Name: _____   Date: _____

Student Exploration: Erosion Rates

[Note to teachers and students: This lesson was designed as a follow-up to the Weathering *and* River Erosion *lessons. We recommend doing those activities before trying this one.]*

Vocabulary: climate, erosion, precipitation, sandstone, shale, vegetation, valley, weathering

Prior Knowledge Questions (Do these BEFORE using the Gizmo.)

1. **Erosion** is the removal and movement of soil, rocks, and other materials from one place to another on Earth's surface. What are some forces that might cause erosion to occur?

   _____

   _____

2. How quickly erosion occurs depends on many factors. In each box of the table below, circle the choice you think would cause erosion to occur *more* quickly.

Hard rocks	Soft rocks	Lots of rain	Little rain
Hot weather	Cold weather	Many plants	Few plants

Gizmo Warm-up
In the *River Erosion* Gizmo, you learned about the ways that rivers erode soil and change landscapes over time. The *Erosion Rates* Gizmo models erosion in a simulated 3D landscape. Using the Gizmo, you will see how quickly erosion happens and observe the long-term effects of erosion on a landscape.
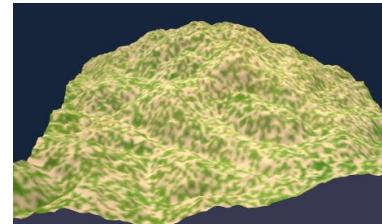
1. Click **Play** (▶). Wait for about 20,000 simulated years, then click **Pause** (⏸). If you want, you can drag the landscape to rotate the view. How much does the landscape change?

   _____

2. Click **Play**, and wait for another 80,000 years or so. Based on what you see, does erosion

   tend to occur quickly or slowly? _____ Explain. _____

   _____

Activity A: **Effects of climate on erosion rates**	<u>Get the Gizmo ready</u>: • Click **Reset** (↺). Check that **Landscape 1** is shown. (If not, restart the Gizmo.) • Select the **Pause every 100,000 years** checkbox.	
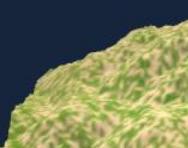
Introduction: Climate describes the average weather in an area over time. Climate takes into account factors such as temperature and amounts of **precipitation**, or how much it rains and snows. Climate also determines what types of **vegetation**, or plants, live in a region. In this activity, you will see how climate also affects erosion.

Question: How do climate and vegetation affect rates of erosion?

1. <u>Observe</u>: The Gizmo shows a simplified model of erosion in a hilly area. Check that the **Precipitation** is 100 cm/yr (39 in/yr), the **Average temperature** is 20 °C (68 °F), and the **Vegetation cover** is 50%. Click **Play**, wait for 100,000 simulated years, and click **Pause**.

   The amount of eroded rock is measured in cubic kilometers (km^3). A cubic kilometer is a

   cube that measures 1 km on each side. How many km^3 of rock were eroded? _____

2. <u>Predict</u>: How do you think precipitation, temperature, and vegetation will affect how quickly rocks are eroded? Fill in each blank with "increase" or "decrease."

   As precipitation increases, the rate of erosion will _____.

   As temperature increases, the rate of erosion will _____.

   As the amount of vegetation increases, the rate of erosion will _____.

3. <u>Experiment</u>: Click **Reset**. Set **Precipitation** to 10 cm/yr.

   A. Click **Play** and wait 100,000 years. How much rock was eroded? _____

   B. Click **Reset**, and repeat the experiment with the **Precipitation** set to 200 cm/yr. How

      much erosion occurred this time? _____

   C. How does precipitation affect the rate of erosion? _____

      _____

   D. Why do you think precipitation has this effect? _____

      _____

(Activity A continued on next page)

Activity A (continued from previous page)

4. Experiment: Click **Reset** and **Return to original settings**. Use the same procedure to see how temperature and vegetation cover affect the rate of erosion. Fill in your findings below:

    Erosion with temperature of 5 °C: _____   Erosion with temperature of 35 °C: _____

    Erosion with vegetation of 0%: _____   Erosion with vegetation of 100%: _____

5. Draw a conclusion: What can you conclude about the effects of temperature and vegetation

    on erosion rates? _____

    _____

6. Infer: **Weathering** is the breakdown of rock into soil.

    A. How does weathering relate to erosion? _____

    _____

    B. In general, weathering tends to occur more rapidly in warm climates than in cool climates. How does this trend explain the effect of temperature on erosion rates?

    _____

    _____

7. Explain: Why do you think increasing vegetation slows the rate of erosion? _____

    _____

8. Compare: Click **Reset** and **Return to original settings**. Using the Gizmo, create a scenario where the maximum amount of erosion happens in 100,000 years. (Note: Do not change the rock type.) Which Gizmo settings did you choose?

    Precipitation: _____   Temperature: _____   Vegetation: _____

    How much erosion occurred in 100,000 years? _____

    Click and drag to rotate the landscape. What changes do you notice? _____

    _____

    _____

Activity B:	Get the Gizmo ready:	
Rock type and erosion	• Click **Reset** (↺). Check that **Landscape 1** is selected and **Pause every 100,000 years** is on.	

Introduction: Sandstone is a rock made from cemented grains of sand. It is very hard and is sometimes used in buildings. **Shale** is a softer rock made of clay and other tiny particles. In this activity, you will compare the erosion of sandstone to that of shale.

Question: How does rock type affect erosion?

1. <u>Predict</u>: Which type of rock do you think will erode more quickly, and why? _____

   _____

2. <u>Experiment</u>: In the dropdown menu, select **Shale**. Set **Precipitation** to 200 cm/yr, **Average temperature** to 35 °C, and **Vegetation cover** to 0%.

   A. Click **Play** and wait 100,000 years. How much rock was eroded? _____

   B. Click **Reset**. Select **Sandstone**. Click **Play** and wait 100,000 years. How much

      erosion occurred this time? _____

   C. How did the results compare to your prediction? _____

3. <u>Explore</u>: With **Sandstone** still selected, click **Play** and wait 200,000 years. After the simulation pauses, rotate the landscape to see the features that were formed.

   A. What evidence do you see that water has eroded the landscape? _____

      _____

   B. Rotate the landscape to show the largest **valley** that forms. Click the **Camera** (📷) at upper right to take a snapshot. Right-click the image, select **Copy**, and then paste the image into a blank document. You will turn in the document with this worksheet.

   C. Click **Reset**. Select **Shale** and play the simulation for about 125,000 years. (This length of time results in about the same volume of eroded rock as 200,000 years of sandstone erosion.) Take a snapshot and paste the image into your document.

   D. Compare the two images. What do you notice? _____

      _____

      Hard rocks such as sandstone and limestone tend to form deep canyons and steep cliffs. Softer rocks such as shale erode into wider valleys with more gentle slopes. In places like the Grand Canyon, you can recognize the high cliffs formed from sandstone and limestone and the broad slopes formed by layers of shale.

Extension:	Get the Gizmo ready:	
Long-term erosion	• Click **Reset** (⟳). • Check that **Pause every 100,000 years** is on.	
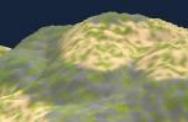
Introduction: Erosion can cause a variety of long-term changes to a landscape. In this activity, you will look at how a single landscape changes over time. Because the Gizmo generates random landscapes, each landscape will be unique.

Question: What long-term changes will erosion cause in a landscape?

1. <u>Predict</u>: How do you think erosion will change a landscape over very long periods of time?

   _____

   _____

2. <u>Choose</u>: You can start with any settings you want. First choose the **Rock type**. You can choose **Sandstone**, **Shale**, or **Mixed**. Then click **New landscape** a few times until you see one that you like. Choose values for **Precipitation**, **Average temperature**, and **Vegetation cover**. (Hint: More will happen if you choose high precipitation and warm temperatures.)

   Rock type: _____   Precipitation: _____

   Average temperature: _____   Vegetation cover: _____

3. <u>Take snapshots</u>: Take a snapshot of the original landscape. Paste this snapshot into your image document. Click **Play**. Every time the Gizmo pauses, take another snapshot and add the snapshot to the document. You may need to shrink the images to fit. Time allowing, you will have images every 100,000 years until you reach one million years.

4. <u>Compare</u>: Take a look at how the landscape changes over time. For each characteristic, describe how it changes as time goes by.

   Height of hills: _____

   Depth of valleys: _____

   Length of rivers: _____

   Other observations: _____

   _____

   If possible, compare your landscapes to those of your classmates. Discuss as a class how the landscapes tend to change over time. (Note: This is a simulated landscape that may not exactly reflect how a real landscape might change over time.)