1. If you had to explain what a rock was to an alien from another planet...what would you say?
2. Do you believe all rocks are the same? How might rocks form?
3. Today is the start of our Lithosphere unit! What do you think the lithosphere is?
Processes of Lithosphere
Lithosphere

• Rigid outermost shell of a rocky planet
  – On earth, Lithosphere is comprised of the crust and the upper mantle of the Earth
The Rock Cycle

Thinking about relationships among the major rock groups
What is a Rock?

- Any solid mass of \textbf{mineral} or mineral-like matter that occurs naturally as part of our planet.
Types of Rock - Igneous

- Igneous rocks form when magma (molten rock) cools and hardens.
- Cooling is called crystallization.

Obsidian
Types of Rocks-Sedimentary

– Forms when *particles* of different things like sand, pebbles, etc. mold together over time and harden into rock on the surface.
Types of Rock - Metamorphic

– Metamorphic rocks form when existing rock meets intense heat and pressure under the surface of the earth, changing its minerals.
The Rock Cycle

• Interactions among Earth’s sun and interior heat cause rocks to change from one type to another
• A continuous process ("cycle")
MAGMA
IGNEOUS

Crystallization

MAGMA
IGNEOUS

Plutonic

Crystallization

MAGMA
Volcanic

IGNEOUS

Plutonic

Crystallization

MAGMA

New lava

Feeders

Layers of basalt
Weathering

Volcanic

IGNEOUS

Plutonic

Crystallization

Uplift

MAGMA
What is Weathering?

• The breaking down and changing of rocks near Earth’s surface
• We will talk more about this tomorrow in lab!
Weathering

Volcanic

IGNEOUS

Plutonic

Crystallization

Uplift

SEDIMENT

MAGMA

Average igneous rocks

weather by

mechanical fragmentation

chemical alteration

Sand

Clay

Dissolved salts
MAGMA

Volcanic

IGNEOUS

Plutonic

SEDIMENT

Weathering

Uplift

Crystallization

MAGMA

SEDIMENTARY

Erosion

Transport

Deposition
Volcanic

IGNEOUS

Plutonic

Weathering

SEDIMENT

Erosion

Transport

SEDIMENTARY

Deposition

Increased P&T

Crystallization

Melting

Uplift

MAGMA

Burial

Weathering

Crystallization

Melting

Uplift

Magma

Burial
The rock cycle demonstrates the relationships among the three major rock groups. It is powered by the interior heat of the Earth and the energy from the sun. It involves processes on the Earth’s surface as well as the Earth’s interior.

In Conclusion...

- The rock cycle demonstrates the relationships among the three major rock groups.
- It is powered by the interior heat of the Earth and the energy from the sun.
- It involves processes on the Earth’s surface as well as the Earth’s interior.
Rock Cycle Lab!

https://www.youtube.com/watch?v=pm6cCg_Do6k

http://www.layeredearth.com/content/rock-cycle-0
Exit Ticket-Did the information “stick?”

1. You are an igneous rock. Tell me where you would likely begin your journey, and create a short paragraph describing how you could change from one rock type to the next through the steps of the rock cycle.
Bellringer-Day 02

1. Create a chart that lists the three rock types and explains their formation.

2. Sediments often aid in the formation of rocks, or they can become parts of different types of soil. How do you think these sediments, or pieces, are formed? Provide examples.
# Rock Cycle Terms

<table>
<thead>
<tr>
<th>Rock Type</th>
<th>How It’s Formed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Igneous Rock</td>
<td>Cooling and hardening, or crystallization, of magma or lava.</td>
</tr>
<tr>
<td>Sedimentary Rock</td>
<td>Compressing and hardening (cementation) of sediments over time.</td>
</tr>
<tr>
<td>Metamorphic Rock</td>
<td>Intense heat and pressure.</td>
</tr>
</tbody>
</table>
Weathering Lab!
Weathering Lab: Things to Remember!

1. Read ALL directions before beginning.
2. You should draw and weigh your cubes each time you shake the sugar cubes. When weighing, you need to zero the scale.
3. You should weigh all five cubes at once each time! Do not weigh the sugar that falls off, only the remaining portion of the cube.
4. If there is not a scale available, wait at your seat until one becomes available.
5. If you finish early, see Ms. Farris for clean up instructions and an enrichment assignment.
What is Weathering?
The breaking down and changing of rocks near Earth’s surface
•Contributes to the rock cycle—what rocks are formed from sediments?
•Results in soils (sand, silt, clay)
Sand Up-Close

- What do you notice?
Mechanical Weathering?

Physical forces break rock into smaller pieces without changing the rock’s composition (make up)

- Examples: Frost wedging, tree roots
Chemical Weathering?

Breaking down of rocks by changing their composition/ makeup

– Examples: Rust, acid rain
Agents and Evidence of Chemical Weathering

• The most important agent in chemical weathering is **water**

• Water picks up CO$_2$ (carbon dioxide) and SO$_2$ (sulfates) in the air which forms **acid rain**.
The rate of weathering depends on temperature and moisture.

- High temperature and high moisture will result in faster weathering.

- The rock composition (e.g., Limestone vs. marble) will also play a role in the process.
Exit Ticket-Did the information “stick”?

• Turn to the person next to you and discuss the following:
  – Erosion can take place by water, wind, ice, gravity, etc...
  – Compare a rocky mountain, a grassy hill, and a sand dune. Which agent of weathering above would have the greatest impact? The least?
  – What type of weathering do you think we see most often here in NC?
Bellringer-Day 03

1. What is the importance of weathering?
2. Weathering occurs on the crust of the Earth. What are other layers of the Earth? List any properties you know.
3. What about our Earth’s interior do you think contributes to plate tectonics, or the plates ability to move?
The Structure of the Earth and Plate Tectonics
Structure of the Earth

- The Earth is made up of 3 main layers:
  - Core
  - Mantle
  - Crust
Layers of the Earth-Crust

- CRUST: Earth’s **Surface** - where we live!
- Continental crust – land
- Oceanic crust-under oceans (more dense)
Layers of the Earth-Mantle

- 82% of Earth’s volume
- **Solid** at top (under crust)
- **Liquid** at bottom
- It moves!
  - Convection currents – mantle heats up & **flows** toward surface then cools and **sinks**
  - **Convection currents within Earth**
Layers of Earth: The Core

- **OUTER CORE:**
  - Iron makes Earth’s magnetic field

- **INNER CORE:**
  - **Solid**
  - High temperatures & pressure
  - Mostly made of **nickel**
What are Plate Tectonics?
If you look at a map of the world, you may notice that some of the continents could fit together like pieces of a puzzle.
World Plates

That’s because they likely did! This once supercontinent was called Pangaea. It is believed they have since spread apart. This theory of how the Earth’s plates move is called “plate tectonics.”
Evidence of Continental Drift

- Shorelines look like they fit together
- Fossils found on different landmasses
- Several mountain belts end at one coastline, only to reappear on a landmass across the ocean
- Ancient Climates
Plate Tectonics

• The Earth’s crust is divided into 12 major plates which are moved in various directions.
• This plate motion causes them to collide, pull apart, or scrape against each other.
• Each type of interaction causes a characteristic set of Earth structures or “tectonic” features.
• The word, *tectonic*, refers to the deformation of the crust as a consequence of plate interaction.
What are tectonic plates made of?

- Plates are made of rigid lithosphere.

The lithosphere is made up of the crust and the upper part of the mantle.
• Includes the crust & uppermost part of the mantle
• Is named because:
  – They from plates that **FLOAT** on the lower, molten mantle
Plate Movement

“Plates” of lithosphere are moved around by the underlying hot mantle convection cells.
Plate Movements

• Slab pull
  – As plate gets subducted, the dense plate pulls the rest of the plate with it.
Exit Ticket-Did the information “stick?”

1. Draw a diagram of the Earth and its layers. What layers make up the Lithosphere?
2. What is special about the mantle in relation to plate tectonics?
Bellringer-Day 04

1. How can water be an agent for physical weathering?
   a) By absorbing gases from the atmosphere and ground to chemically react with minerals
   b) By seeping into the soil and dissolving in the minerals of rocks
   c) By absorbing sulfur oxides and creating acid precipitation
   d) By seeping into the cracks of rocks and freezing

2. What is plate tectonics? What kind of features could we get from plate tectonics?
Three types of plate boundary

- Divergent
- Convergent
- Transform
Divergent Boundaries

• When two plates move apart
• Location Example: Iceland
• Landform: Causes ocean ridges and rift valleys; Creates new seafloor (seafloor spreading)
Iceland: An example of continental rifting
Convergent Boundaries

- When two plates move together
  - Three types: continental-continental, continental-oceanic, oceanic-oceanic
- Location Example: Himalayas
- Landform: Mountains (continental-continental)
Himalayas
Transform Boundaries

• Two plates grind past each other without production and destruction of lithosphere
• Location Example: San Andreas Fault in California
• Landform: Earthquakes
Exit Ticket-Did the information “stick?”

1. At what type of boundary would you see the formation of mountains? (Be specific!)

2. Why does oceanic crust sink below continental crust when they collide?

3. Sketch out the three main types of plate boundaries. Use arrows to show their movement!
Identify whether the boundary is divergent, convergent, or transform.

a) Citizens felt a shaking vibration of earth because two plates scraped past each other horizontally.

b) Over time, a mountain range appeared due to tectonic plates colliding.

c) At the subduction zone, oceanic plates sink below continental plates due to density.

d) Seafloor spreading is due to the separation of plates on the ocean floor, causing new magma to rise to the surface, cool, and harden.
Volcanoes and Plate Tectonics...
...what’s the connection?
Volcanism is mostly focused at plate margins.
Volcanoes are formed by:

- Subduction
- Rifting
- Hotspots
Subduction

- From new melt that will rise through the crust to be erupted at the surface
- Subduction Zone: Oceanic crust sinks below continental crust at a convergent boundary
Rifting

- As the plates diverge, the lithosphere thins out and new melt reaches the surfaces. Melt cools to become new sea floor (or new earth)
Hot Spots

• Does not occur along a plate boundary.
• Form in the middle of tectonic plates
Volcanic Eruptions

- Magma
  - Molten rock *underground*
- Lava
  - Molten rock *aboveground*
Volcanic Eruptions

- **Pyroclastic Flow** – cloud of ash and debris
  - Travel at hundreds of mph
  - Hundreds of degrees
Volcanic Eruptions

- **Lahar** – mud flows which are very destructive to landscape
Volcanic Eruptions

• “Ash” emitted includes small stones
• Very dense
• Chokes life
• Blots out sunlight
• Causes wide range temperature drops
Bellringer-Day 06

1. Which structure can result from a divergent plate boundary?
   a) A continental volcanic arc, due to the collision of two plates
   b) A continental mountain, due to the collision of two plates
   c) A mid-ocean ridge, due to the separation of two plates
   d) An ocean trench, due to the separation of two plates
Earthquakes and Plate Tectonics...

...what’s the connection?
• As with volcanoes, earthquakes are not randomly distributed over the globe.

• At the boundaries between plates, friction causes them to stick together. When built up energy causes them to break, earthquakes occur.
Where do earthquakes form?

• We know there are three types of plate boundaries:
  • Movement and slipping along each of these types of boundaries can form an earthquake.
Faults

- Faults are formed by fractures in rocks
- They occur at all plate boundaries, and sometimes outside them as well
- Slipping fault lines can cause earthquakes!
Strike-Slip Fault

- Faults in which the movement is horizontal and parallel (like transform boundaries)
Reverse Fault

• A fault in which the hanging wall moves up (convergent boundaries)
Normal Fault

- Occurs when the hanging wall moves down (divergent boundaries)
Bellringer-Day 07

1. Which will most likely form when movement along a plate boundary forces a landmass to be pulled apart?
   a) Volcanic island arc
   b) Continental mountains
   c) Continental rift
   d) Ocean trench

2. What is a pyroclastic cloud? Lahar?

3. Describe any experience you may have had with earthquakes.
Earthquakes
What is an earthquake?

- Vibration of Earth produced by a sudden release of energy
- Movements along the fault line.

https://www.youtube.com/watch?v=FW-TkpvKPl0
https://www.youtube.com/watch?v=EPKEgO4Ojmk
Earthquake Anatomy

• **Focal point** – where the actual earthquake originated underground

• **Epicenter** – location of earthquake on earth’s surface
  – Above the focal point
Seismology

- Seismology – study of earthquake waves
- Seismograph – instruments that record earthquake waves
Earthquake Anatomy

• **P Waves (primary)** — waves which travel fastest, first, and moves through any material
  – Reach seismographs
  – Moves land back and forth

• **S Waves (secondary)** — actual surface waves which travel slower and only moves through solids
  – Moves land up and down

Locating an earthquake

• The difference in velocities between P waves and S waves helps to locate an earthquake's epicenter.
• Need data from at least three seismograph stations.
Earthquake Magnitude

- Scale number increases the stronger the earthquake
- Higher # = more damage
- Scale is called the Richter Scale

![Earthquake Magnitude Scale](image)
Results..

• Land destruction/alteration
• Fire (breaking of gas and power lines)
• Buildings destroyed
• Tsunami’s
Exit Ticket-Did the information “stick?”

1. What is the cause of an earthquake?
2. How do we measure earthquakes when they occur?
3. What can be done to prevent damage from earthquakes?
Bellringer-Day 08

1. What is a fault? How does it trigger an earthquake?

2. What layers of the earth make up our lithosphere? How does this enable the lithosphere to move?

3. Brainstorm: What do you think could be done to prepare for an earthquake?
1. Scientists are studying a graph showing the time differences between seismic P-waves and the seismic S-waves as they travel through Earth. Which information can they learn from the graph?
   a) The magnitude of the earthquake
   b) The duration of the earthquake
   c) The epicenter of the earthquake
   d) The intensity of an earthquake

2. Why is it important to study and map the areas where earthquakes commonly occur?
Tsunami

- “Harbor Wave”
- Seismic sea wave caused from slipping of fault on ocean floor

https://www.youtube.com/watch?v=foxww-tMoNg
Exit Ticket-Did the information “stick?”

1. Imagine that you were working as a geologist studying earthquakes and tsunamis. You are giving a presentation to an area that is at risk for tsunamis. Explain to them the following:
   a) How are tsunamis caused?
   b) What are some warning signs that a tsunami is approaching?
   c) Why is it sometimes hard to detect a tsunami in the deep ocean before it reaches shore?
Bellringer-Day 10

1. What is a tsunami and how is it formed?
2. Volcanoes may form at a location which is not at the border of plate tectonics. They are formed by a magma plume under Earth’s surface. These are known as:
   a) Ridging areas
   b) Subduction zones
   c) Hot spots
   d) Irregularities
What is Mass Movement?

- The movement of soil down-slope due to gravity
- Examples: avalanches, slides, rock falls
## Triggers of Mass Movement

<table>
<thead>
<tr>
<th>Trigger</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Water</strong></td>
<td>Heavy rains + fast melting of snow</td>
</tr>
<tr>
<td>Over steepened</td>
<td>The steeper the slope the greater the chance for movement</td>
</tr>
<tr>
<td><strong>Slopes</strong></td>
<td></td>
</tr>
<tr>
<td>Removal of</td>
<td>Roots keep the soil from eroding away during rain</td>
</tr>
<tr>
<td><strong>vegetation</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Earthquakes</strong></td>
<td>Move rocks around</td>
</tr>
</tbody>
</table>
Clearly, Earthquakes can trigger all kinds of events...

- How can we prevent them?
  - Earthquake predictions based on idea that earthquakes repeat (plate boundaries)
  - Stronger structures; spending money to avoid future damage
Bellringer-Day 11

1. How can we help prevent damage from major lithospheric events?

2. Cracks in rock widen as water in them freezes and thaws. How does this affect the surface of the Earth?
   a) It reduces the rates of soil formation
   b) It changes the chemical composition of the rocks
   c) It exposes rocks to increased rates of erosion and weathering
   d) It limits the exposure of rocks to acid precipitation
Draw a complete diagram of the rock cycle

• Your cycle needs to include the three types of rocks, and six labeled arrows.
Which of the following processes occur beneath Earth’s surface?

a) Erosion  
b) Transportation  
c) Melting  
d) Weathering
Which of the following processes may occur on or below Earth’s surface?

a) Weathering
b) Crystallization
c) Deposition
d) Melting
Crystallization may result in which of the following rocks?

a) Plutonic Igneous
b) Volcanic Igneous
c) Metamorphic
d) Both A and B
Sedimentary rocks:

a) Are only composed of pre-existing rocks
b) Are the only rocks which contain fossils
c) Are formed by increased heat and pressure
d) Both A and B
What is the primary difference between igneous rock and metamorphic rock?

a) Metamorphic rock is the only rock formed beneath Earth’s surface
b) Metamorphic rock is the only rock which may contribute to a sedimentary rock
c) Metamorphic rock comes from pre-existing rocks and igneous rock comes only from the crystallization of magma
d) Metamorphic rock contains preserved fossils while igneous rock does not
Draw and label...

• ...the three types of plate boundaries. Include arrows.
Volcanoes may form at a location which is not at the boarder of plate tectonics. They are formed by a magma plume under Earth’s surface. These are known as:

a) Ridging areas
b) Subduction zones
c) Hot spots
d) Irregularities
Draw a picture...

• ...that shows what is happening at a subduction zone
The hot cloud which travels at hundreds of miles per hour and burns everything it touches is called the:

a) Lahar
b) Ash
c) Pyroclastic flow
d) Lava
When the volcano becomes weak and the mountain may slide away, this mud flow is called the:

a) Lahar
b) Ash
c) Pyroclastic flow
d) Lava
Volcanic ash is very destructive for several reasons. Which of the following is caused by ash of volcanic eruptions?

a) Blotting out of the sun
b) Choking wildlife
c) Change in temperature over large area
d) All of the above
Quizlet Review

• You have a test today. Take a few minutes to study!

• https://quizlet.com/_1ken89