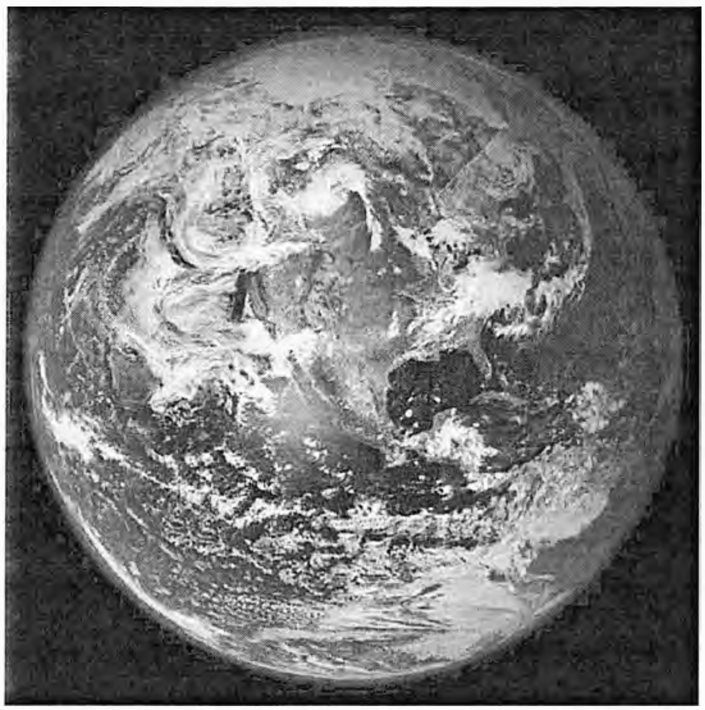
Dynamic Earth



[M2U4]

Name ____________________

Date ___________ Period ____

Activity--What On Earth? Rocks

M2 Unit 4 -Dynamic Earth

Part One

Rocks can be evidence of evolution (change over time of the Earth. Your assignment at your table is simple (but difficult!)

1) You have been given two rock samples. Use your chromebooks and combined brains to figure out what the two rocks are.

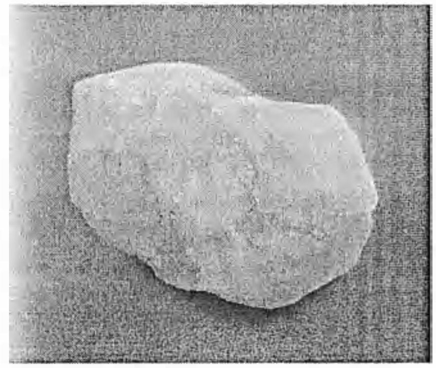
2) Tell me the visual evidence that determines your conclusion

3) Explain how these two specific rock types are evidence for Earth's evolution.

Part Two

As you have undoubtedly learned, the two rocks at your desk are samples of **obsidian** and **quartz.**

Obsidian



Quartz

4) Explain how obsidian is formed and where it might be found in California

5) Explain how quartz is formed and where it might be found in California

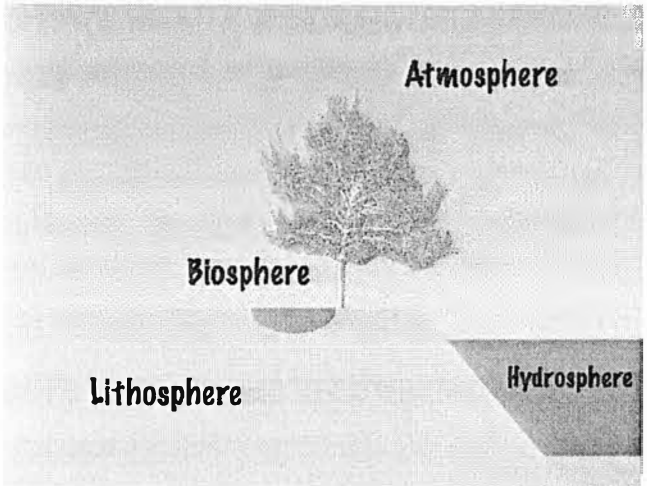
Dynamic Earth Vocabulary 1 Module 2 Unit 4

Name: ______________________________________ Date: ________ Period: ___

Word or Term	Definition/Explanation	Image and/or illustration
Plate Tectonics		
Rock Strata		
Biogeology		
Continental Drift		
Tectonic Plate		

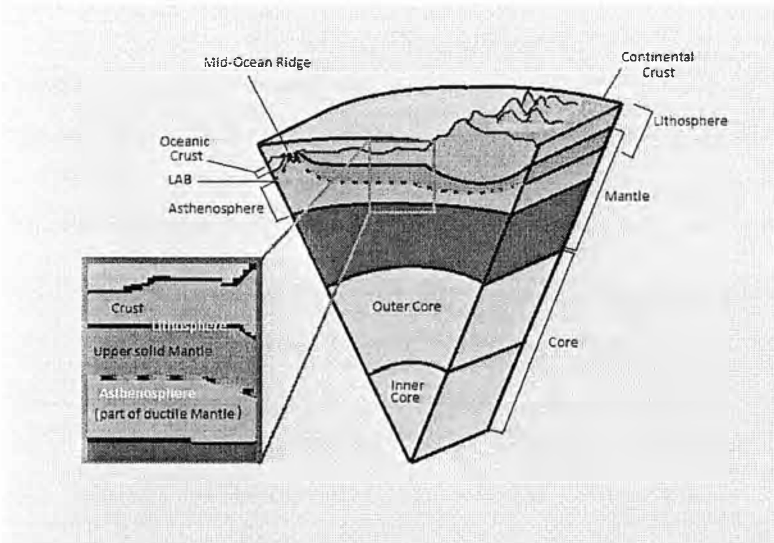
Word or Term	Definition/Explanation	Image and/or illustration
Lithosphere		
Sthenosphere.		
Plate boundary		
Heat convection		
Heat conduction		

Substances move in cycles throughout the Earth. Substances such as oxygen, water, carbon, nitrogen and many others move through the **biosphere**, the **lithosphere**, the **atmosphere** and the **hydrosphere**. Each of these spheres is an *integral* (very important) part of our planet.

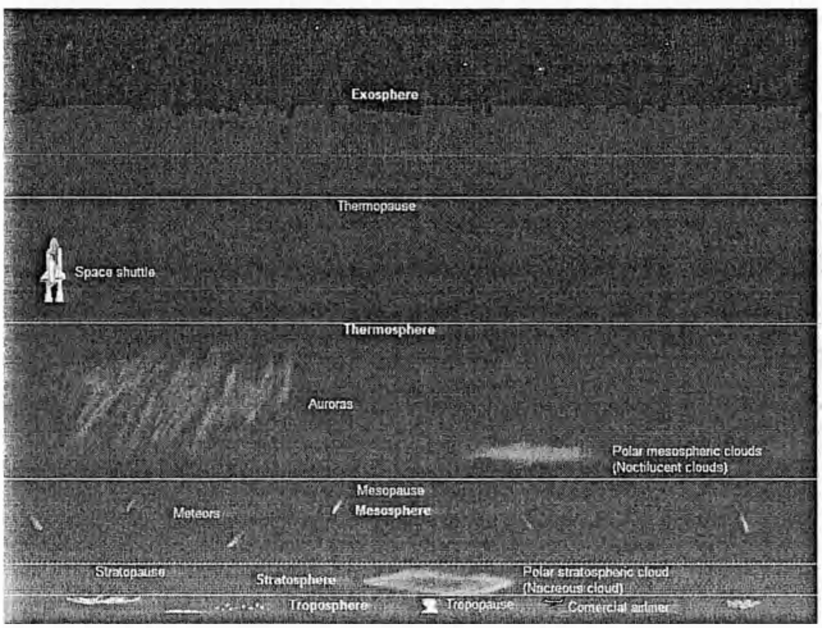


The **biosphere** refers to the the living parts of our planet. This includes bacteria, protists, fungi, plants and animals. Nutrients and various chemicals cycle through organisms as well as through the *abiotic* (non-organic, never living) parts of ecosystems on Earth. The elements such as carbon, hydrogen and oxygen which make up chemicals on Earth never vanish, they simply are reorganized as they move from one sphere to another.

Chemicals found in the **biosphere** are also found in the other three abiotic spheres; the **lithosphere,** the **atmosphere** and the **hydrosphere**. The **lithosphere** is the part of our planet made up of the crust and upper mantle of our Earth; these are what we study when we look at plate tectonics, earthquakes and volcanoes



The **atmosphere** is the part of the planet that is made up of the gasses surrounding our planet.



The **hydrosphere** is made up of all the forms of water on Earth; fog, rivers, snow, oceans and so on.

Chemicals cycle throughout all of these spheres. Some cycles occur quickly, others take hundreds of millions of years. For example, carbon in sugars made through photosynthesis and stored in fruit may move in the **biosphere** from a plant to a bird and then be released as carbon dioxide into the **atmosphere** within a matter of hours. Carbon may also be stored as fossil fuels in the **lithosphere** beneath the Earth's surface and not change for millions of years. (https://fossil.energy.gov/education/energylessons/coal/gen_howformed.html)

The biosphere, atmosphere, lithosphere and hydrosphere are all in constant interaction with each other. A change in one affects all the others. These changes have influenced the processes of evolution on our planet in many ways.

USGS
science for a changing world

Return to the Alaska Wilderness: USGS Scientists visit one of North America's fastest-moving faults

Release Date: NOVEMBER 18, 2017

A team of USGS scientists spent two weeks in the isolated Glacier Bay National Park, exploring one of the fastest-moving faults in North America.

Five geologists spent two weeks in the Alaskan wilderness studying one of the fastest-moving earthquake faults in North America. Project leader Rob Witter led the team on the expedition to the Fairweather Fault, only accessible by boat, with the group camping outdoors during their field work.

Even though their work takes place 500 miles from the contiguous U.S., much of what the team will learn during the ongoing project can be utilized in many other areas.

"Our research in Alaska likely will have its greatest impact elsewhere in the U.S., by informing federal agencies and the public about the seismic hazards posed by the Fairweather Fault," said Witter. "Our data will be used to update the Alaska seismic hazard map, part of the collection of USGS maps used to support effective building codes. Other federal agencies, such as the National Park Service, NOAA, U.S. Forest Service, and FEMA use our data to increase public safety related to earthquake and tsunami hazards."

▶ Video Transcript

A team of USGS scientists spent two weeks in the isolated Glacier Bay National Park, exploring one of the fastest-moving faults in North America. Credit Dr. Katherine Scharer, USGS(Public domain.)

The team hopes to also determine how fast the tectonic plates on each side of the fault slide past each other and how this fault "slip" has altered the landscape at Icy Point. The rate (or speed) that a fault slips controls the time between earthquakes, and is a critical input for seismic hazard assessments in a region.

In 1958, a magnitude 7.7 earthquake struck Lituya Bay, Alaska — leading to a tsunami that devastated the area. The earthquake was studied right after it occurred by USGS geologist Don Miller and University of California, Berkeley geologist Don Tocher. Last year, Witter and his team picked up the trail to use new technologies to understand the Fairweather Fault's motion.

Witter's work leverages research done by USGS geologist George Plafker, who worked along the Fairweather Fault in the 1970s.

"We continue to consult these scientists to take advantage of legacy data they contribute, including field observations, aerial photography, and radiocarbon dates on glacial moraines

Contacts

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Connect

USGS News: Everything We've Got:

Geology:

Natural Hazards:

and marine terraces," Witter said. "Their many years of experience working in the region can help our team target the right research questions and be better prepared for what we might find in the field."

Rob Witter examining the contact between glacial lake beds (grey, below) and river gravels (brown, above) that show how the landscape has changed over time.(Credit: Kate Scharer, USGS. Public domain.)

This year, Witter's field team included USGS geologists Adrian Bender, Richard Lease, Kate Scharer, and Humboldt State University geologist Harvey Kelsey.

Field Work Advances Science Research

Despite huge advancements in remote sensing (e.g., satellite) technology, there is still a need for scientists to physically look at, study, and collect samples from the Earth's surface in order to decipher its history.

For example, during their fieldwork, the team discovered that the valley east of Icy Point had been impacted by both glaciers and faulting in the geologic past. They discovered the valley once had been filled by a lake. The field crew collected samples of trees buried by gravel from glacial outwash streams, and radiocarbon dating will determine when the trees died. They also found bivalve shells on a terrace lifted 30 feet above today's sea level, from which they will determine the age and rate of that uplift. The team will use the age and elevation of the deposits above sea level to understand how fast the landscape has been lifted up or down by large earthquakes.

All these field observations and samples can only be collected by scientists with "boots on the ground."

"Geologists have to go into the field to collect data," said San Andreas Fault-expert Dr. Kate Scharer. "Though satellite images are important, we cannot collect samples of the past landscapes from behind our desk. We will take our observations back to the lab and the computer, but for this type of work, there is no other method but to start in the field."

Dr. Kate Scharer using a GPS unit to get precise measurements of the elevation of the coast line. Glacier Bay National Park (Credit: Rob Witter, USGS. Public domain.)

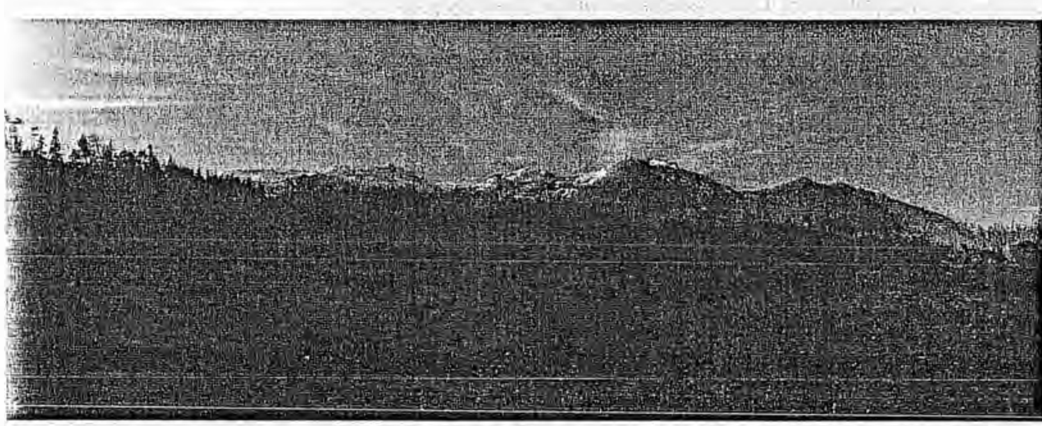
Scharer describes Icy Point as a beautiful yet complicated place with a geological history spanning many thousands of years. The diverse terrain, with a deep-rooted history, requires more than the physical ability to endure the strenuous work needed to explore this remote area.

fullscreen

"In an early edition of the Boy Scout Merit Badge pamphlet for Geology, there is a phrase about how geologists wear their 'mental boots.' I have always loved this, because it is our job to be out there, to make clear observations, and to recreate the past from what we can see on the ground and analyze in the lab." Scharer said. "This takes careful thought, but also a lot of walking around! Certainly the most challenging and rewarding aspect of this science is to keep developing hypotheses and then building on them or discarding them, depending on the data collected from our field work. It takes mental boots!"

Learn more

Read about the team's previous work in Alaska: Uncharted: Exploring one of America's fastest faults



Glacier Bay National Park pano(Credit: Dr. Kate Scharer, USGS. Public domain.)

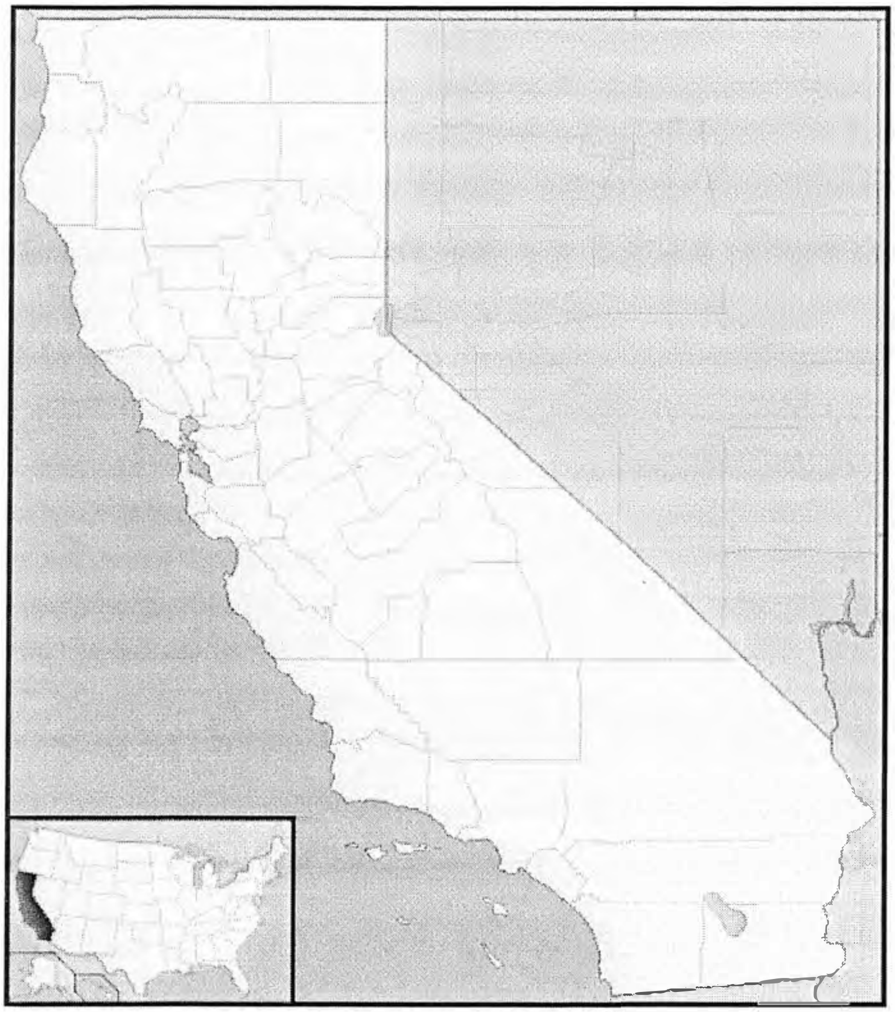
Activity What's Shaking in California?

NGS 1 Dynamic Earth

Name: ______________________________ Date: ______ Period: _____

We live in a very active geologic area in the world. Today, you will be looking at recent earthquake activity in California and making some inferences about the evolution about our physical Earth. Go to the website below and look for information to complete the map.

https://earthquake.usgs.gov/



On the map, use a *blue pencil* to mark any earthquakes over 2.0 which have occurred in the past two weeks.

On the map, use an *orange pencil* to mark any earthquakes over 3.0 which have occurred in the past 6 months.

On the map, use an *red pencil* to mark any earthquakes over 4.0 which have occurred in the past 12 months.

Use the information to answer the questions below.

What are three observations you would make about the data you just recorded?

____

____

____

Next, use the information on the USGS site to sketch the faultlines for the San Andreas Fault, the the Hayward Fault and Garlock Fault in *green pencil.*

What connections do you see between the earthquake data you recorded and the faultlines you drew?

Evolution is a process of change over time. How does the data and information you have recorded provide evidence for the process of evolution on the physical Earth?

Lab Play Dough Plate Tectonics

NGS 1 Dynamic Earth

Name: ___________________________ Date: _________ Period _____

The purpose of this lab is to model some of the concepts in plate tectonics. Plate tectonics is the field of science that looks at movement of the solid plates on the surface of our planet Earth.

Materials

- 4 colors of play dough / clay
- 4 colored pencils
- Plastic cutting board sheet
- Chromebook

Purpose of the lab

In this activity you will be investigating different types of stresses, faults, and folds. A fault is a break in the rock, a fold is a bend in the rock, and the stress is the cause of faulting or folding. Compression, tension, and shear are the three most common types of stress and they result in folding and faulting of the lithospheric plates. Normal, Reverse, and Strike Slip are the three most common types of faults resulting in tectonic stresses. Anticline, Syncline, and Monocline are the three most common types of folds as a result of tectonic stresses. Convergent, Divergent, and Transform are the three types of plate boundaries found across the globe. You will be using a moldable substance to model the different stresses, faults and folds found when tectonic plates meet.

You will be using a moldable substance to model the different stresses, faults and folds found when tectonic plates meet. Your goal is to illustrate as many vocabulary words by making a model by using playdoh. You will need to

1) Research the word/term using your chromebook. You will have a list of useful websites below that will help you with this part of your project. You will need to find out what the word/term means and then an illustration of the term.

2) Next, you will need to create a Google Doc with all of your team members. The title of your document is **Plates in Action**--your name, partner name, partner name.
3) After you have found an image, you will need to use the playdoh to model the image.
4) Next, put the information requested next to your model. When you are satisfied with your work, , you will then use your chromebook to take a picture and insert in into your document. Each image must be a separate page for a total of an 8 page document.
5) The first page of your document should be an image of your playdough colors and the name of each person in your group.
6) You will need to complete all of the steps above for each of the terms.
7) Your group ID Period ___ Group First and Last Name Initials, must be in all images.
8) Once you are happy with your document, share it with your teacher.

Below are the terms and queries you will research and respond to on your document. You will get a hard copy of the document to cut out and place on your models before taking your pictures. Be careful as you work with your modeling material--you will not get any replacements (so if you damage it, too bad.)

Subduction Zone

What are the results of movement at a subduction zone?

An interesting fact about subduction zones is

Anticline-Syncline

What causes anticline-syncline patterns in geology?

How can we use the patterns of anticline-syncline to show the age of rocks?

Volcano

Explain a volcano to a 1st grade student.

Why are many volcanoes located on the geologic feature known as the Ring of Fire?

Rift Zone

What is a rift zone?

How do **dikes** form in rift zones?

______________	______________
Convergent Plate Boundary What does converge mean? ____________________________________ ____________________________________ ____________________________________ ____________________________________ ____________________________________ ______________ Explain how the Cascade volcanoes are a result of convergent plate boundaries. ____________________________________ ____________________________________ ____________________________________ ____________________________________ ____________________________________ ______________	**Divergent Plate Boundary** What does diverge mean? ____________________________________ ____________________________________ ____________________________________ ____________________________________ ____________________________________ ______________ Explain how the Mid Atlantic Ridge demonstrates the action of a divergent plate boundary. ____________________________________ ____________________________________ ____________________________________ ____________________________________ ____________________________________ ______________

Deep Sea Trench	Monterey Bay Canyon
What are the geologic causes of deep sea trenches?	Explain how the topography of the Monterey Bay Canyon has led to the biological diversity found there.
Tell me the connection between deep sea trenches and the Monterey Bay Canyon.	

Subduction Zone

Anticline
Syncline

Monocline

Volcano

Rift Zone

Convergent

Divergent

Continental Ridge

Mountain Range

Mid-Ocean Ridge

Deep Sea Trench

Play Dough Plate Tectonics

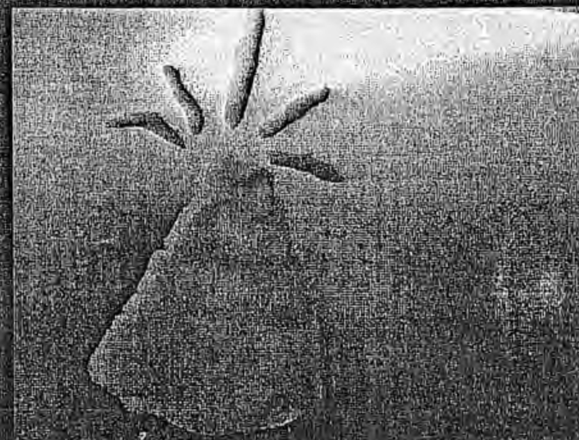
Lizbeth Mojica, Jonathan Fernandez, and Frankie Barragas

Subduction Zone

The result of movement in the subduction zone are earthquakes, volcanoes, and geohazards. Subduction zones are also the only sites of deep earthquakes.

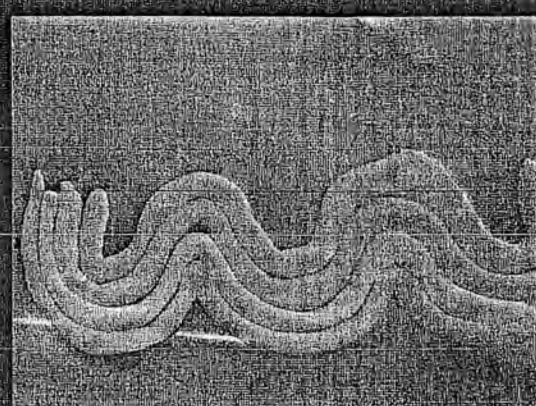
Volcano

A volcano is a mountain or hill with a vent through which either lava or rock fragments are erupted. Most volcanoes are located near the ring of fire since that's where most of Earth's subduction zones are.



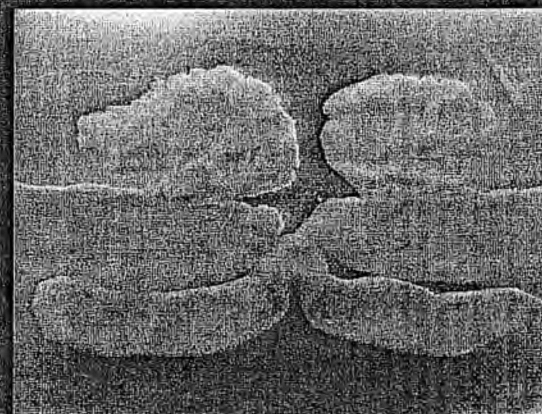
Anticline-Syncline

These are usually caused by compressional stress. We can use these anticlines and synclines to see the age of rocks by seeing the amount of layers.



Rift Zone

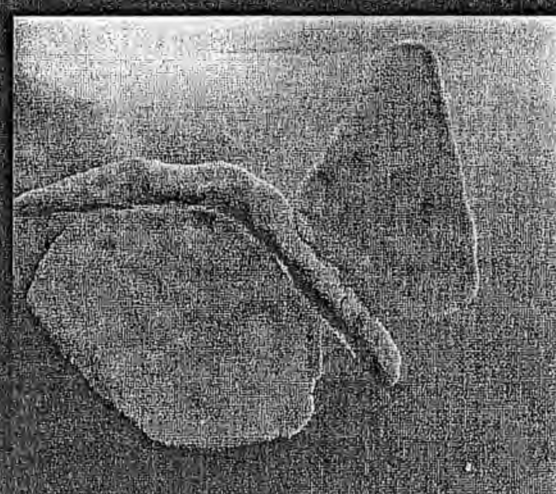
A rift zone is a large area in which plates move away from each other. Dykes form in rift zones from the fissures in rift zones.



Convergent Plate Boundary

Convergent means coming closer together, especially in characteristics or ideas.

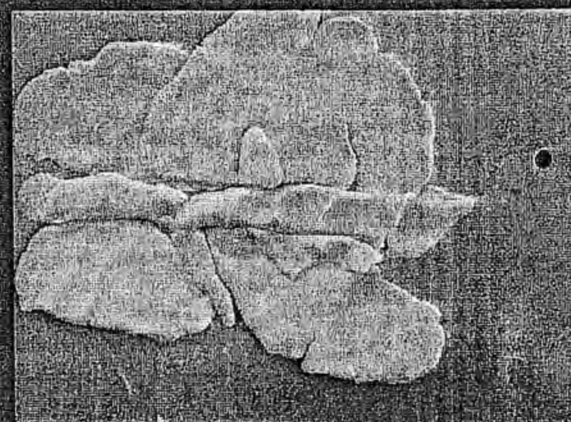
This newly formed magma rises toward the Earth's surface to erupt, forming a cascade range above the subduction zone. A dense oceanic **plate** sinks beneath a more buoyant continental plate.



Deep Sea Trench

Trenches are formed by subduction, a geophysical process in which two or more of Earth's tectonic plates converge.

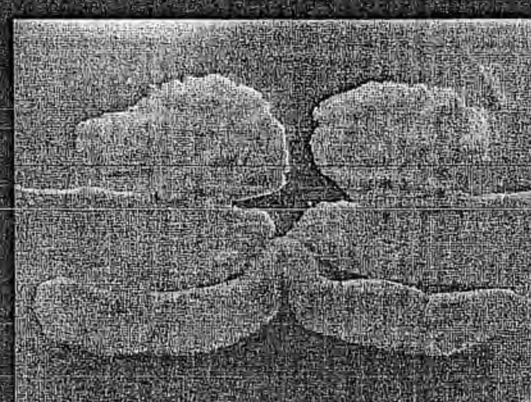
Both, trenches and the Monterey Bay Canyon are long, narrow, steep-sided depression in the ocean bottom in which occur the maximum oceanic depths.



Divergent Plate Boundary

Divergent means tending to be different or develop in different directions.

The Atlantic ridge is created by magma pushing up from the mantle.



Monterey Bay Canyon

Areas of the canyon have shown that the terrain changes substantially every few months due to large sediment-transport events involving both debris flows and turbidity currents. If the water drained from Monterey Bay, the newly revealed terrain would be stunning, with cliffs, gorges, valleys, and spires matching the scenery found in some of our most beautiful national parks.

Name: ______________________________________ Date: _______ Period: ___

Word or Term	Definition/Explanation	Image and/or illustration
Plateau		
Sea floor		
Mariana Trench		
Oceanic Ridge		
Seamount		

Word or Term	Definition/Explanation	Image and/or illustration
Magma		
Volcanism		
Tectonic uplift		
Earth's' Lithosphere		
Earth's Mantle		

Notes 3 Internal and External Processes of Earth

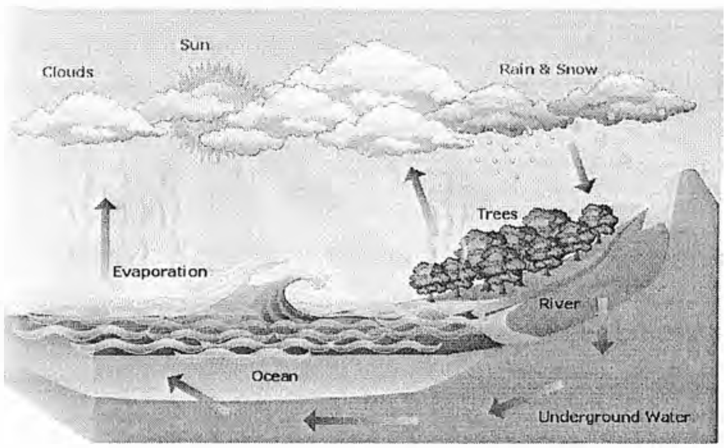
Dynamic Earth NGS 1

Adapted from: http://www.cabrillo.edu/~dschwartz/documents/ES10_Geol_Proc_Hazards_Fall12.pdf

Geology is the study of the materials and processes on Earth. This study includes both external and internal processes that occur on our planet.

External Geologic Processes: energy from the sun and gravity power these processes that alter our planet

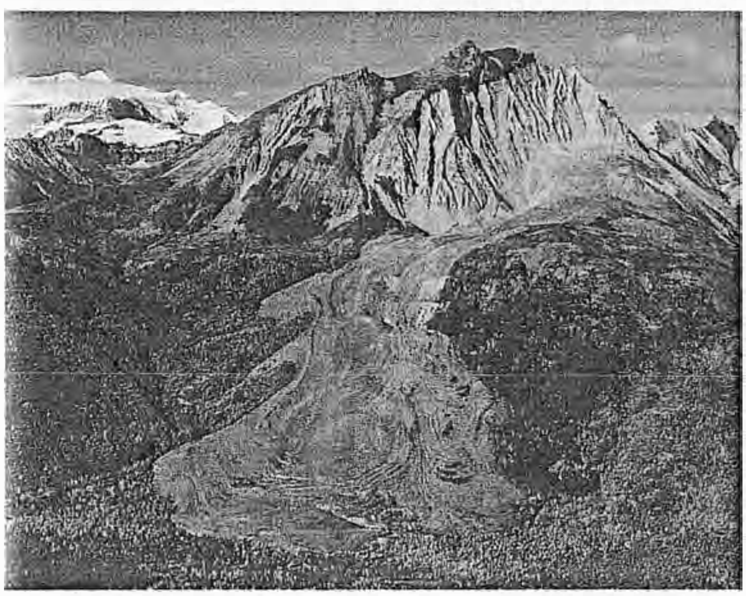
Hydrologic Cycle--looks at how water moves through our planet. Water is found in gas, liquid and solid forms at various times and in various places as it is moved around our planet. Water has been and continues to be a major force in shaping our planet; ice can shatter rock and the movement of liquid water shapes our continents.



Weathering and Erosion-include processes such as wind and water movement that break down rock into soils. These processes take place over long periods of time.

Deposition and Soil Formation-as weathering occurs, rock is broken into smaller and smaller pieces. Those small pieces are moved down mountains by water and wind and combine with organic material to become soils.

Glaciers, Rivers and Streams--solid and liquid forms of water can literally move mountains over time, Glaciers smooth out edges as the rocks embedded in the ice 'polish' the landscape as the glacier slowly but inevitably moves. Rivers and streams also change landforms as they too carry materials around the Earth.



Mass Movement--landslides and rockfalls change surfaces when large amounts of earth move at a single time.

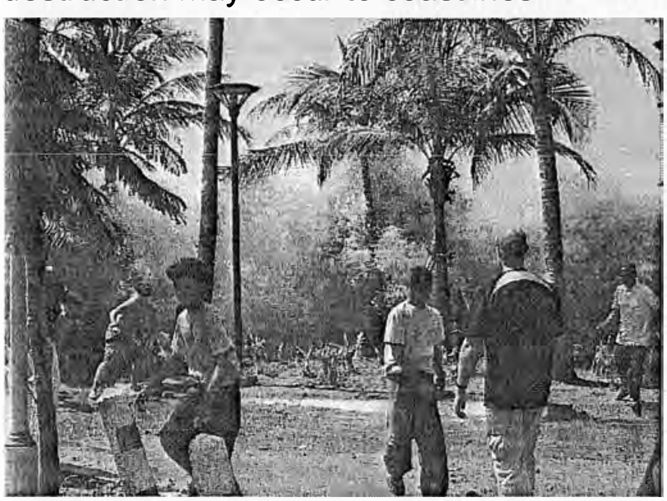
Coastal Change--wave movement, the tides and oceans rise and fall alter coastlines and ecosystems over time.

Internal Processes: are those processes caused by energy from the interior of the planet

The Earth is made up of 12 solid major plates that sit on the top of a liquid layer below. The plates moving and interacting with each other due to convection (movement of heat below the surface), creates geologic activity in the form of earthquakes, tsunamis, volcanoes and geothermal activity.

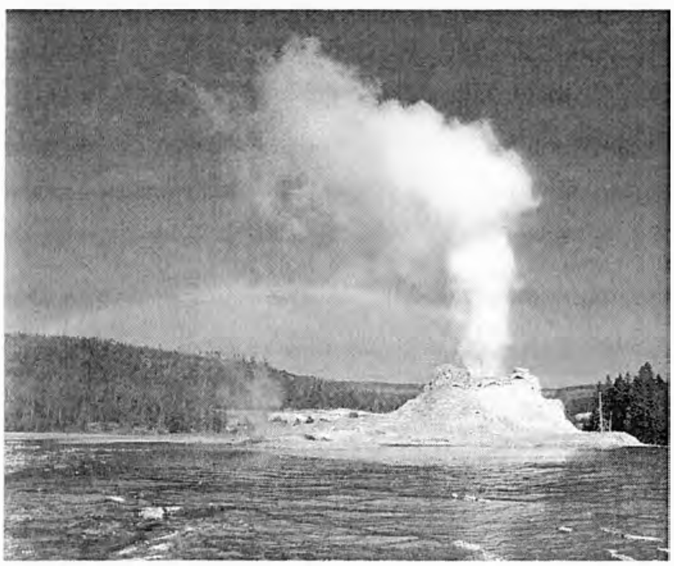
Earthquakes are the result of movement between two plate boundaries. The movement can be sidewise, colliding with each other or moving apart from each other. These occurrences alter landscapes worldwide.

Tsunami is the large scale, powerful movement of ocean water caused by earthquakes. If the seismic waves caused by tsunamis reach land, great destruction may occur to coastlines



Volcano an opening to the liquid hot magma layer below the solid land masses. Generally found where tectonic plates are moving next to each other. Volcanos may release liquid magma, ash, vent gases and even mud.

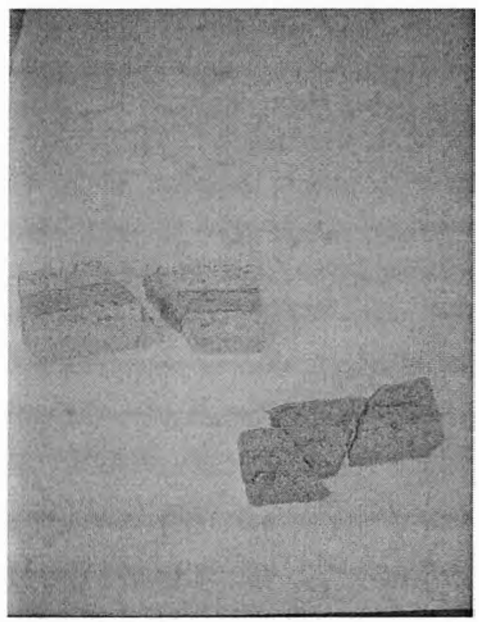
Geothermal activity is a generalized term referring to many different processes arising from movement of tectonic plates and heat. Evidence of geothermal activity is a rise in temperature in soil or water on the Earth's surface.



Arguing Causes of Faults & Folds—Sponge Fault Model

The faults and folds in rocks provide evidence that the rocks are subjected to compressional, tensional, and/or shear stress.

Students begin this activity by experimenting with Silly Putty™ to identify different stresses that rocks can experience, and examining the relationship between stress type and strain. This lays the foundation for students to understand that the structure (strain) we see in rocks provides evidence for they type of stress that caused it. Students apply this idea by examining images of faults and folds to determine how the structures formed. Additional evidence is collected through experimentation with sponge models. Students summarize their ideas and evidence for each image in a short written paragraph or in alternative presentation format. Sponge models are particularly useful because they allow students to interact physically with the models to consider the forces necessary to create these features as well as visualizing deformation in 3-D. Sponge models can be constructed using inexpensive materials obtained from a dollar store or any home improvement store.



Objectives: Students will be able to:

- Use foam models to demonstrate the forces and relative motions of a block of rock to form of anticlines and synclines.
- Use foam models to demonstrate the forces and relative motions acting on blocks of rock to form normal, reverse and strike-slip faults.
- Use evidence to support or refute the claim made in an argument

14) Worksheet Plate Tectonics

NGS 1 Dynamic Earth

Name: ________________________ Date: ________ Period: ____

http://www.cotf.edu/ete/modules/msese/dinosaur.html

Go to the Earth Floor in the website above. Begin your exploration by looking at the Sphere's Room. Use the information as you go through the room to answer the following questions.

Fill in each square below with the name of one of the 'spheres'. As you go through the room, describe what is found in each of those spheres.

Name: ____________ Description ________________________ ________________________ ________________________ ________________________ ________	Name: ____________ Description ________________________ ________________________ ________________________ ________________________ ________
Name: ____________ Description ________________________ ________________________ ________________________ ________________________ ________	Name: ____________ Description ________________________ ________________________ ________________________ ________________________ ________
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Name: ___________________________ Date: _________ Period: ____

http://www.cotf.edu/ete/modules/msese/dinosaur.html

Now go to the Plate Tectonics room. On the map below, show me in **RED** pencil where the extensional plate boundaries are.

Now draw the image of a **convergent plate boundary** and explain how these create **mountain ranges**

____

____

____

____

____

Show me on the map in **GREEN** pencil an example of where a mountain range has been created at a *convergent plate boundary*

Name: ________________________ Date: ________ Period: ____

http://www.cotf.edu/ete/modules/msese/dinosaur.html

Go to the Earth Floor in the website above. Begin your exploration by looking at the Plate Tectonics Room. Use the information as you go through the room to answer the following questions.

Go to the Divergent Plate Boundaries Section and draw the image of a divergent plate boundary.

Explain what a rift valley is and how it is created.

____

____

____

Next go to the website below and scroll through the images to answer the following questions.

http://www.nationalgeographic.org/encyclopedia/rift-valley/

Explain how the Thingvellir Rift shows common characteristics of rift valleys.

____

____

____

How is a 'black smoker' evidence for divergent plate boundaries?

What is the oldest rift valley on Earth?

Describe the Great Rift Valley.

Return to the ***Earth Floor*** *website and go to* ***Transform Plate Boundaries.***
Explain how transform plate boundaries cause earthquakes.

Is California going to fall into the ocean? Why or why not?

Use the search in youtube to look for *earthquake san francisco* and watch the video at this address: https://www.youtube.com/watch?v=p4LFu91Xrw0

Changing Earth Packet Earth's Structure

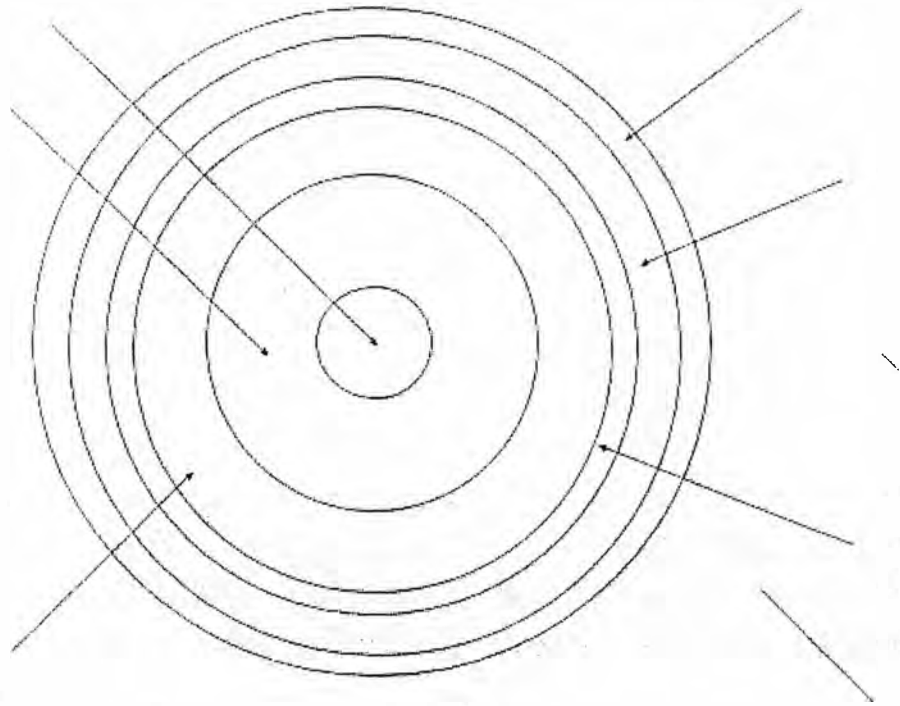
https://docs.google.com/document/d/13G2wcTxu2Asbbuln_a2h3fpSEGloYgXrv3BshQBPwfM/edit

Changing Earth Packet Earth's Structure

Name: ________________________________ Date: __________ Period: __________

Complete the following for each term below

	Color the section	Approximate temperature range	Describe the material	How wide is the layer
Earth's Crust	green			
Upper Mantle	yellow			
Transition Zone	orange			
Lower Mantle	red			
Outer core	purple			
Inner core	blue			



Label and Color

17) Notes 3 Internal and External Processes of Earth

Dynamic Earth NGS 1

Adapted from: http://www.cabrillo.edu/~dschwartz/documents/ES10_Geol_Proc_Hazards_Fall12.pdf

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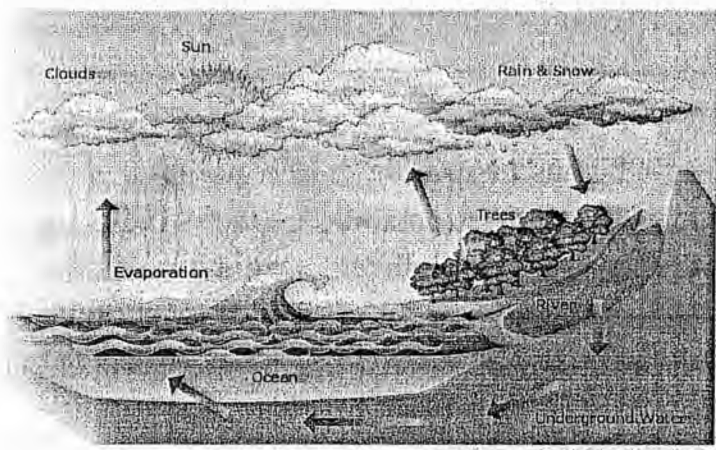
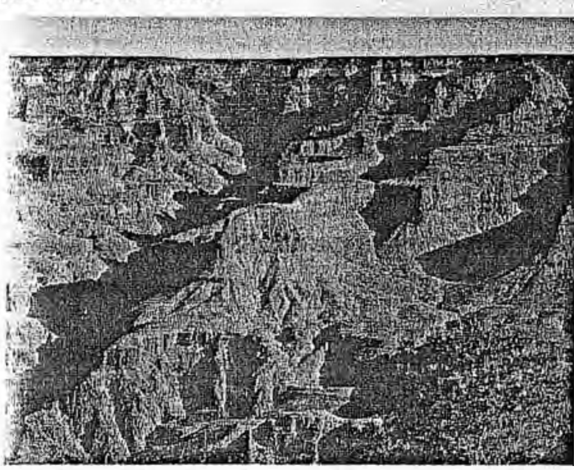
External Geologic Processes: energy from the sun and gravity power these processes that alter our planet

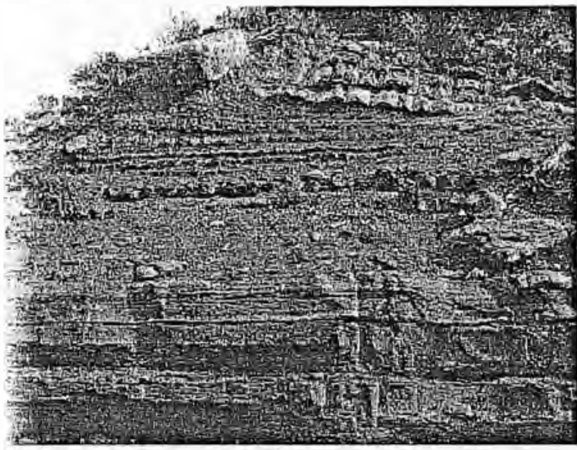
Hydrologic Cycle--looks at how water moves through our planet. Water is found in gas, liquid and solid forms at various times and in various places as it is moved around our planet. Water has been and continues to be a major force in shaping our planet; ice can shatter rock and the movement of liquid water shapes our continents.



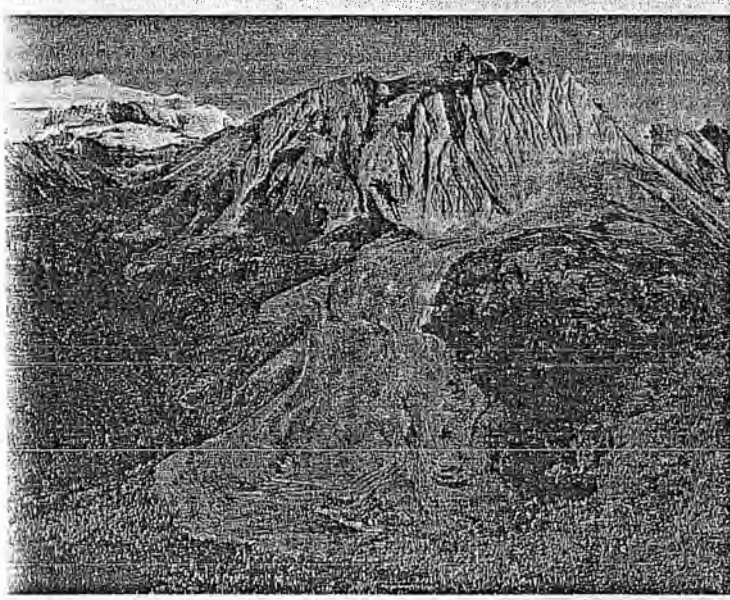
Weathering and Erosion-include processes such as wind and water movement that break down rock into soils. These processes take place over long periods of time.



Deposition and Soil Formation-as weathering occurs, rock is broken into smaller and smaller pieces. Those small pieces are moved down mountains by water and wind and combine with organic material to become soils.



Glaciers, Rivers and Streams--solid and liquid forms of water can literally move mountains over time. Glaciers smooth out edges as the rocks embedded in the ice 'polish' the landscape as the glacier slowly but inevitably moves. Rivers and streams also change landforms as they too carry materials around the Earth.



Mass Movement--landslides and rockfalls change surfaces when large amounts of earth move at a single time.

Coastal Change--wave movement, the tides and oceans rise and fall alter coastlines and ecosystems over time.

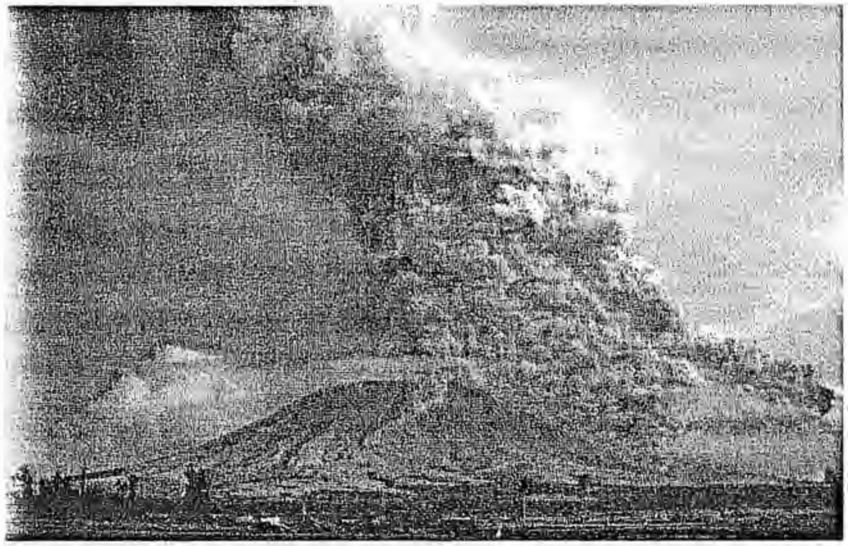
Internal Processes: are those processes caused by energy from the interior of the planet

The Earth is made up of 12 solid major plates that sit on the top of a liquid layer below. The plates moving and interacting with each other due to convection (movement of heat below the surface), creates geologic activity in the form of earthquakes, tsunamis, volcanoes and geothermal activity.

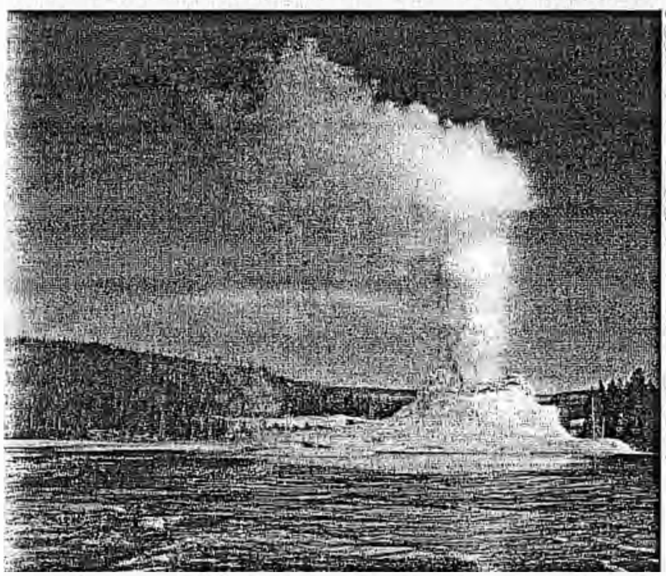
Earthquakes are the result of movement between two plate boundaries. The movement can be sidewise, colliding with each other or moving apart from each other. These occurrences alter landscapes worldwide.

Tsunami is the large scale, powerful movement of ocean water caused by earthquakes. If the seismic waves caused by tsunamis reach land, great destruction may occur to coastlines

Volcano an opening to the liquid hot magma layer below the solid land masses. Generally found where tectonic plates are moving next to each other. Volcanos may release liquid magma, ash, vent gases and even mud.



Geothermal activity is a generalized term referring to many different processes arising from movement of tectonic plates and heat. Evidence of geothermal activity is a rise in temperature in soil or water on the Earth's surface.



Activity: Moving Water NGS 1 Dynamic Earth

Name: _____________________________ Date: ________ Period: ___

Today, you and your group will be looking at the effects of moving water on substrate. This is a simulation of what occurs in various ecosystems, and is one way in which environmental and city planners predict will happen with rains and flooding.

You will need to put the sand in the container and you will be running water through the container to simulate water movement. You will also put rocks and organic material in the substrate to simulate obstacles in the way of the water. You will observe and describe the actions of the water and how that could affect an ecosystem in 'real life'.

Begin by putting the sand into the container and using your hands to create an even layer of substrate. Place the part of the shoebox with the hole near the bottom on a piece of flat wood and the upper part of the shoebox with the holes near the top on an upright piece of wood. Explain how in what way the set up realistically depicts a genuine ecosystem and in what way it differs from a genuine ecosystem.

Same	Different

Now begin water flowing through the simulated ecosystem by gently but continuously squirting water through the top middle opening of the container. Carefully observe what processes happen as the water flows through the substrate. Describe what you observe below.

____

____

____

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____

Put the sand that has come onto the tray back into the container and smooth it out. Now place some of the stones into the sand to create obstacles and repeat the process of adding the water. Draw and describe what occurs to the stream flow this time.

Draw what happens to the stream flow	Explain what happens when obstacles are in the way of flowing water ____________________ ____________________ ____________________ ____________________ ____________________ ____________________ ____________________

Put the sand that has come onto the tray back into the container and smooth it out. This time use some of the small twigs to simulate fallen trees to create obstacles and repeat the process of adding the water. Draw and describe what occurs to the stream flow this time.

Draw what happens to the stream flow	Explain what happens when obstacles are in the way of flowing water ____________________ ____________________ ____________________ ____________________ ____________________ ____________________ ____________________

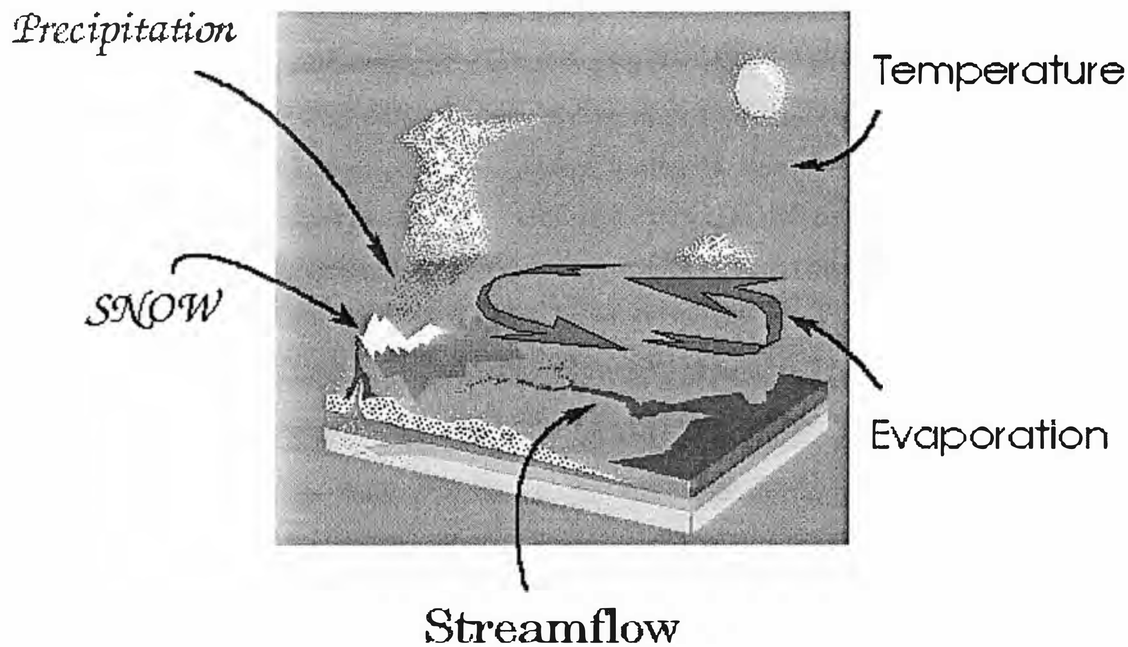
Earth's Water Vocabulary 3 NGS 1 Dynamic Earth

Name: ______________________________________ Date: ________ Period: ___

Word or Term	Definition/Explanation	Image and/or illustration
Hydrologic cycle		
Rock cycle		
Stream disposition		
Erosion		
Mechanical Weathering		

Word or Term	Definition/Explanation	Image and/or illustration
Chemical weathering		
.Aquifer		
Glacier		
Watershed		
Tidal Forces		

Description of the Hydrologic Cycle



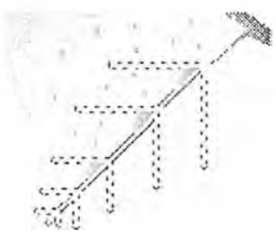
This is an education module about the movement of water on the planet Earth. The module includes a discussion of water movement in the United States, and it also provides specific information about water movement in Oregon.

The scientific discipline in the field of physical geography that deals with the water cycle is called hydrology. It is concerned with the origin, distribution, and properties of water on the globe. Consequently, the water cycle is also called the hydrologic cycle in many scientific textbooks and educational materials. Most people have heard of the science of meteorology and many also know about the science of oceanography because of the exposure that each discipline has had on television. People watch TV weather personalities nearly every day. Celebrities such as Jacques Cousteau have helped to make oceanography a commonly recognized science. In a broad context, the sciences of meteorology and oceanography describe parts of a series of global physical processes involving water that are also major components of the science of hydrology. Geologists describe another part of the physical processes by addressing groundwater movement within the planet's subterranean features. Hydrologists are interested in obtaining measurable information and knowledge about the water cycle. Also important is the measurement of the amount of water involved in the transitional stages that occur as the water moves from one process within the cycle to other processes. Hydrology, therefore, is a broad science that utilizes information from a wide range of other sciences and integrates them to quantify the movement of water. The fundamental tools of hydrology are based in supporting scientific techniques that originated in mathematics, physics, engineering, chemistry, geology, and biology. Consequently, hydrology uses developed concepts from the sciences of meteorology, climatology, oceanography, geography, geology, glaciology, limnology (lakes), ecology, biology, agronomy, forestry, and other sciences that specialize in *other aspects of the physical, chemical or biological environment. Hydrology, therefore, is one of the interdisciplinary sciences that is the basis for water resources development and water resources management.*

The global water cycle can be described with nine major physical processes which form a continuum of water movement. Complex pathways include the passage of water from the gaseous envelope around the planet called the atmosphere, through the bodies of water on the surface of earth such as the oceans, glaciers and lakes, and at the same time (or more slowly) passing through the soil and rock layers underground. Later, the water is returned to the atmosphere. A fundamental characteristic of the hydrologic cycle is that it has no beginning an it has no end. It can be studied by starting at any of the following processes: evaporation, condensation, precipitation, interception, infiltration, percolation, transpiration, runoff, and storage.

The information presented below is a greatly simplified description of the major contributing physical processes. They include:

EVAPORATION

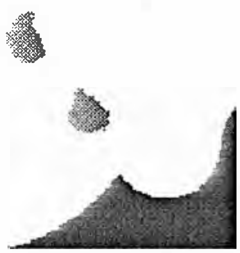


Evaporation occurs when the physical state of water is changed from a liquid state to a gaseous state. A considerable amount of heat, about 600 calories of energy for each gram of water, is exchanged during the change of state. Typically, solar radiation and other factors such as air temperature, vapor pressure, wind, and atmospheric pressure affect the amount of natural evaporation that takes place in any geographic area. Evaporation can occur on raindrops, and on free water surfaces such as seas and lakes. It can even occur from water settled on vegetation, soil, rocks and snow. There is also evaporation caused by human activities. Heated buildings experience evaporation of water settled on its surfaces. Evaporated moisture is lifted into the atmosphere from the ocean, land surfaces, and water bodies as water vapor. Some vapor always exists in the atmosphere.

CONDENSATION

Condensation is the process by which water vapor changes it's physical state from a vapor, most commonly, to a liquid. Water vapor condenses onto small airborne particles to form dew, fog, or clouds. The most active particles that form clouds are sea salts, atmospheric ions caused by lightning,and combustion products containing sulfurous and nitrous acids. Condensation is brought about by cooling of the air or by increasing the amount of vapor in the air to its saturation point. When water vapor condenses back into a liquid state, the same large amount of heat (600 calories of energy per gram) that was needed to make it a vapor is released to the environment.

PRECIPITATION



Precipitation is the process that occurs when any and all forms of water particles fall from the atmosphere and reach the ground. There are two sub-processes that cause clouds to release precipitation, the coalescence process and the ice-crystal process. As water drops reach a critical size, the drop is exposed to gravity and frictional drag. A falling drop leaves a turbulent wake behind which allows smaller drops to fall faster and to be overtaken to join and combine with the lead drop. The other sub-process that can occur is the ice-crystal formation process. It occurs when ice develops in cold clouds or in cloud formations high in the atmosphere where freezing temperatures occur. When nearby water droplets approach the crystals some droplets evaporate and condense on the crystals. The crystals grow to a critical size and drop as snow or ice pellets. Sometimes, as the pellets fall through lower elevation air, they melt and change into raindrops.

Precipitated water may fall into a waterbody or it may fall onto land. It is then dispersed several ways. The water can adhere to objects on or near the planet surface or it can be carried over and through the land into stream channels, or it may penetrate into the soil, or it may be intercepted by plants.

When rainfall is small and infrequent, a high percentage of precipitation is returned to the atmosphere by evaporation.

The portion of precipitation that appears in surface streams is called runoff. Runoff may consist of component contributions from such sources as surface runoff, subsurface runoff, or ground water runoff. Surface runoff travels over the ground surface and through surface channels to leave a catchment area called a drainage basin or watershed. The portion of the surface runoff that flows over the land surface towards the stream channels is called overland flow. The total runoff confined in the stream channels is called the streamflow.

INTERCEPTION

Interception is the process of interrupting the movement of water in the chain of transportation events leading to streams. The interception can take place by vegetal cover or depression storage in puddles and in land formations such as rills and furrows.

When rain first begins, the water striking leaves and other organic materials spreads over the surfaces in a thin layer or it collects at points or edges. When the maximum surface storage capability on the surface of the material is exceeded, the material stores additional water in growing drops along its edges. Eventually the weight of the drops exceed the surface tension and water falls to the ground. Wind and the impact of rain drops can also release the water from the organic material. The water layer on organic surfaces and the drops of water along the edges are also freely exposed to evaporation.

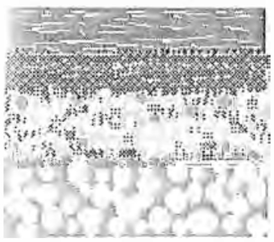
Additionally, interception of water on the ground surface during freezing and sub-freezing conditions can be substantial. The interception of falling snow and ice on vegetation also occurs. The highest level of interception occurs when it snows on conifer forests and hardwood forests that have not yet lost their leaves.

INFILTRATION

Infiltration is the physical process involving movement of water through the boundary area where the atmosphere interfaces with the soil. The surface phenomenon is governed by soil surface conditions. Water transfer is related to the porosity of the soil and the permeability of the soil profile. Typically, the infiltration rate depends on the puddling of the water at the soil surface by the impact of raindrops, the texture and structure of the soil, the initial soil moisture content. the decreasing water concentration as the water moves deeper into the soil filling of the pores in the soil matrices, changes in the soil composition, and to the swelling of the wetted soils that in turn close cracks in the soil.

Water that is infiltrated and stored in the soil can also become the water that later is evapotranspired or becomes subsurface runoff.

PERCOLATION



Percolation is the movement of water though the soil, and it's layers, by gravity and capillary forces. The prime moving force of groundwater is gravity. Water that is in the zone of aeration where air exists is called vadose water. Water that is in the zone of saturation is called groundwater. For all practical purposes, all groundwater originates as surface water. Once underground, the water is moved by gravity. The boundary that separates the vadose and the saturation zones is called the water table. Usually the direction of water movement is changed from downward and a horizontal component to the movement is added that is based on the geologic boundary conditions.

Geologic formations in the earth's crust serve as natural subterranean reservoirs for storing water. Others can also serve as conduits for the movement of water. Essentially, all groundwater is in motion. Some of it. however, moves extremely slowly. A geologic formation which transmits water from one location to another in sufficient quantity for economic development is called an aquifer. The movement of water is possible because of the voids or pores in the geologic formations. Some formations conduct water back to the ground surface. A spring is a place where the water table reaches the ground surface. Stream channels can be in contact with an unconfined aquifer that approach the ground surface. Water may move from the ground into the stream, or visa versa, depending on the relative water level. Groundwater discharges into a stream forms the base flow of the stream during dry periods, especially during droughts. An influent stream supplies water to an aquifer while and effluent stream receives water from the aquifer.

TRANSPIRATION

Transpiration is the biological process that occurs mostly in the day. Water inside of plants is transferred from the plant to the atmosphere as water vapor through numerous individual leave openings. Plants transpire to move nutrients to the upper portion of the plants and to cool the leaves exposed to the sun. Leaves undergoing rapid transpiration can be significantly cooler than the surrounding air. Transpiration is greatly affected by the species of plants that are in the soil and it is strongly affected by the amount of light to which the plants are exposed. Water can be transpired freely by plants until a water deficit develops in the plant and it water-releasing cells (stomata) begin to close. Transpiration then continues at a must slower rate. Only a small portion of the water that plants absorb are retained in the plants.

Vegetation generally retards evaporation from the soil. Vegetation that is shading the soil, reduces the wind velocity. Also, releasing water vapor to the atmosphere reduces the amount of direct evaporation from the soil or from snow or ice cover. The absorption of water into plant roots, along with interception that occurs on plant surfaces offsets the general effects that vegetation has in retarding evaporation from the soil. The forest vegetation tends to have more moisture than the soil beneath the trees.

RUNOFF

Runoff is flow from a drainage basin or watershed that appears in surface streams. It generally consists of the flow that is unaffected by artificial diversions, storages or other works that society might have on or in a stream channel. The flow is made up partly of precipitation that falls directly on the stream , surface runoff that flows over the land surface and through channels, subsurface runoff that infiltrates the surface soils and moves laterally towards the stream, and groundwater runoff from deep percolation through the soil horizons. Part of the subsurface flow enters the stream quickly, while the remaining portion may take a longer period before joining the water in the stream. When each of the component flows enter the stream, they form the total runoff. The total runoff in the stream channels is called streamflow and it is generally regarded as direct runoff or base flow.

STORAGE

There are three basic locations of water storage that occur in the planetary water cycle. Water is stored in the atmosphere; water is stored on the surface of the earth, and water stored in the ground.

Water stored in the atmosphere can be moved relatively quickly from one part of the planet to another part of the planet. The type of storage that occurs on the land surface and under the ground largely depend on the geologic features related to the types of soil and the types of rocks present at the storage locations. Storage occurs as surface storage in oceans, lakes, reservoirs, and glaciers; underground storage occurs in the soil, in aquifers, and in the crevices of rock formations.

The movement of water through the eight other major physical processes of the water cycle can be erratic. On average, water the atmosphere is renewed every 16 days. Soil moisture is replaced about every year. Globally, waters in wetlands are replaced about every 5 years while the residence time of lake water is about 17 years. In areas of low development by society, groundwater renewal can exceed 1,400 years. The uneven distribution and movement of water over time, and the spatial distribution of water in both geographic and geologic areas, can cause extreme phenomena such as floods and droughts to occur.

ESTIMATED GLOBAL WATER CYCLE

TYPE OF WATER	LOCATION	VOLUME millions of cu. miles	VOLUME millions of cu kilometer	PERCENT OF TOTAL VOLUME
SALT WATER				97.00
	oceans	314.2	1308.0 (96.4%)	
	saline bodies	2.1	8.7 (0.6%)	
FRESH WATER				2.90
	ice & snow	6.9	28.7 (2.1%)	
	lakes	0.5	2.1 (0.15%)	
	rivers	0.01	0.04 (0.003%)	
	accessible groundwater	1.0	4.2 (0.31%)	
ATMOSPHERIC				0.10

sea evaporation	0.1	0.42 (0.03%)	
land evaporation	0.05	0.21 (0.015%)	
precipitation over sea	0.09	0.37 (0.03%)	
precipitation over land	0.03	0.12 (0.01%)	
water vapor	0.005	0.02 (0.002%)	
ROUNDED TOTAL	326.00	1357.00	100.0

If a fifty-five gallon drum of water represented the total supply of water on the planet then:

a) the oceans would be represented by 53 gallons, 1 quart, 1 pint and 12 ounces;
b) the icecaps and glaciers would represent 1 gallon, and 12 ounces;
c) the atmosphere would contribute 1 pint and 4.5 ounces;
d) groundwater would add up to 1 quart, and 11.4 ounces;
e) freshwater lakes would represent one half ounce;
f) inland seas and saline lakes would add up to over one third of an ounce;
g) soil moisture and valdose water would total to about one fourth of an ounce;
h) the rivers of the world would only add up to one-hundredth of an ounce (less than one one-millionth of the water on the planet).

WATER BUDGET IN THE UNITED STATES

The atmosphere above the 48 coterminous United States of America stores about 36.5 cubic miles per day of atmospheric water. A little over 10 percent or 3.9 cubic miles of it falls as precipitation each day. About 1,430 cubic miles of precipitation fall over the 48 states annually. This volume would be enough each year to cover the states with about 30 inches of water.

The greatest average yearly precipitation in the world of 460 inches (1,168 cm) occurs at Mt. Waialeale, Hawaii. The lowest average annual precipitation of 1.63 inches (4.1 cm) in the United States occurred over a 42-year period in Death Valley, California. The longest dry period with no precipitation in the United States occurred during a 767 day period from October 3, 1912 to November 8, 1914 at Bagdad, California.

An average of 70 percent of the annual precipitation to the coterminous U.S. (1,001 cubic miles) evaporates back into the atmosphere from land and water surfaces and by transpiration from vegetation. The remaining 30 percent of the annual precipitation (429 cubic miles) is transported through the other surface and subterranean processes of the water cycle to a stream, lake, or ocean.

Groundwater storage in the coterminous United States has been estimated to be about 15,100 cubic miles both in the shallow groundwater (less than 2,600 feet deep) and an equal amount in the *groundwater deeper than 2,600 feet. Soil moisture in the top 3 feet of soil is estimated to be equivalent to about 150 cubic miles of water.*

The United States has approximately 4,560 cubic miles of water stored in freshwater lakes. Although there are about 5,540 cubic miles of water are stored in the Great Lakes alone, over 50 percent of the volume is considered to be in the United States. Also, about 14 cubic miles are stored in salt lakes of the nation. In addition, there is approximately 12 cubic miles of surface waters stored in stream channels in route to the oceans. Other sources of surface storage in the coterminous states include 16 cubic miles of frozen water in glaciers.

The stream flow volume that reach the oceans of the nation is about 1.12 cubic miles per day (409 cubic miles per year). The total combined surface and groundwater flow to the nation's oceans is 1.18 cubic miles per day. The Mississippi River alone contributes 0.34 cubic miles per day (annual natural runoff of 593,000 cubic feet per second).

There are approximately 2700 reservoirs and controlled natural lakes of more than 5,000 acre-feet in storage in the United States. The reservoirs provide 142 cubic miles of storage, almost 90% of which occurs in 600 of the largest reservoirs. Also, there are approximately 50,000 reservoirs ranging from 50 to 5,000 acre-feet in storage. It is also estimated that there are about 2 million farm ponds in the United States. Most of the major reservoirs in the nation are owned by the public. The Bureau of Land Management is the manager of the most federal dams (over 750), but most are small dams. The larger reservoirs are managed by the U.S. Army Corps of Engineers, the Bureau of Reclamation, and the Tennessee Valley Authority. The Corps has built and operates almost 600 dams and reservoirs ,the Bureau of Reclamation operates nearly 300 dams and reservoirs, and the TVA has over 50 dams and reservoirs. Other federal agencies that manage small dams include the US Forest Service with about 400, the Bureau of Indian Affairs with over 300, the National Park Service with over 260, the US Fish and Wildlife Service with over 175, and the Department of Energy with about 30 dams.

WATER IN THE STATE OF OREGON

Oregon is divided into two distinct rainfall zones by the Cascade Range. The annual precipitation west of the Cascade Mountains ranges from 40 to 140 inches. East of the Cascades, precipitation ranges from 10 to 20 inches per year. The average annual precipitation for the entire state is 28 inches. The average annual runoff is about 20 inches. The state has a network of 112,000 miles of rivers and streams to accommodated the annual runoff. There are over 365 waterfalls mapped in Oregon that are in the cascade and the cataract categories of waterfalls. Cascade waterfalls have small volumes of water with perpendicular movement of the flowing water often associated in a succession of stages. Cataract category waterfalls have large volumes of water that move perpendicularly. Over 120 geothermal hot springs in the state have been identified with water temperatures that are 15 degrees F above the mean annual air temperature. The total groundwater supply in Oregon has not been quantified.

Oregon has an estimated available, annual surface water supply of over 66 million acre-feet (19.5 cubic miles). Differences in the seasonal and geographic distribution of water resources throughout the state results in annual water shortages in many areas of the state, especially in eastern Oregon. Use of natural flow of surface waters, surface storage in reservoirs, and ground water supplies from aquifers are used to meet the year around demands.

The major river affecting Oregon is the 1,243 mile long Columbia River. It forms much of Oregon's northern border with the state of Washington. One of the Columbia's major tributaries, the Snake River forms a major portion of the eastern border of Oregon with Idaho and is the location of the 7,900 feet deep Hell's Canyon. The Columbia River originates in adjacent states of Washington, Idaho, and Montana and in Canada. The average annual flow is 265,000 cubic feet per second. This volume represents 0.15 cubic miles per day.

Other major watersheds in Oregon can be divided into 20 additional basins. They include:

North Coast Drainages	Malheur
Willamette	Owyhee
Sandy	Malheur Lake*
Deschutes	Klamath
John Day	Chetco
Umatilla	Rogue
Grande Ronde	South Coast Drainages
Powder	Umpqua
Snake	Mid-Coast Drainages

There are seven watersheds that empty into the Pacific Ocean. Two of the basins (*) are closed basin and do not discharge water to the ocean or to receiving streams. Eleven are interior basins that empty into receiving streams.

Oregon abounds with over 6,000 natural lakes, ponds, marshes, sloughs and reservoirs. Over 1,400 of them are named lakes. They have a combined surface area of 500,000 acres (781 square miles). Hundreds of the lakes are unnamed. There are 13 Lost Lakes, 11 Blue Lakes, 10 Clear Lakes and 10 Fish Lakes. They range in surface area size from a maximum of 90,000 acres (141 square miles) at Upper Klamath Lake to cattle pond, farm ponds, and mill ponds of less than one acre. Crater Lake is the deepest lake in the United States. It is 1,932 feet deep, with a capacity of 14 million acre-feet (4.14 cubic miles) and a surface area of 13,139 acres (20.5 square miles). Following heavy rainfall and runoff during in 1984, Malheur and Harney lakes in southeastern Oregon were joined together for several years. Malheur Lake and Harney Lake are again separate lakes, but connected as part of a closed basin wetland system, with Malheur Lake being about 90,000 acres. The Malheur Lake complex is still considered the largest natural body of water in Oregon. The 180,000 acres (281 square miles) of the lake/wetland complex located in the closed basin forms the largest freshwater marsh in the western contiguous United States. Other large lakes in Oregon include Waldo, Odell, and Wallowa lakes. More than half of the lakes in the state are volcanic or glacial depressions located on the high elevation areas between the summits of the Cascade Range. Nearly 100 of the natural lakes are clustered in the Wallowa Mountains of northeastern Oregon. Many other lakes are located between sand dunes near the Oregon shore. Many of the natural lakes throughout the state have had water control structures built at their outlets to enhance storage in the lakes and to control the release of stored water for downstream irrigation.

Oregon has more than 60 reservoirs with capacities of over 5,000 acre-feet each. The largest reservoir in the state is the Bureau of Reclamation's Owyhee Lake in southeastern Oregon with over 1 million acre-feet (0.3 cubic miles) of storage. Most of the reservoirs in Oregon were built, at least partially, to *store irrigation water. There are hundreds of small single purpose reservoirs built by local irrigation companies. Rarer types of single purpose reservoirs include recreation reservoirs, fish and wildlife reservoirs, and water quality enhancement reservoirs.*

Reservoirs are generally characterized by their project purposes. Water supply reservoirs are distinguished by large storage volumes that are capable of providing an expected annual supply of water and capable of outlasting most droughts. Irrigation reservoirs have large conservation pools with maximum conservation pools at the beginning of the growing season and a minimum pool during the nongrowing season. Flood control reservoirs have a small permanent pools with a large storage capacities to reduce downstream water levels key locations on rivers. Another characteristic of flood control reservoirs is that they are generally drawndown as quickly as possible following a high runoff event to reestablish their storage capabilities. A hydroelectric reservoir is characterized by storage and release properties that meet regional energy demands, especially during the winter or the summer. Re-regulation reservoirs are built below hydroelectric dams to stabilize water flow in rivers to reduce flow fluctuations between daily power generation periods. Headwater storage reservoirs for navigation purposes have large storage pools at the beginning of the dry season and they release enough water to support seasonal navigation traffic. Lock and dam reservoirs, however, support waterborne navigation by creating slightly vary pools that extends upstream a considerable distance from the run-of-river projects.

US Army Corps of Engineers reservoirs are multiple purpose impoundments meeting several types of water resources needs such as flood control, hydroelectric power generation, navigation, irrigation, municipal and industrial water supply, water quality, fisheries, and recreation. The Portland District, Corps of Engineers built and operates three run-of-river reservoirs on the main stem of the lower Columbia River, Bonneville, The Dalles, and John Day dams, that meet navigation, hydroelectric power, irrigation, fisheries, water quality and recreation needs. The Portland District also has built and operates 13 multiple purpose storage projects with a total capacity of 2,308,020 acre-feet of water at maximum conservation pool (0.68 cubic mile) in the Willamette River Basin. The district also stores 547,191 acre-feet of water (0.16 cubic mile) at the maximum pools of the two Rogue River Basin projects. Additionally, John Day Dam, on the Columbia River, has 534,000 acre-feet (0.16 cubic miles) of usable storage. Portland District's Willow Creek Dam, on the north central Oregon tributary to the Columbia River, stores 6,249 acre-feet (0.002 cubic miles) at it's normal summer conservation pool level. Therefore, the total volume of water stored in Portland District reservoirs is equivalent to over 75 percent of the single daily flow of water from U.S. rivers into the oceans.

The scheduling of water storage and release from dams is part of a water resources engineering function called reservoir regulation.

Provided by Corps of Engineers - Portland District

Water Cycle Worksheet 1 Dynamic Earth NGS 1

https://www.nwrfc.noaa.gov/info/water_cycle/hydrology.cgi

Go to the website and read.

Answer the following questions using the information from the website

What is groundwater and why is it important?

Talk about groundwater as you explain why a single rainy year may not end a several year period of drought

What are 2 reasons water resources are being stressed world wide

What are two ways in which climate change affects water resources

We talked about time and cycles yesterday. Explain how the water could be seen as a short term cycle.

Now explain how water can be seen as a long term cycle.

Biology The Changing Earth Water Worksheet 2

Name: ______________________________ Date: _______ Period: ___

Use a search engine to look up *northwest river hydrologic cycle" and you should reach:

https://www.nwrfc.noaa.gov/info/water_cycle/hydrology.cgi

Use this website to complete this worksheet.

Read the introductory paragraph and complete the following

The science of physical geography that deals with the water cycle is called

_______________.

Hydrology deals with the ____________________ (where it comes from), the _______________ (where it goes) and _______________ (how it works) of water.

M______________ and O______________ are two sciences that are closely connected with the study of hydrology

Meteorology is the study of ______________ while oceanography is the study of the

____________________.

The global water cycle can be described with _____ physical processes.

Use the information from each of the physical processes below to complete the following.

Find and draw a different image of evaporation below.

How many calories of heat are required to change liquid water to steam?

____________ calories/gram of water

List five factors that may affect the rate of evaporation.

_______________ _______________ _______________

_______________ _______________

Earth has gone through various climate changes throughout its' existence. How do you think those changes such as Ice Ages might have affected rates of evaporation? Why do you think this?

____

____

____

Find and draw a different image of condensation below.

Condensation is the process by which ________________changes its physical state from a vapor to a ________________.

Condensation occurs when _______________________or by increasing the amount of vapor in the air to ___________________________.

When water vapor condenses back into a liquid state, the same large amount of heat (600 calories of energy per gram) that was needed to make it a vapor is ___________________ to the environment.

Briefly explain how evaporation and condensation are an example of evolution.

____

_____

Biology The Changing Earth Water Worksheet 3

Name: ______________________________ Date: _______ Period: ___

Use a search engine to look up *northwest river hydrologic cycle" and you should reach:

https://www.nwrfc.noaa.gov/info/water_cycle/hydrology.cgi

Use this website to complete this worksheet.

Use the information from each of the physical processes below to complete the following.

Precipitation

Find and draw a different image of precipitation below.

There are two sub-processes that cause clouds to release precipitation, the ______________________ process and the ______________________ process.

Coalescence occurs when smaller drops fall and are overtaken to join____ which produces liquid rain.

Ice-crystal formation occurs when ice develops in clouds high in the atmosphere where freezing temperatures occur. When nearby water droplets approach the crystals some droplets ____on the crystals. The crystals grow to a critical size and drop as snow or ice pellets.

Precipitated water on the ground may be seen as ____________ (liquid water) or ___________________________ (crystallized water)

Precipitated water in hot climates often returns quickly to the atmosphere through ________________________________.

Interception

Find and draw a different image of interception below.

Water that has precipitated on land may be intercepted by plants or different land formations. Below, use drawings and words to explain how these two things could intercept water movement.

plants	Specific land formation

Write 3-4 sentences that explain how the evolution of land masses could affect the processes of interception. Consider how precipitation occurs as well as how interception takes place.

Notes Changing Waters

Dynamic Earth NGS 1

ESS2.C: The Roles of Water in Earth's Surface Processes

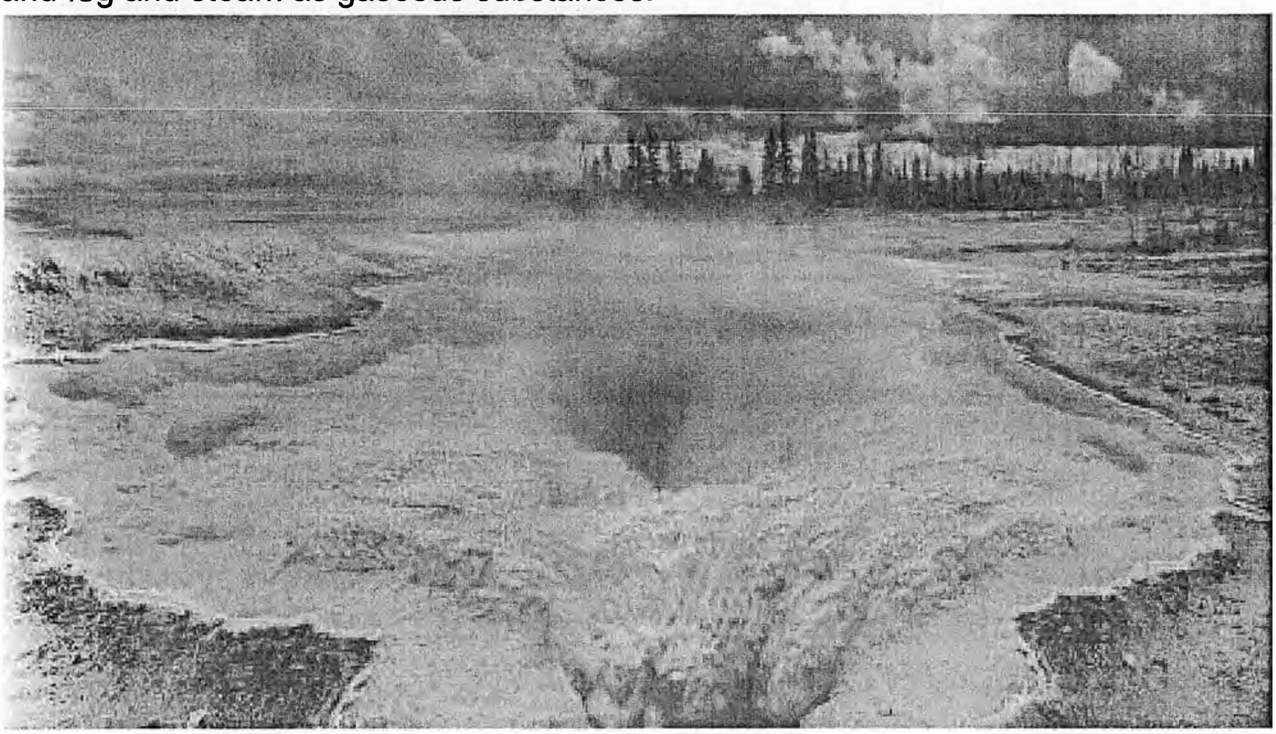
- The abundance of liquid water on Earth's surface and its unique combination of physical and chemical properties are central to the planet's dynamics. These properties include water's exceptional capacity to absorb, store, and release large amounts of energy, transmit sunlight, expand upon freezing, dissolve and transport materials, and lower the viscosities and melting points of rocks.

Earth has an abundance of water both on top of and below the surface of the planet. The combination of physical and chemical properties of water combine to shape the face of our planet in many ways.

Water on earth is seen in a variety of forms. Solids in the shape of snow and ice,

both fresh and salt water in liquid form

and fog and steam as gaseous substances.



Water alters landforms, quickly through actions such as tornadoes,

floods

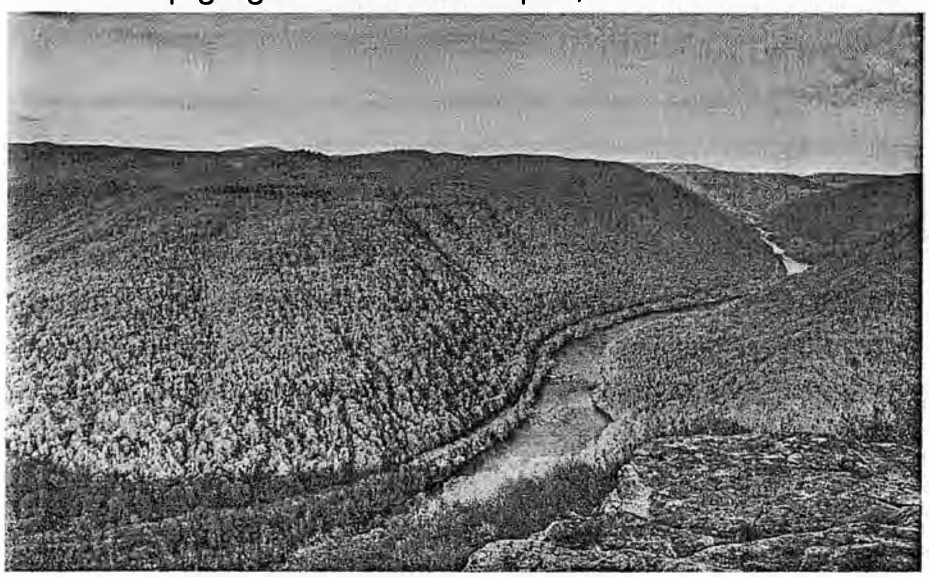
and mudslides....

Water also transforms landforms slowly through erosion, wave action and river movement....

- These properties include water's exceptional capacity to absorb, store, and release large amounts of energy, transmit sunlight, expand upon freezing, dissolve and transport materials, and lower the viscosities and melting points of rocks.

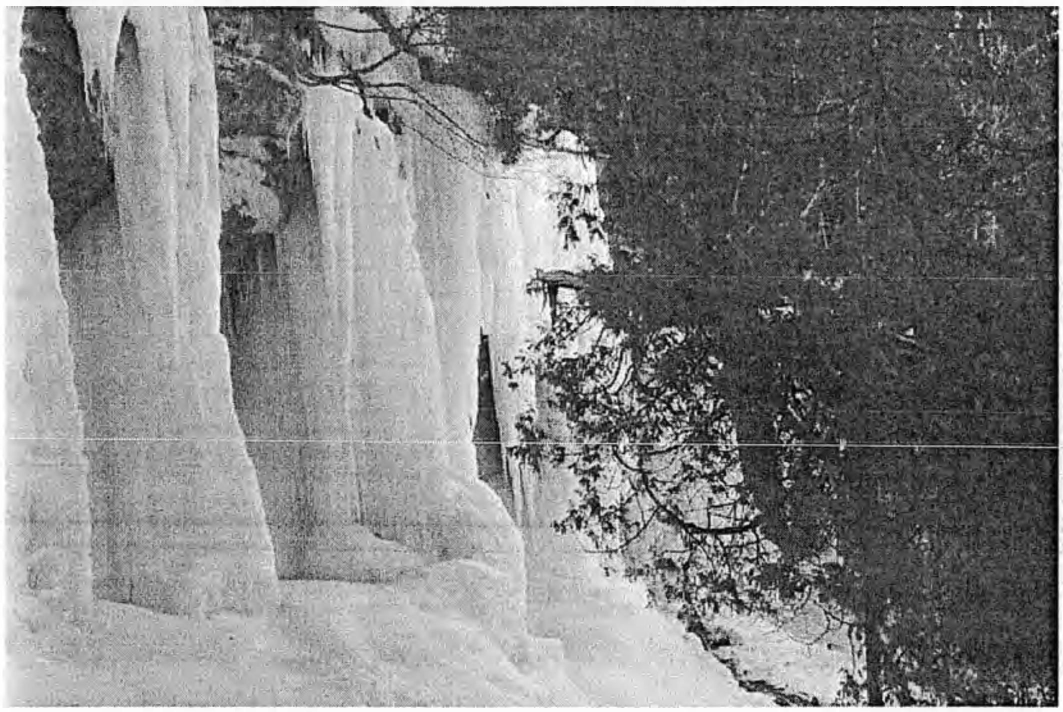
Water has great capacity to absorb, store and release large amounts of energy. This property is an essential part of both physical and organic energy pathways in ecosystems. Water in its various forms moderates rapid temperature changes--energy stored in water can (but doesn't always) keeps weather patterns from altering very rapidly. The high heat capacity of water also explains why the temperatures of land near a body of water such as oceans or lakes are more moderate. The high heat capacity of water keeps its temperature within a relatively narrow range, causing nearby coastal areas to also have a narrow daily and seasonal temperature range.

Water also alters ecosystems through slow acting movement. Over time, rivers create deep gorges in the landscapes,



glaciers grind down mountains,

freezing and thawing break rocks



All of these actions can create plains from mountain ranges, sand from boulders, and over the process of physical evolution, alter ecosystems.

http://www.ces.fau.edu/nasa/module-3/regional-temperature/exploration-1.php

Name(s) ______________________________ Period _________ Date ______________

How Has Temperature Varied Regionally Since the Industrial Revolution?

Introduction

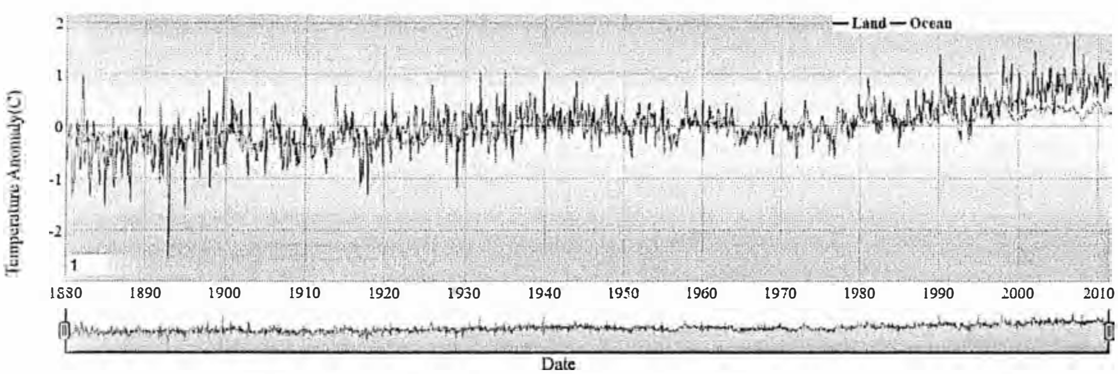
In the previous investigations you have examined how Earth's climate has fluctuated over geologic history. You have seen that on a global scale Earth has been warming since the industrial revolution in the late 1880s. But is Earth warming on a regional scale? Are the oceans also warming? Are both hemispheres warming? Are the tropics and poles warming? In the next three explorations, you will analyze temperature trends over different geographic regions to answer these questions.

The temperature data used for the following investigations is derived from NASA's Goddard Institute of Space Sciences (GISS), which is a laboratory in NASA's Goddard Space Flight Center. This institute focuses on a broad study of changes to our environment, addressing both natural and man-made changes that occur on various time periods from one-time climate events such as volcanic explosions, to seasonal and annual effects such as El Niño. Program areas include climate forcings, model development, Earth observations, radiation, atmospheric chemistry, climate impacts, paleoclimate, planetary atmospheres, and other earth science-related disciplines.

In the first exploration, you will compare the change in ocean temperature to that of land.

Exploration 1: A Comparison of Change in Land and Ocean Temperature Anomalies

You have learned that temperature has fluctuated several times over Earth's history. In this exploration, you will investigate if the temperature change of Earth's ocean is different from the temperature change on land.



Use the interactive, time series graphing tool to answer the following questions.

1. Make a few hypotheses before you begin to compare the 130-year land and ocean temperature anomalies.
   A. Do you think land and ocean temperature anomalies will both show a warming trend?
      _____ Yes _____ No
   B. Do you think that the more recent decades will show an increased rate of warming for both land and ocean?
      _____ Yes _____ No
   C. Which do you think will have a greater range between high and low temperature anomalies?
      _____ Land _____ Ocean

D. Which do you think has more variable temperature anomalies over time?

_____ Land _____ Ocean

2. To analyze the land temperature anomaly variation, check the *Global* box beneath the graph to uncheck the global data. Check the box next to *Land*. You should see the land temperature anomaly data displayed on the graph.
   A. Describe the general temperature anomaly trend over this time period.

   B. What is the lowest temperature anomaly recorded during that time period? What is the highest? What is the range of temperature anomalies (lowest to highest)?

3. To analyze ocean temperature anomaly variation, click on the *Land* box beneath the graph to uncheck it. Check the *Ocean* box. You should see the ocean temperature anomaly data displayed on the graph.
   A. Describe the general temperature anomaly trend over this time period.

   B. What is the lowest temperature anomaly recorded during that time period? What is the highest? What is the range of temperature anomalies (lowest to highest)?

4. Use the data you recorded in questions 1 – 3 to complete the table below.

Geographic Area	Lowest Temperature Anomaly (˚C)	Highest Temperature Anomaly (˚C)	Range (˚C) Lowest to Highest Temperature Anomaly
Land			
Ocean			

Which area has the smallest range in temperature variation? Which has the largest? Explain why you think this difference occurred.

5. Now check the *Land* box again. You should see temperature anomaly data for both land and ocean. Zoom into the graph for the last 25 years (1985-2010) by moving the slider below the graph. Describe the general temperature anomaly trend over this time period.

Activity Stone to Sand: Ice and Eggshells

NGS 1 Dynamic Earth

The goal of this activity is to engage students in understanding how processes of erosion can occur. It is a simple but highly effective activity in achieving comprehension of the concept at a very accessible level for students.

<u>Materials</u>
Whole eggshells
Egg carton
Water (dyed any color)
Freezer

Teacher Instructions:

You will need whole eggshells with just the top broken off

that look like this: 

Each group of students will get an eggshell. Tell them to be VERY careful not to crack the shell. They will get a small beaker of water--they are to add dye to the water. They will need to use a permanent marker to write their names/initials on the bottom of the eggshell while being VERY careful not to crack the shell.

Next they will fill the eggshell with water and put it into a the egg carton in the plastic bag. The carton then goes into the freezer overnight.

The next day they should have 5 min to observe the carton (the ice will melt a bit which is fine) and then the eggs go back into the freezer. Repeat for the next few days (as long as you want to do this). Students are to record their results and compare them to the predictions they have made. Students are then asked to apply their knowledge to processes of weathering stone.

What students will see is that the ice expands the shell will crack--over several days the cracking becomes greater and greater.

Activity Stone to Sand: Ice and Eggshells NGS 1 Dynamic Earth Unit 2 Evolution

Student Worksheet

Names(s) ____________________________ Period ___ Date ________

Prior Knowledge

Write 3 things you already know about processes of weathering.

____

____

____

What prior knowledge do you have about ice?

____

____

____

Hypothesize: What do you think will happen when an eggshell is filled with water and put into the freezer?

____

____

____

Experiment

Step 1: write your initials on the bottom of the eggshell in permanent ink. Be VERY CAREFUL not to crack the shell.

Step 2: fill the eggshell up to the top with colored water. CAREFULLY place in the egg carton. Go back to your other assignment.

Step 3: Complete your observations over the next few days.

Results

Time after placing eggshell in freezer	Observations	Why do you think this is occuring?

Conclusion

In what way might what you have observed mimic the process of weathering in an ecosystem?

____

____

____

____

Critique

How could you make this lab better? What other experiments might you design to test or mimic the processes of erosion and weathering?

____

____

____

____

Name ________________ Date __________ Period _______

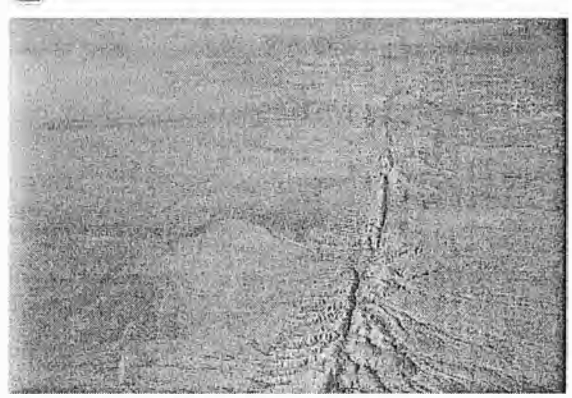
Assessment Dynamic Earth

NGS 1 Module 2 Unit 4

Devils Postpile, California

Shasta Mountain, California

Red Rock Canyon, California



San Andreas Fault, Carrizo Plains, California

Bumpass Hell, Lassen Volcanic Park, California

How mountains are formed; 3 minute video
http://www.bbc.co.uk/science/earth/surface_and_interior/mountain_formation#p00fzsnd

Observe the gallery of images which show the various way in which physical features change our planet Earth. Choose two of the images and describe the processes of physical evolution that are shown in the images and explain how these processes are evidence for evolution.

	Rubric 4- student uses 2 examples to describe **and** explain how the process of evolution occurs 3-- student uses 2 examples to describe **or** explain how the process of evolution occurs 2- student uses 1 examples to describe **or** explain how the process of evolution occurs **or** explains some processes but missing some.

	1- student uses 1 examples to describe **or** explains in part how the process of evolution occurs **or** writes of evolution but does not explain.

Scientists on a diving expedition collected rock samples at a plate boundary 10 km offshore between the ocean and a continent. Upon analysis of the rock collection, the rocks were found to be of differing ages. How can this be possible if the rocks all came from the same collection area?

Prompt: Write a scientific explanation that justifies why continental and oceanic rocks are different ages. Make sure to include a rebuttal in your answer.

	Rubric 4- student uses 2 examples to describe **and** explain how the process of evolution occurs 3-- student uses 2 examples to describe **or** explain how the process of evolution occurs 2- student uses 1 examples to describe **or** explain how the process of evolution occurs **or** explains some processes but missing some. 1- student uses 1 examples to describe **or** explains in part how the process of evolution occurs **or** writes of evolution but does not explain.

You are talking to your 90-year-old Grandpa Frank, who also happens to be a geologist, though not a currently practicing one. Grandpa Frank always has the magnifying glass out, reading the current research, and you often hear him mumbling about wanting to see this or that rock before he dies. He even has a bucket list that he keeps by his side at all times. Today you brought him brownies, and he wants to tell you something about the history of Earth. This time, you sit and listen because you have an assessment coming up on the history of Earth, and you might gain some new insights. You have a feeling it might be a long conversation. In the past when Grandpa Frank talked about dating in his thirties, you just assumed that is when he met your grandma. Now you realize that he was talking about radiometric dating, and it turns out that he was actually working to date rocks that were formed in different periods of Earth's history. Grandpa Frank explains that although active geologic processes have destroyed or altered most of the very early rock record on Earth, other objects in the solar system, such as lunar rocks, asteroids, and meteorites, have changed little over billions of years. He explains that studying these objects can provide information about Earth's formation and early history. Just then Grandpa Frank falls asleep, but in his hand is his bucket list that you finally decide to read.

Part I: Construct an Account (HS-ESS1-6)

Considering the "bucket list" on the Student Reference Sheet and the knowledge you have gained from the prerequisite modules covered in this assessment, construct an account of Earth's formation and early history with an emphasis on scientific supporting evidence. This can be a visual account such as a flow map or a written sequence of events. Be sure to address the following concepts:

- Solar system formation in relation to Earth formation
- Significance of impact craters (size and distribution) on Earth and other planetary surfaces
- Erosion and plate tectonic effects on evidence
- Radiometric dating of materials to support accounts of Earth's history
- Significance of the composition of solar system objects
- Reasoning as to why most of Earth's rocks are much younger than Earth itself.

When Grandpa Frank wakes up, you ask him why he wants to visit Iceland one last time. He tells you that you cannot possibly understand the history of Earth unless you see the largest part of the Mid-Atlantic Ridge that is above sea level. Then he starts mumbling about the ages of rocks again. The only clear thing that you hear him say is that there is a pattern to where rocks of different ages are located on Earth's surface.

Part II: Evaluate and Explain Evidence (HS-ESS1-5)

Use evidence from the two diagrams on the Student Reference Sheet and your knowledge of plate tectonics to explain patterns in ages of crustal rocks. Your explanation should include the following components:

- Descriptions of the diagrams on the Student Reference Sheet
- Cause and effects of the patterns in crustal materials of different ages on Earth's surface
- Discussion of the relative age of continental crust vs. oceanic crust
- Identification of additional evidence that was not provided but is relevant to the explanation

Student Reference Sheet

History of Earth

Bucket List

By Frank Lee Geology

1. Visit the Lunar Sample Laboratory at the Johnson Space Center to see rocks from the Apollo space mission dated between 4.4-4.5 billion years in age.

2. Travel to Greenland to see the oldest rocks on Earth dated at 3.7-3.8 billion years. These started as lava or sedimentary rocks.

3. Travel to Australia to see where the oldest minerals (dated between 4.0-4.2 billions years) on Earth have been found in sedimentary rocks.

4. Travel to the Barringer Crater near Flagstaff, Arizona, which is thought to be formed about 50,000 years ago, and view the biggest fragment of an iron meteor (called the Canyon Diablo meteorite) that made the crater there.

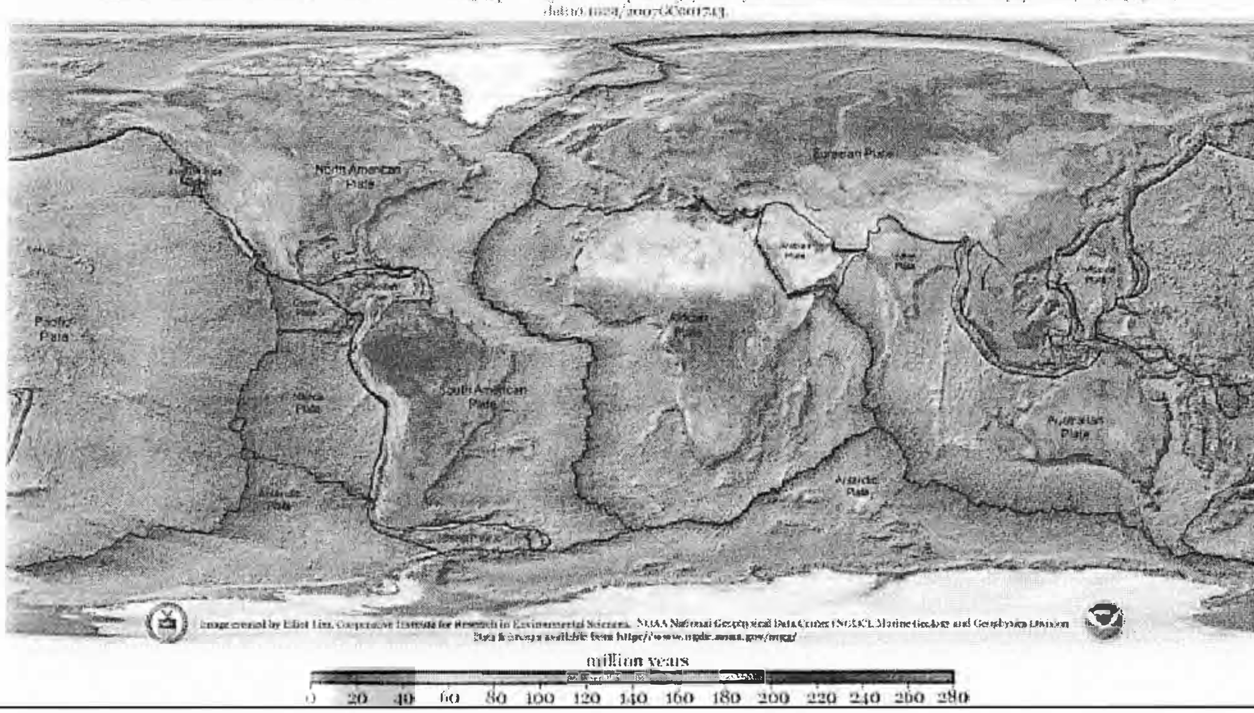
5. Study meteorites dated between 4.4-4.6 billion years that are used as evidence that our solar system formed between 4.53 and 4.58 billion years ago. From studies of this meteorite, the "best age" of Earth is estimated to be 4.54 billion years.

6. Travel to South Africa to the Vredefort Impact Center, Earth's oldest and biggest crater, which is thought to be formed 2 billion years ago.

7. Return to Iceland one last time. It is the largest part of the Mid-Atlantic Ridge above sea level.

Age of Oceanic Lithosphere (m.y.)

Data sources:
Müller, R.D., M. Sdrolias, C. Gaina, and W.R. Roest 2008. Age, spreading rates and spreading symmetry of the world's ocean crust, Geochem. Geophys. Geosyst., 9, Q04006, doi:10.1029/2007GC001743.



Age of Last Thermo-Tectonic Event

Source: USGS "Geologic Province and Thermo-Tectonic Age Maps." *Geologic Province and Thermo-Tectonic Age Maps.* Web.