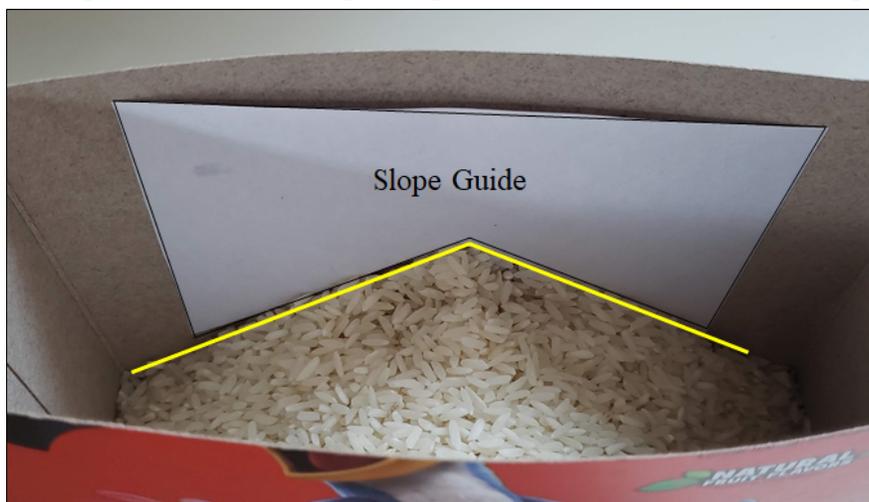
1. Cut out the slope guide from the “Additional Materials” section.
2. Cut the cereal box horizontally 15 cm above its bottom. If the box has any holes in the bottom or sides where rice could leak through, patch them up with tape. Optionally, you can place the box on a tray to avoid any mess in later steps.



3. Pour 3 cups of rice into the middle of the box using a funnel, creating a “drainage divide” in the middle of the box with hillslopes on either side. If you do not have a funnel, make one using the cutout and instructions included at the end of this laboratory guide.



- Align the slope guide with the divide and slopes and use your hands or a spoon to shape the slopes to match the slope guide. The slope guide will ensure the slopes are angled at 30° , close to the angle of repose, which is the steepest slope a material can hold without slumping.

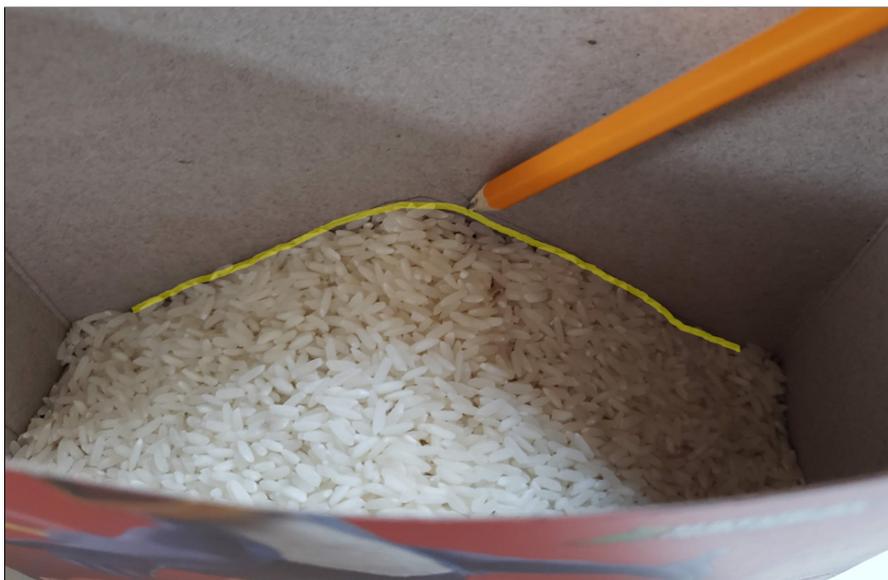


- Insert the bean, which represents a gold deposit, 1 cm to the right of the drainage divide and 3 cm deep. Do this by using a ruler to poke down the bean, stopping when the ruler reaches the 3 cm mark. Reshape the rice to fit the slope guide if it was disturbed at all while inserting the bean.

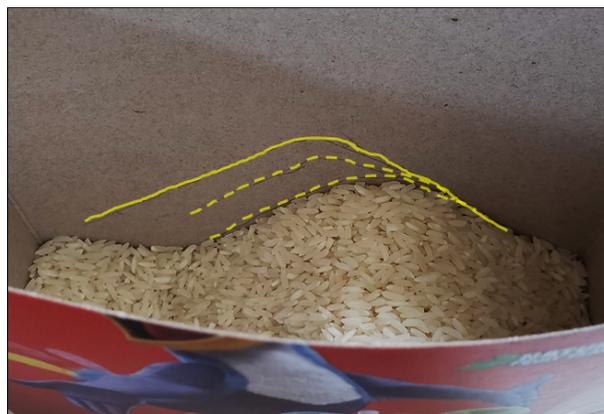


Part B: Scooping the Rice

6. Trace along the slopes with a pencil, as shown by the yellow line in the image below.

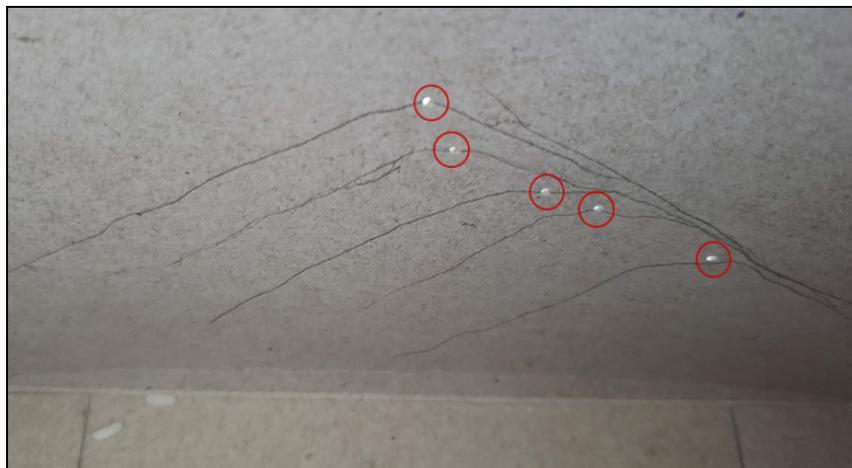


7. Scoop rice from the bottom of the left side of the ridge in 5 tbsp increments and trace the drainage divide at each increment. Do this 4 times. The image below on the right shows how your box might look after you have removed 10 tablespoons of rice. As you scoop, keep an eye out for the bean. If you see it, note which side of the divide it is on in the data section.

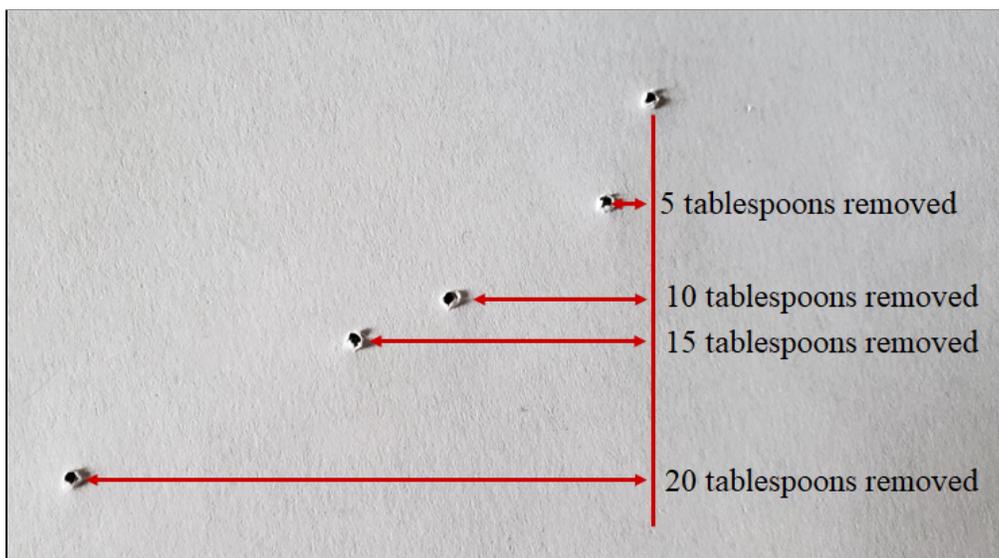


Part C: Measuring Divide Migration

8. If you did not see the bean while scooping rice, carefully search for it on each side of the divide. Once you find it, note which side of the divide it is on in the data section found on page 6.
9. Empty the rice from the box. Use a thumbtack to poke a hole through the box at the divide at the top of the slopes you traced.



10. On the outside of the box, use a ruler to measure how much the drainage divide shifts after each 5 tbsp increment by measuring horizontally between the original ridge of your pencil markings and its new locations after erosion, represented by the thumbtack holes. Record this in the provided table.



11. Plot your data in the provided graph.

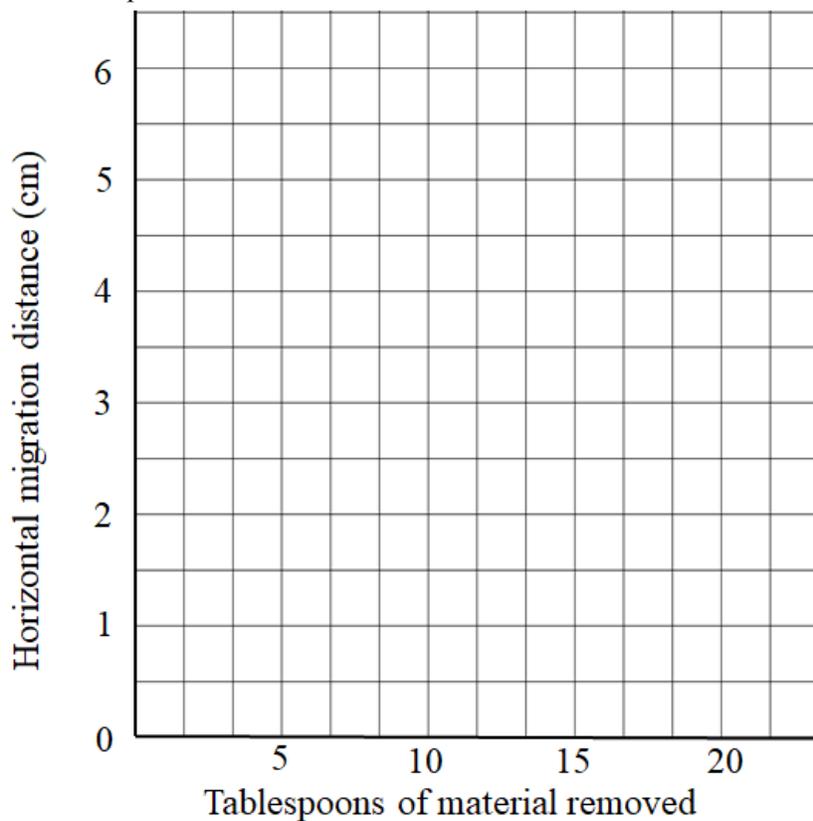
4. Data

- Where did you find the bean (left or right side of the divide)? _____
- Data table

Tablespoons Removed

	5	10	15	20
Horizontal migration in cm				

c. Graph

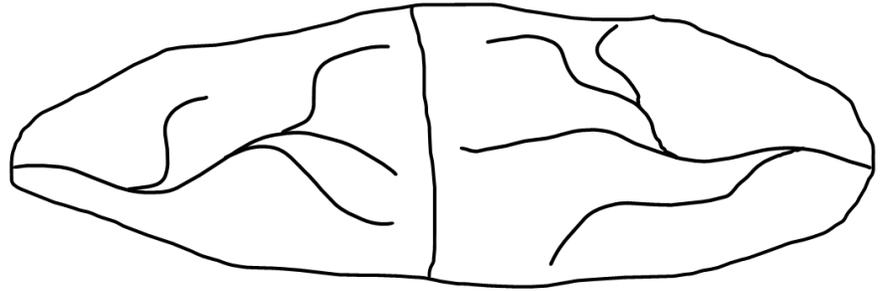


5. Questions

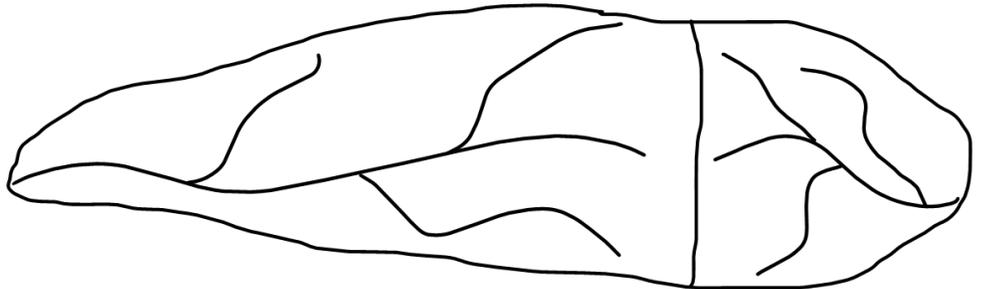
1. In the experiment, you scooped rice from the left side of the box and observed how the drainage divide migrated. Which way do you think the drainage divide would migrate if you scooped rice from the right side of the box?
2. What processes in the real world are similar to the 'scooping out' of rice? Have you seen such processes in action?

3. The figure below shows two drainage basins that share a divide at time one and time two. Which side had more erosion in order to cause the transformation?

Time 1



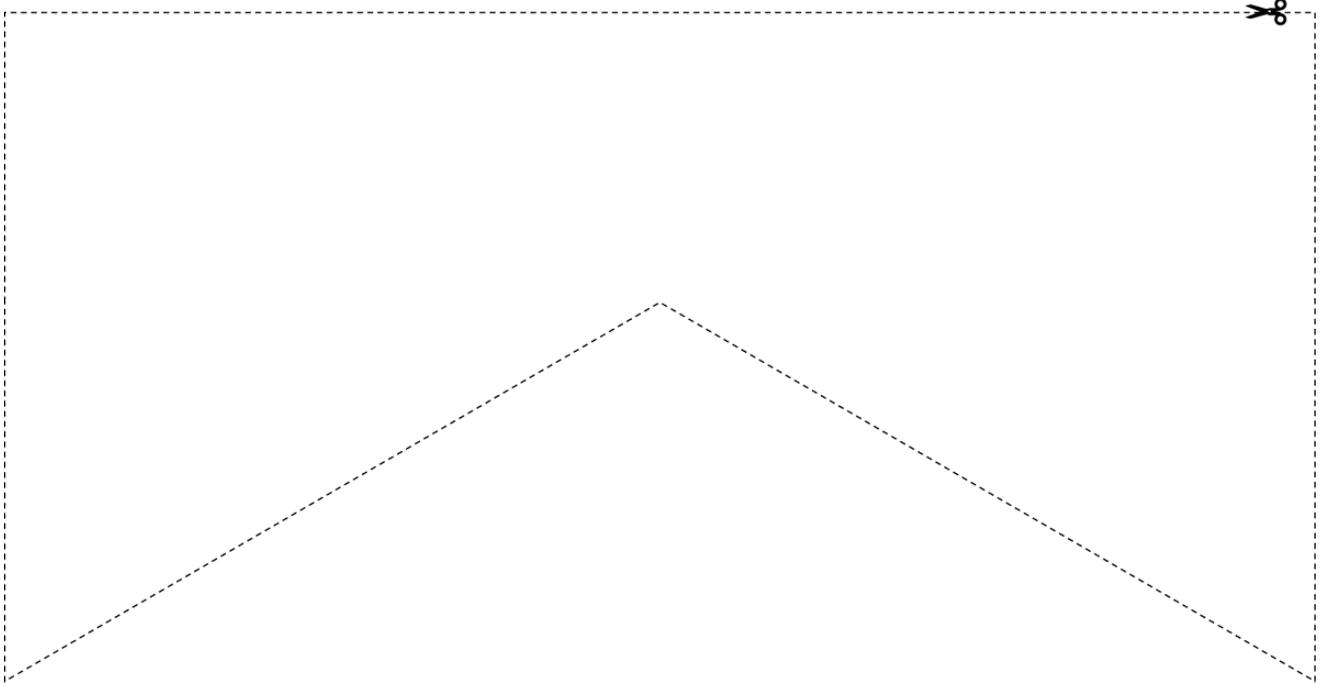
Time 2



4. Now that you've learned about how and why drainage basin divides migrate, think back to the story about the gold on page one and the accompanying drawing. Explain why the gold deposit was found in a different drainage basin than the one where the kids found the gold pebbles.

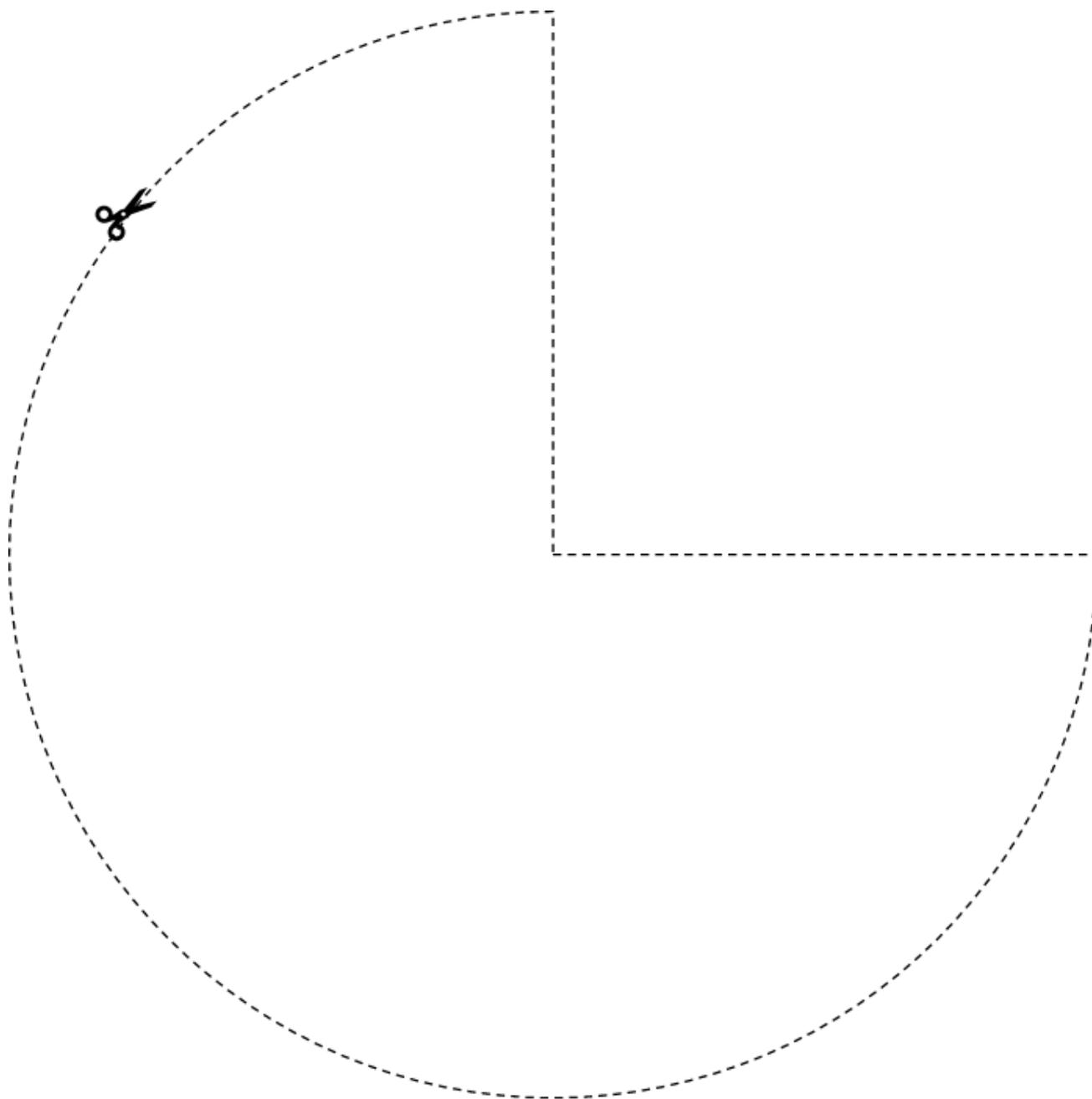
6. Additional Materials

- a. Slope guide



b. Funnel guide

- Instructions: Cut out the funnel guide. Bring the straight edges towards each other and overlap them until you have created a cone about 10 cm in diameter. Tape it on both the outside and inside. Finally, use scissors to snip off the end of the cone about 1 cm up, creating a funnel.



Supplemental Part 2: Tilting

1. Introduction

In part 1 of this experiment, you saw how scooping rice, or “eroding,” one side of the drainage divide shifted the divide’s location. Now, in part 2, you will see how tilting influences drainage divide migration.

2. Materials

- Cardboard cereal box
- Scissors
- 3 cups of rice
- Pencil
- Tape
- Tablespoon measurer
- 1 cup measurer
- Ruler
- Thumbtack
- Funnel

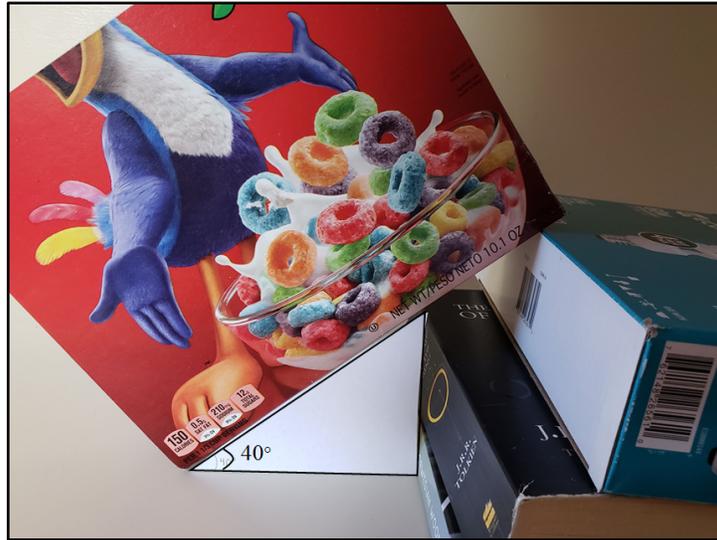
3. Procedure

1. Cut out the tilt guides from the “Additional Materials” section.
2. Empty the rice from Part 1 from the box and flip the box around so that you are facing a blank inside with no pencil markings from Part 1.
3. Pour 3 cups of rice into the middle of the box using a funnel, creating a “drainage divide” in the middle of the box with a slope on either side.
4. Align the slope guide with the ridge and use your hands or a spoon to shape the slopes to match the slope guide.
5. Insert the bean, which represents a gold deposit, just to the right of the drainage divide and 3 cm deep. Do this by using a ruler to poke down the bean, stopping when the ruler reaches the 3 cm mark. Reshape the rice to fit the slope guide if it was disturbed at all while inserting the bean.
6. Trace along the divide with a pencil
7. Use the first tilt guide to tilt the box to 10° and use something to prop it as closely to this angle as you can such as a book, rock, eraser, etc..



8. Trace the divide with a pencil.

9. Following the same method as in step 7, tilt the box to 20°, 30°, and finally 40° using the appropriate tilt guides and trace the divide after each tilting.



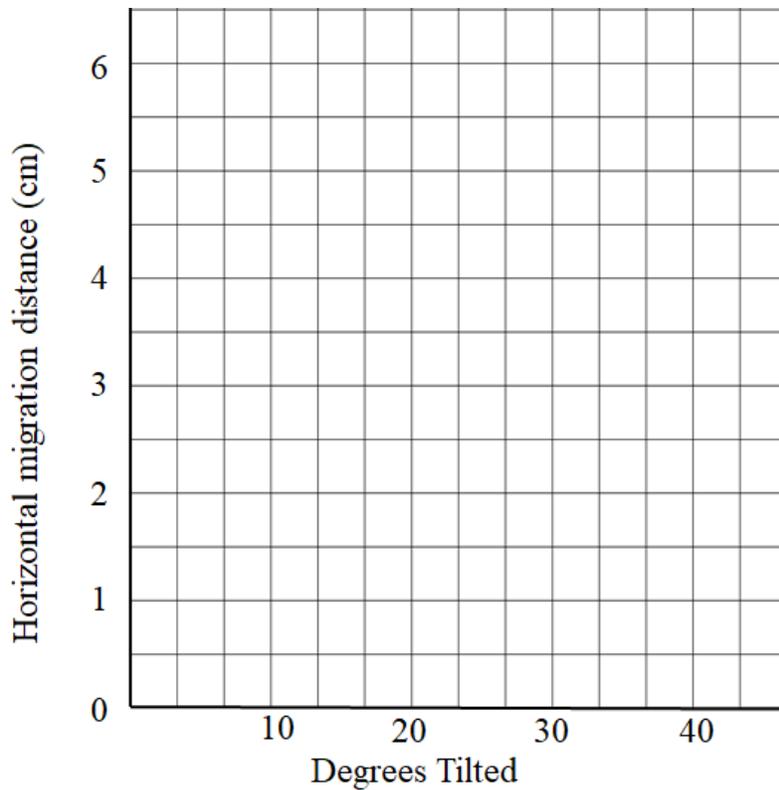
10. Use a thumbtack to poke a hole through the box at the ridge of each drainage divide you traced. Then, on the outside of the box, use a ruler to measure how much the drainage divide shifts after each tilting increment by measuring horizontally between the original ridge of your pencil, just like in Part 1. Record this data in the data table.
11. Plot your data in the provided graph.

4. Data

- a. Data table

	Degrees Tilted			
	10°	20°	30°	40°
Horizontal migration in cm				

- b. Graph



5. Questions

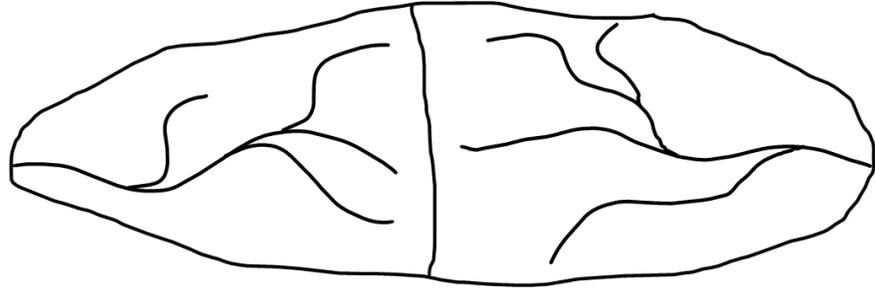
1. Based on your data and graphs, how did your results from Part 1, where the drainage divide was eroded, differ from your results in Part 2 where the drainage divide was tilted? Does it appear that tilting or erosion is more effective in migrating drainage divides?

2. In the experiment, you raised the right side of the box and observed how the divide migrated. What do you think would happen to the divide if you had tilted the box the other way?

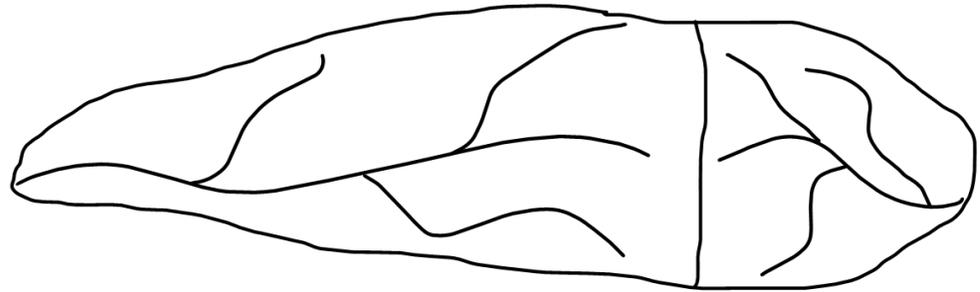
3. What processes do you think can cause tilting of drainage divides in the real world?

4. The figure below shows two drainage basins that share a divide at time one and time two. Which way would these basins have been tilted to cause the transformation? (state which side was uplifted)

Time 1



Time 2



6. Additional Materials

- a. Tilt guides

