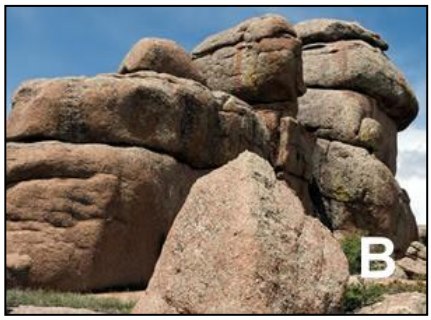
Name: _____ Date: _____

Student Exploration: Weathering

Vocabulary: abrasion, chemical weathering, clay formation, climate, dissolving, frost wedging, granite, limestone, mechanical weathering, rusting, sandstone, shale, weathering



Prior Knowledge Questions (Do these BEFORE using the Gizmo.)
Compare the two pictures at right. Both pictures show the same kind of rock, granite.

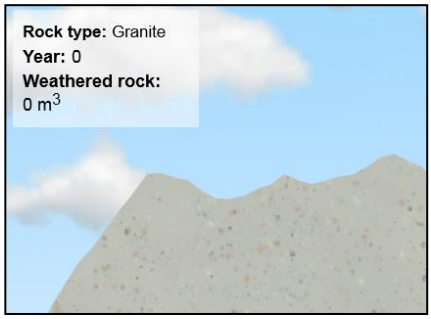
1. Which rock do you think has been exposed on Earth's surface longer? _____

2. Why do you think so? _____

_____

_____

_____



Gizmo Warm-up
When rocks are exposed on Earth's surface, they are gradually broken down into soil by the actions of rain, ice, wind, and living organisms. This process is called **weathering**. In the *Weathering* Gizmo, you will explore how weathering takes place.

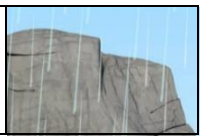
To begin, select the SIMULATION tab. Notice the selected **Rock type** is **Granite**, a hard, dense rock.

1. Click **Play** ( ). Wait for about 5,000 simulated years, and click **Pause** ( ). What do you notice? _____

2. Click **Fastplay** ( ). Wait for about 50,000 simulated years. What do you notice? _____

_____

3. Based on your observations, is weathering a fast or slow process? _____

Activity A: **Types of weathering**	Get the Gizmo ready: • Select the ANIMATION tab. Check that **Frost wedging** is selected.	

Introduction: Mechanical weathering occurs when rocks are physically broken or worn down. **Chemical weathering** occurs when the minerals in the rock are changed by chemical reactions.

Question: What are the most common ways in which weathering occurs?

1. Observe: Read the text about **frost wedging**, then click **Play**.
   A. In the process of frost wedging, how does ice cause cracks in rocks to become larger? _____
   B. Is frost wedging more important in a warm or a cold climate? _____

2. Observe: Read about and look at the animations for the other major types of weathering: **Abrasion**, **Pressure release**, **Dissolving**, **Clay formation**, and **Rusting**.
   A. What are three different ways that rocks can be worn down by **abrasion**? _____
   _____
   _____
   B. How can a large block of granite form layers like an onion? _____
   _____
   C. What type of rock is affected by **dissolving**, and what features result? _____
   _____
   D. How does **clay formation** affect a rock? _____
   _____
   E. Which part of a rock will undergo **rusting**? _____

3. Fill in: Scientists use the terms “oxidation,” “carbonation,” “hydrolysis,” and “exfoliation” for different types of weathering. Fill in each blank with the appropriate term.

   Pressure release: _____ Dissolution: _____

   Clay formation: _____ Rusting: _____

(Activity A continued on next page)

Activity A (continued from previous page)

4. Observe: Select **Other**. Read the descriptions of each type of weathering, then match each to its description below:

_____	Salt weathering	A.	Weathering from chemicals produced by colonies of algae and fungi.
_____	Heat expansion	B.	Weathering that occurs when crystals grow.
_____	Root weathering	C.	Weathering caused by the growth of trees.
_____	Lichen growth	D.	Weathering common in desert climates.

5. Categorize: List all of the types of mechanical weathering you have learned about in the left column of the table, and all of the types of chemical weathering you have read about in the right column.

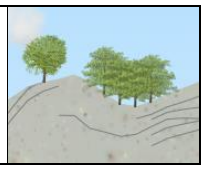
Mechanical weathering	Chemical weathering

6. Interpret: Based on the descriptions and images, guess which type of weathering is shown by each of the images below. Explain each answer.

"Honeycomb" rocks in Spain

Stalactites in South Dakota

Split rock in Scotland

Activity B: **Weathering of different rocks**	Get the Gizmo ready: • On the **Simulation** tab, click **Reset** ( ). • Set the **Average temperature** to 25 °C and **Precipitation** to 250 cm/yr.	

Introduction: The *Weathering* Gizmo lets you explore weathering of four common rocks. **Granite** is a very hard rock formed from the crystallization of magma deep underground. **Sandstone** forms when sand grains become cemented together. **Limestone** is formed from ancient corals, shells and skeletons. **Shale** is formed from compacted mud.

Question: How does weathering affect different rock types?

1. Observe: Below **Rock type**, select **Granite**. Click **Fastplay** and run a simulation of about 100,000 years. Click the **Tools** palette and select **Screen shot** ( ). Right-click the image, click **Copy**, and then paste the image into a blank document. Label this image "Granite." (When you are done, print out and turn in this document with this sheet.)

   Describe what you see: _____

   _____

   Look at **Weathered rock** above the outcrop. How much rock was weathered? _____

2. Observe: Click **Reset** ( ). Repeat the same procedure for **Sandstone**, **Limestone**, and **Shale**. After 50,000 years, take an image of each, and describe your observations below. List the amount of weathered rock for each type of rock.

   Sandstone: _____

   _____ Weathered rock: _____

   Limestone: _____

   _____ Weathered rock: _____

   Shale: _____

   _____ Weathered rock: _____

3. Compare: Compare the results of weathering of different landscapes:

   A. Which rock types tend to weather into rounded shapes? _____

   B. Which rock weathers into caves and lumpy hills? _____

   C. Which rock weathers most quickly? _____ Most slowly? _____

(Activity B continued on next page)

Activity B (continued from previous page)

4. Observe: Click **Reset**. Select **Granite** and click **Fastplay**. Run the simulation until you can see large cracks forming in the rock. (This may take a while, be patient!) Take a snapshot of the resulting outcrop and add it to your document. Label this image "Granite cracks."

   What type of weathering forms these cracks? _____

   (Hint: You may need to review the different types of weathering on the ANIMATION tab.)

5. Infer: Some types of weathering only affect certain kinds of rocks. The **Types of weathering** that apply to each kind of rock are listed above the outcrop. If a type of weathering does not affect the selected rock, it is faded.

   Select each rock and list the types of weathering that affect it.

   Granite: _____

   Sandstone*: _____

   Limestone: _____

   Shale: _____

   *Note: Sandstones are only affected by clay formation when they contain minerals other than quartz. Sandstones that are pure quartz do not form any clay.

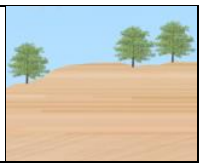
6. Challenge: Based on the weathering patterns, guess the rock type shown in each photo.

_____

_____

_____

_____

Activity C: **Weathering rates**	Get the Gizmo ready: • On the **Simulation** tab, select **Sandstone**. • Check that **Frost wedging**, **Clay formation**, and **Other** are all selected.	

Introduction: The most important things that determines how quickly a particular rock type weathers is the **climate**, or typical weather conditions. Rocks in cool and dry climates weather much differently than rocks in hot and rainy climates.

Question: How does the climate and rock type affect how quickly a rock weathers?

1. Predict: In each "Climate type" box, circle the condition you think will lead to the fastest weathering for the given weathering type.

Weathering type	Climate type	
Frost wedging	Hot or Cold	Wet or Dry
Clay formation	Hot or Cold	Wet or Dry
Dissolving	Hot or Cold	Wet or Dry

2. Experiment: Click **Return to original settings**. Using the Gizmo, test the effect of precipitation on the rate of weathering by measuring the amount of weathered sandstone in 20,000 years with low and high precipitation. Be sure to keep all the other variables the same. Describe your results below.

   Weathered rock (low precip.) _____ Weathered rock (high precip.) _____

   How does the amount of precipitation affect the amount of weathering? _____

   _____

3. Experiment: Click **Reset** and **Return to original settings**. Now test the effect of temperature on weathering rates. Describe your results below.

   Weathered rock (low temp.) _____ Weathered rock (high temp.) _____

   How does the temperature affect the amount of weathering? _____

   _____

4. Explain: Why do you think the rate of weathering tends to increase at hotter temperatures

   and higher amounts of rainfall? _____

   _____

(Activity C continued on next page)

Activity C (continued from previous page)

5. Experiment: Click **Return to original settings** and select **Limestone**. Turn off **Frost wedging** and **Other** so that only **Dissolving** is selected. Using the Gizmo, test the effect of precipitation and temperature on the rate of dissolving.

   Dissolved rock (low precip.) _____ Dissolved rock (high precip.) _____

   Dissolved rock (low temp.) _____ Dissolved rock (high temp.) _____

   Summarize your findings: _____

   _____

   Dissolving occurs more quickly at low temperatures because cold water can dissolve more carbon dioxide than warm water. The greater the amount of dissolved carbon dioxide, the more acidic the water is and the faster the rate of dissolving.

6. Experiment: Click **Return to original settings** and select **Shale**. Test the effects of temperature on frost wedging and clay formation. Summarize your findings below. (Hint: Be sure to test just one type of weathering at a time.)

   Effect of temperature on frost wedging: _____

   _____

   Effect of temperature on clay formation: _____

   _____

7. Summarize: The chart to the right summarizes different combinations of temperature and precipitation.

   Based on what you have learned in this lesson, write the name of each weathering type listed below into the box on the chart where it would happen most quickly.

   Frost wedging

   Clay formation

   Dissolving