Norfolk Public Schools
Science Learning in Place Plan: Earth science Lessons

Week 10: May 18 – 22, 2020 (Oceanography)

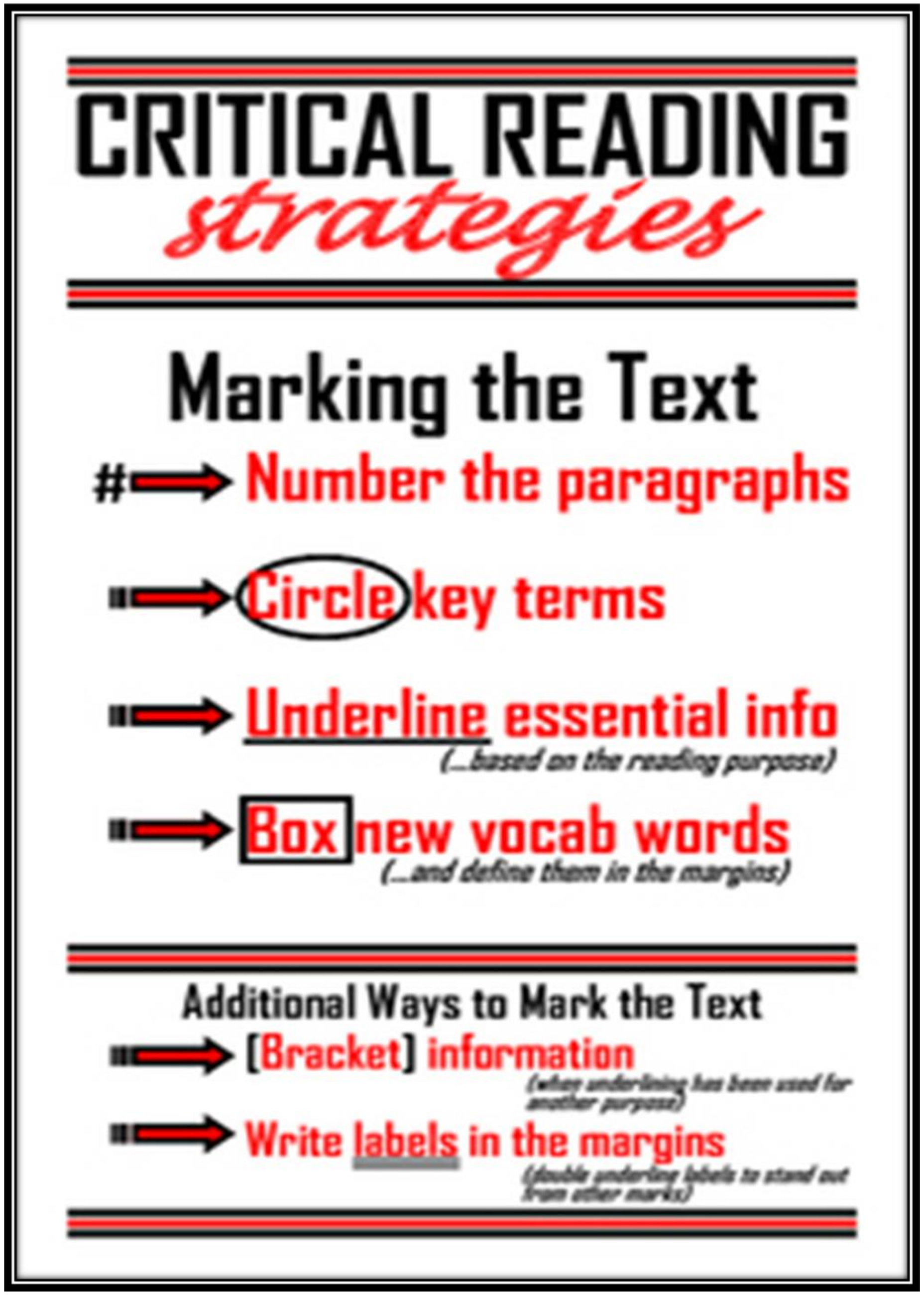
Monday	Tuesday	Wednesday	Thursday	Friday
Reading and Text Annotation • Read "**Scientist at Work: I dive into the deep sea to study volcanoes.**" • Use Critical Reading Strategies to make note of the key points in the passage	Concept Analysis • Read and review "**Mapping the Ocean Floor: Instruction and data sheet.**" • Use the data provided to graph the contour of the ocean floor.	Data Analysis • Review the contour of the ocean floor you mapped. • Answer questions 1-8. Attempt to use vocabulary and examples from the background information and graphs.	Concept Analysis • Read and review "**Ocean Current Worksheet.**" • Answer questions 1-3 in part 1. Attempt to use examples from the background and diagrams.	Data Analysis • Review data table on part 2 of "**Ocean Current Worksheet.**" • Label and color in ocean currents using the data table and answer questions based on the diagram you created.

Week 11: May 25 – 29, 2020 (Plate Tectonics)

Monday	Tuesday	Wednesday	Thursday	Friday
Reading and Text Annotation • Read "**The Pacific Ring of Fire, home to 452 volcanoes.**" • Use Critical Reading Strategies to make note of the key points in the passage.	Text Synthesis • Write a paragraph using information from "**The Pacific Ring of Fire, home 452 volcanoes**" • See the writing prompt after the passage.	Reading and Text Annotation • Read "**How Volcanoes formed the Hawaiian Islands.**" • Use Critical Reading Strategies to make note of the key points in the passage.	Concept Analysis • Read and review "**Rate of Plate Movement.**" • Use Map, Data Table, and formula to complete Hypothesis and Analysis of Data questions 1-3.	Data Analysis • Fill in the Rate chart on "**Rate of Plate Movement**" worksheet then use instruction to find the average rate of movement. • Complete conclusion questions and answer "further questions" 1-2.

Week 12: June 1 – 5, 2020 (Hydrogeology)

Monday	Tuesday	Wednesday	Thursday	Friday
Reading and Text Annotation • Read "**Permeability and Groundwater.**" • Use Critical Reading Strategies to make note of the key points in the passage	Concept Analysis • Answer questions 1-7 based on "**Permeability and Groundwater**"	Data Analysis and Experimental Design • Examine the experimental design set up, fill in the data table (#8) and answer questions 9-12	Reading and Text Annotation • Read "**The earth opened up, and buildings began to crumble in Florida resort** • Use Critical Reading Strategies to make note of the key points in the passage	Concept Analysis • Using the article Answer questions 1-5 about karst topography.



newsela

Scientist At Work: I dive into the deep sea to study volcanoes

By Michael Perfit, The Conversation, adapted by Newsela staff on 01.08.20
Word Count **921**
Level **950L**

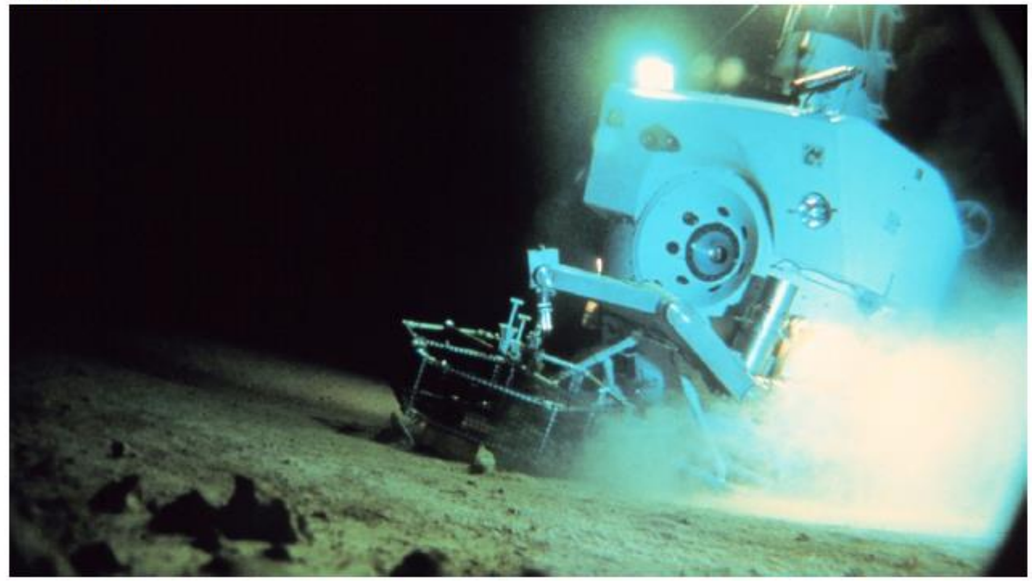


Image 1. Alvin is a Human Occupied Vehicle (HOV) that goes on deep-sea dives to investigate the seafloor. It uses robotic arms to collect samples of rocks and sea life. Scientists inside Alvin make recordings and observations. Photo by: OAR/National Undersea Research Program (NURP)/NOAA Photo Library

As a marine geologist, I study the history and structure of the ocean floor. From inside a cramped submersible vessel, I explore the mysteries of the deep sea.

After obtaining my Ph.D., I was asked to join a team of scientists from the National Oceanic and Atmospheric Administration. They were using a HOV, or Human Occupied Vehicle, to study the geology of the Galapagos Rift. This is a volcanically active area in the Pacific Ocean. The HOV they used was named Alvin.

My first Alvin dive in 1985 was the beginning of my career as a geologist who studies undersea volcanoes. Since then, I've had around 40 dives in Alvin to depths of nearly 13,000 feet. In total, I have spent nearly 250 hours on the bottom of the ocean as an "aquanaut."

Preparing Alvin In Advance

The research ship Atlantis is specially designed to host Alvin. Most cruises last about a month, with around 20 to 25 dives planned in advance. Researchers meet a few days before each dive. They study maps of the dive area to discuss sites for specific sampling and measurements.

The night before the dive, scientists each prepare a bag full of the clothing and recording materials they'll need. They often bring warm clothes. The sub gets cold and damp in the near-freezing seawater at the bottom of the ocean.

By 8 a.m., Alvin is ready for the three aquanauts to slip down into the hatch and settle into position. The pilot sits in the middle of the sphere. Another scientist and I sit on either side of the pilot. The heavy hatch above us is closed and sealed air and watertight to maintain atmospheric pressure throughout the dive.

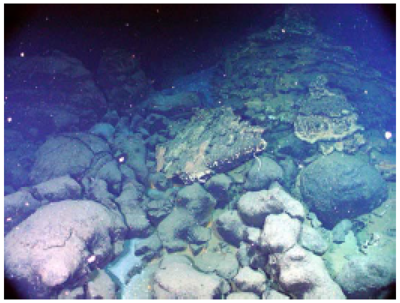
The pilot flicks on carbon dioxide scrubbers, machines that recycle the air we breathe during the dive. Alvin is lifted off the deck and swung out over the water. As we enter the ocean, seawater starts to cover the five small circular windows. I can see divers swimming around the sub, checking our equipment and undoing the line to the ship.

The Slow, Dark Descent

We run through a number of equipment and safety tests. Then, we get the OK to begin our slow descent. We descend at about 110 feet a minute, and it will take over an hour to reach 2,400 meters (8,000 feet). As we steadily drift to the bottom, the light outside quickly starts to fade, becoming greenish at first, then slowly very dark blue. Tiny red reading lights glow inside the sphere. After 10 minutes, deeper than 180 meters (590 feet), it's almost lightless. A half hour goes by and around 1,000 meters (3,280 feet) we are in the "midnight zone," where light cannot reach.

Alvin's outside lights turn on as we approach the seafloor. We let the pilot know when we see the bottom. For me, this is one of the most exciting and awe-inspiring parts of a dive because one never knows what will be there. Very slowly the lava- and sediment-covered floor of the ocean begins to appear as if out of a fog into the headlights.

It is safer for us to land away from the volcanically active areas. These areas typically are covered with different types of lava flows. Some areas have hundred-foot-high mounds of pillow lavas that have oozed out of vents. Others have sheer walls hundreds of feet tall that have been thrust upward.



Hydrothermal vents are common in these areas. These vents are openings in the seafloor through which superheated water flows. I've seen hydrothermal vents releasing black, sulfur-rich smoke. These are typically surrounded by communities of tubeworms, crabs, shellfish, shrimp and unusual fish. These creatures can survive this extreme environment thousands of feet below the surface.

Most dives last six hours. While on the bottom, I direct the pilot where to go and what to sample or measure using Alvin's two mechanical arms. Multiple digital still and video cameras mounted on Alvin's outside record our journey along the seafloor. Mini voice recorders and handwritten notes document our observations. When it's time to ascend, the pilot drops hundreds of pounds of iron weights. This allows us to start floating toward the surface. Even with our extra clothes on, it gets quite cold by the end of a dive. The glow of sunlight announces our approach to the surface. Once onboard Atlantis, the hatch is opened, and it's a relief to fill my lungs with fresh air. I spend the evenings checking out the samples we recovered.

45 Years And Counting

I've been researching the seafloor for more than 45 years, and I'm still excited about taking dives in Alvin. We're still trying to answer a number of questions. How do undersea volcanoes erupt and what are they made of? Where and why do hydrothermal vents form? And how does life thrive in these unwelcoming environments?

There are many unmanned robotic subs that can dive to deeper depths than Alvin. They can stay at the bottom for longer periods of time. However, looking at the ocean floor through a video feed on a screen can't compare to seeing it in three dimensions.

Mapping the Ocean Floor

Name: ___________________________________

Instructions and data sheet

Background:

The surface of the oceans covers an area of more than 12 million square km! Did you ever wonder what was below the surface of all that water? Many early explorers did, and they used several methods to try to determine the shape of the ocean floor. At one time, sailors tied weights to the end of ropes and lowered them to the ocean floor, marked the distance when the rope hit bottom, and then measured that distance. You can imagine what a slow process this was!

In the early 1900s, sonar was invented by a French scientist. He used this technology to get sound wave readings of the ocean floor. This was a great discovery because it allowed scientists to get faster and more accurate readings. A device called an "echo sounder" is simply aimed downward, at which point it gives off a sound signal. The sound signal travels to the ocean floor and bounces, or "echoes", off the surface. The device picks up the echo and then computes the ocean depth at that point. To do this calculation yourself, all you need to know is the speed of sound in water (1,500 m/s), and the time it took for the sound signal to echo.

During this activity, you will use this method to construct a map for two different regions of the ocean floor.

Procedures:

Part 1: Atlantic Profile

1. Compute the *Total Distance Traveled* by multiplying the *Time for the Signal to Return* by the speed of sound (1,500 m/s), and record this distance on the data table on the back of this sheet.
2. Divide your *Total Distance Traveled* by 2 to get your *Ocean Depth* in meters. Record this depth on the data table. This *Ocean Depth* data is what you will be graphing.
3. Along the bottom of the graph, label the x-axis as "**Distance from Beach (km)**", and set up the scale, counting by 100's.
4. On the "Mapping the Ocean Floor Lab" handout, plot the *Distance from Beach* (x-axis) vs. *Ocean Depth* (y-axis) for the Atlantic Profile graph. **Sea level (0 meters) is the line already shown on the graph.**
5. Once the points are plotted, connect the points and shade in the profile of the ocean floor.
6. **Label the following ocean floor features on your graph.** Use page 48 and 49 as a reference.

Continental Shelf, Continental Slope, Continental Rise, Island, Mid-ocean ridge, Abyssal Plain

Part 2: Pacific Profile

1. Label the x-axis as "**Distance from Beach (km)**", and set up the scale, this time counting by 8.
2. On the "Mapping the Ocean Floor Lab" handout, plot the *Distance from Beach* (x-axis) vs. *Ocean Depth* (y-axis) for the Pacific Profile graph. **For this set of data, the depth has already been calculated for you.**
3. Once the points are plotted, connect the points and shade in the profile of the ocean floor.
4. **Label the following ocean floor features on your graph.** Use page 48 and 49 as a reference.

Continental Slope [directly next to shore], Seamounts [next to the subduction zone], Trench [the deep one]

Part 3: Labeling

1. The Pacific Profile shows the Pacific Plate subducting beneath the Philippine Plate. Beneath the ocean floor on this profile, **sketch what you think the subduction zone would look like** (*HINT → Show one plate going under the other*). **Label these two plates; then draw in the rising magma that is leading to the creation of the seamounts.**

2. In this activity you created two different ocean floor profiles. One major difference between the two profiles is the scale of the distance from the shore. Even though both of your profile pictures cover the width of your paper, they do NOT represent the same distance. You need to get a sense of how each of the two profiles compare to each other.
   a. **First determine how wide the entire Pacific Profile is (in km): __________**
   b. **Now take that number and find where that same distance would be along the Atlantic Profile. Draw a vertical dotted line at this point.**
   c. **Use a colored pencil (any color) to lightly shade in everything to the left of this dotted line.**
   d. **Using the same colored pencil, write "Width of Pacific Profile" under this shaded section.**

* **When finished with Parts 1 – 3, answer all discussion questions in complete sentences.** *

Data for Atlantic Profile

This column is what you're graphing on the Y-axis for the Atlantic Profile.

Distance from Beach (km)	Time for Signal to Return (seconds)	Total Distance Traveled (meters) (Time x 1500 m/s)	Ocean Depth (meters) (Total Distance ÷ 2)
50	0.4		
100	0.5		
150	0.6		
200	0.7		
250	1.1		
300	1.4		
350	2.1		
400	3.2		
450	3.7		
500	4.3		
550	4.9	7350	***3675***
600	5.4	8100	***4050***
650	5.4	8100	***4050***
700	5.7	8550	***4275***
750	5.7	8550	***4275***
800	5.6	8400	***4200***
850	5.7	8550	***4275***
900	5.7	8550	***4275***
950	5.7	8550	***4275***
1000	5.7	8550	***4275***
1050	5.4	8100	***4050***
1100	5.4	8100	***4050***
1150	4.3	6450	***3225***
1200	3.2	4800	***2400***
1250	0.7	1050	***525***
1300	N/A	N/A	***- 500*** *(above sea level)*
1350	1.4	2100	***1050***
1400	4.3	6450	***3225***
1450	4.9	7350	***3675***
1500	4.9	7350	***3675***
1550	5.4	8100	***4050***
1600	5.7	8550	***4275***
1650	5.7	8550	***4275***
1700	5.6	8400	***4200***
1750	5.7	8550	***4275***
1800	5.4	8100	***4050***
1850	5.4	8100	***4050***
1900	4.9	7350	***3675***
1950	4	6000	***3000***
2000	3.7	5550	***2775***
2050	4.6	6900	***3450***
2100	6	9000	***4500***
2150	4.3	6450	***3225***
2200	3.2	4800	***2400***
2250	4.3	6450	***3225***
2300	5.4	8100	***4050***
2350	6	9000	***4500***
2400	6	9000	***4500***

Data for Pacific Profile

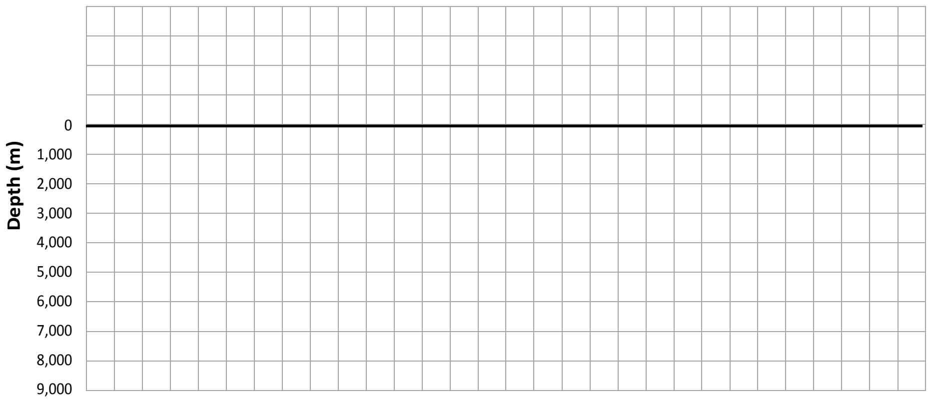
Distance from Beach (km)	Ocean Depth (meters)
0	- 400 (above sea level)
8	1300
16	1000
24	30
32	1000
40	3000
48	4000
56	4500
64	3000
72	2800
80	3000
88	2800
96	3700
104	3000
112	3200
120	2500
128	3100
136	4200
144	7100
152	8200
160	11000
168	10000
176	9000
184	8000
192	7000
200	6000
208	5100
216	4500
224	4200
232	3840
240	3800

Rip this instruction sheet off of the graph and analysis questions page. When you turn it in, you will **submit only that page!**

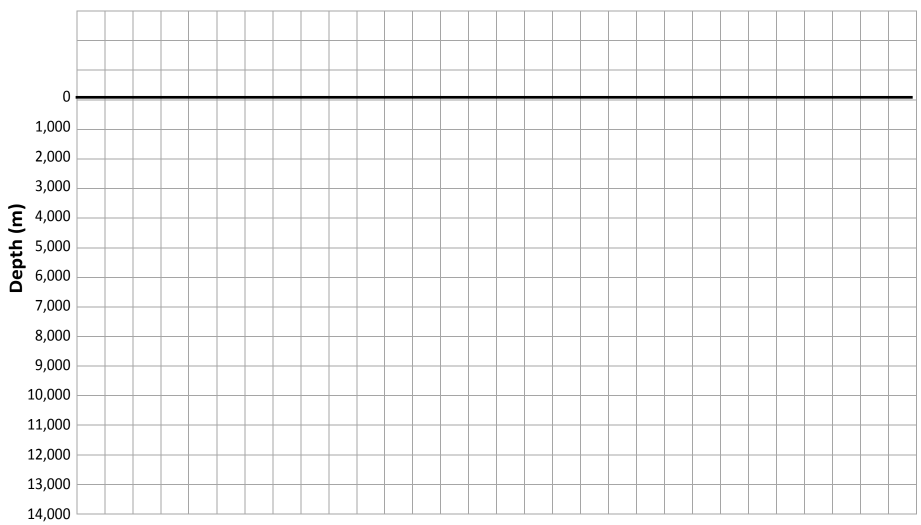
Name: ____ Period: ________ Date: ____________

Mapping the Ocean Floor Lab

Atlantic Profile:



Pacific Profile:



Discussion Questions:

Answer in complete sentences.

Atlantic Profile

1. What two pieces of information are needed to determine ocean depth through echo-sounding?
   (*HINT → Distance from the shore is NOT one of them.*)

   ______________________________ and ______________________________

2. Describe how a volcanic seamount could become an island. **ALSO,** describe how an island could become a seamount.

3. The island on your graph for the **Atlantic Profile** is part of a chain of islands located near 26°W and 38°N latitude. Use a globe or world map to locate and identify this island chain:

   ____

4. For the first data table, once you have found the total distance traveled by the sound wave, why is it necessary to divide it by 2? (*HINT → Think about where the sound signal has to travel.*)

Pacific Profile

5. This profile shows the seafloor at the Marianas Trench, the deepest known point in any of the world's oceans. **Please write the name of this trench <u>on your profile</u>.** What is the name of the process that's occurring here?

   Process name: ________________________________

6. Explain how the seamounts (between 72 km and 128 km from the shore) probably formed near this trench.

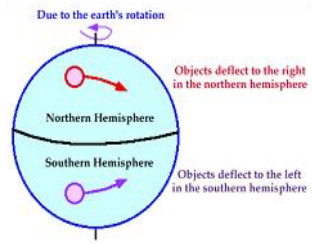
Comparing the two profiles:

7. Besides the scale, how do the two profiles differ from one another? What are the main differences between the seafloor features in either place?

8. In oceanography, the edges of the continents are referred to as "margins". Depending on what type of plate activity is occurring, a margin may be considered an active margin or a passive margin. Based on your knowledge of plate tectonics, which of the two profiles would you consider to be "active", and which would be "passive". Explain your reasoning **in detail**, referring to each profile. **Then, label each profile as either "passive" or "active" on each graph**.

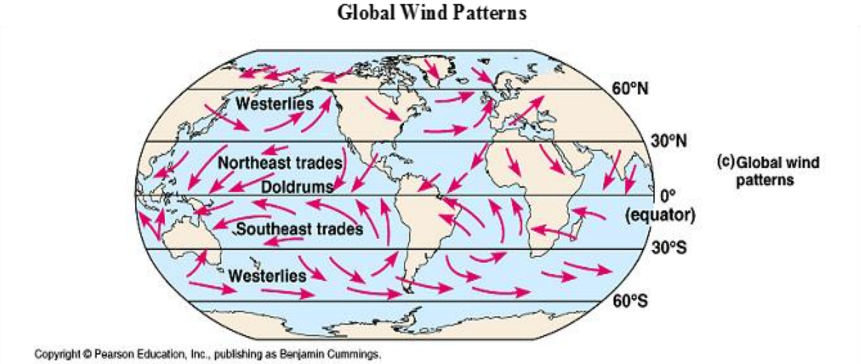
Ocean Current Worksheet

Temperature Affects and Surface Currents: Surface waters of the Earth's oceans are forced to move, primarily by winds. Where winds blow in the same direction for a long period of time, currents will develop that transport large masses of water over considerable distances across ocean surfaces. Why do ocean currents and global winds move in a circular pattern? The circular pattern is caused by the **Coriolis Effect**. The Earth's rotation on its axis causes ocean currents and winds to curve to the right (clockwise direction) in the Northern Hemisphere and to the left (counter clockwise direction) in the Southern Hemisphere. As the winds and currents move, the Earth rotates underneath them. The currents appear to curve in relation to the Earth's surface. If the Earth did not spin on its axis then the currents and winds would appear to move in a straight direction.

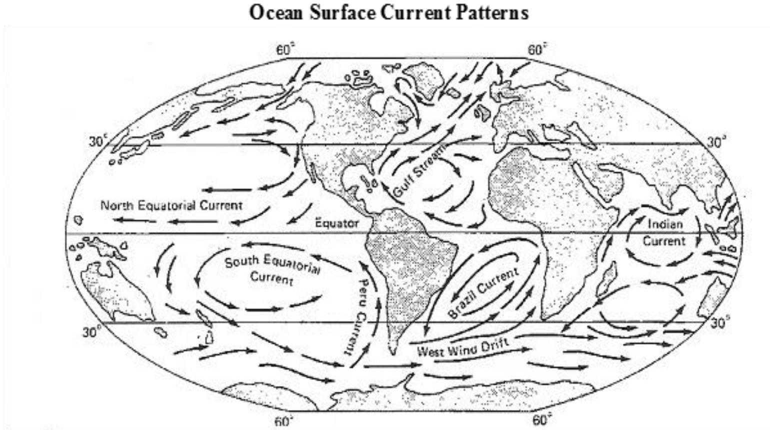


Part I:
Compare the two pictures below (surface ocean currents and global wind patterns).

Global Wind Patterns



Ocean Surface Current Patterns



Questions:

1. Take a look at the two pictures above. What do you notice about the global wind and surface current patterns? In general, the direction of the wind flows in the _____________ direction as the ocean surface currents.

2. The global winds in the first map generally travel in either a **clockwise or counterclockwise** direction. Look at the global winds and compare the general direction of flow in the Northern Hemisphere with the general direction in the Southern Hemisphere.
   a. In the Northern Hemisphere the general direction is _________________.
   b. In the Southern Hemisphere the general direction is _________________.

3. The difference in direction is caused by the ______________ ______________.

Part II:
Using the table below label and color the currents in the picture (red = warm, blue = cold).

Number	Name of Surface Current	Characteristic Temperature of Water Transported by Current
1	California Current	Cold
2	Canary Current	Cold
3	Gulf Stream	Warm
4	Kuroshio Current	Warm
5	East Australian Current	Warm
6	Benguela Current	Cold
7	Brazil Current	Warm
8	Peru Current	Cold
9	Antarctic Circumpolar Current	Cold

Questions:

1. The ocean currents on your map generally travel in either a **clockwise or counterclockwise** direction. Look at the ocean currents and compare the general direction followed by currents in the Northern Hemisphere with the direction of those in the Southern Hemisphere.
   a. In the Northern Hemisphere the general direction is _________________.
   b. In the Southern Hemisphere the general direction is _________________.

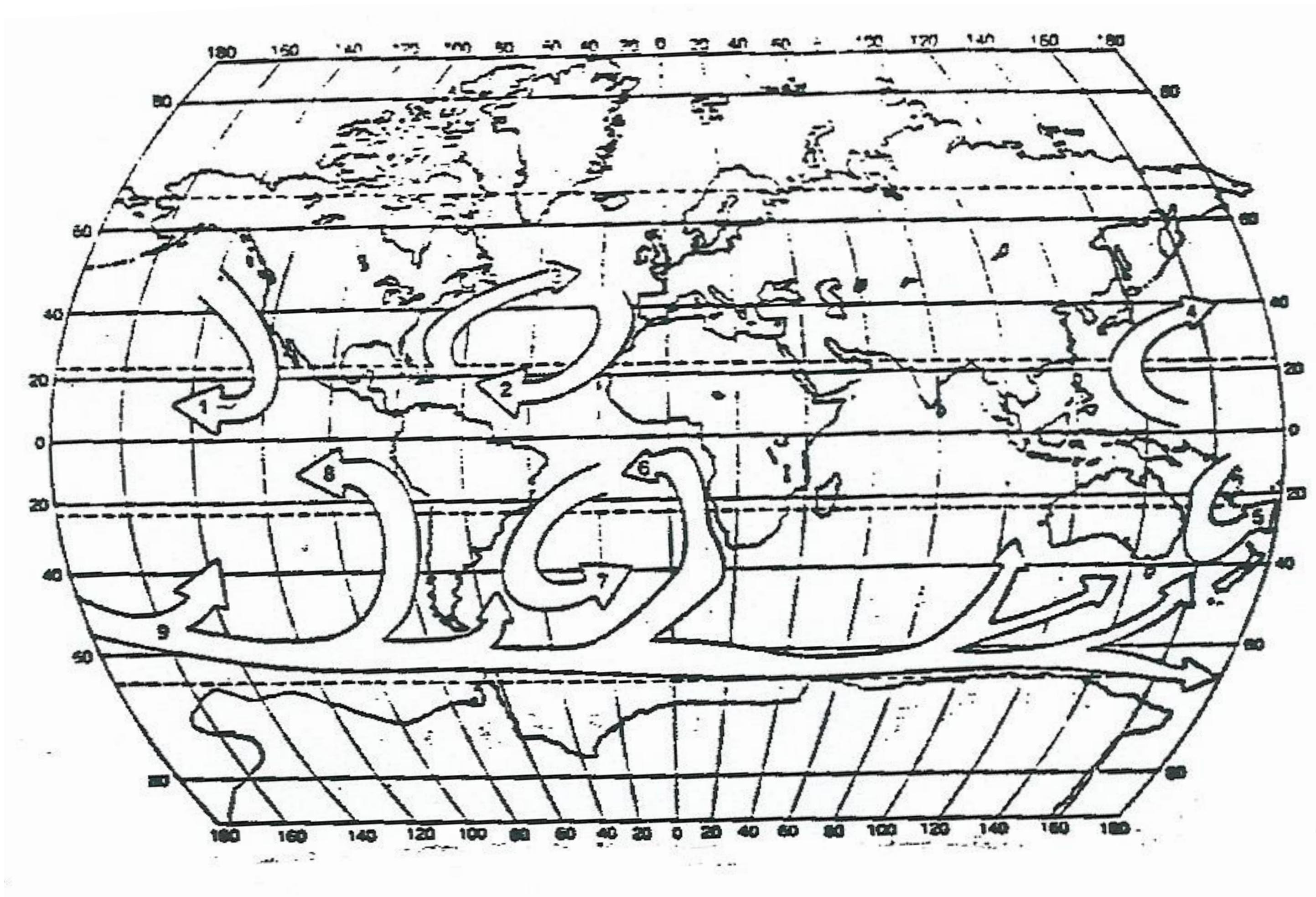
2. What happens to the direction of an ocean current when it approaches the coast of a large landmass?

3. Cold water currents tend to have a cooling effect on the continental coastlines that they border, while warm water currents tend to have a warming effect. Look at the pattern of currents in the Northern and Southern hemispheres and describe the effect the currents have on the temperature of the coastal areas they border.
   a. The East coasts generally have _________ (warm or cold) water currents.
   b. The West coasts generally have _________ (warm or cold) water currents.
   c. The East coast climates will generally be ___________ (warmer or cooler) than it's supposed to be.
   d. The West coast climates will generally be ___________ (warmer or cooler) than it's supposed to be.

4. Look at the pattern of cold and warm water currents. What seems to determine whether a current carries warm or cold water? Explain why this is so.

Ocean Currents

Directions: Label and color in ocean currents using the information in the data table.



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The Pacific Ring of Fire, home to 452 volcanoes

By National Geographic Society, adapted by Newsela staff on 04.17.19
Word Count **889**
Level **980L**

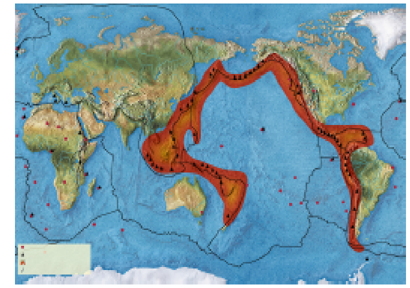
Image 1. Steam rising as lava from Kilauea flows into the Pacific Ocean in Hawaii, September 2016. Lava levels of one of the worlds most active volcanoes rose quickly and showed no signs of slowing down. Kilauea volcano in Hawaii had seen a rise in its magma chamber in recent months with its lava lake visible to all visitors to the Hawaii Volcanoes National Park. Photo by Marc Szeglat / Barcroft Media via Getty Images

The Ring of Fire is a string of volcanoes and earthquake sites around the edges of the Pacific Ocean. Roughly 90 percent of all earthquakes occur along the Ring of Fire. The ring is dotted with 75 percent of all active volcanoes on Earth.

The Ring of Fire is shaped like a 25,000-mile horseshoe and contains 452 volcanoes. These volcanoes stretch from the southern tip of South America, up along the coast of North America, over to eastern Russia, down through Japan and into New Zealand. Several volcanoes in Antarctica close the ring.

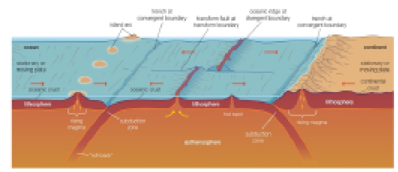
NATIONAL GEOGRAPHIC

Plate Boundaries?



The Ring of Fire is the result of huge slabs of Earth's crust called tectonic plates. The plates are constantly moving atop a layer of solid and liquid rock called the mantle. The mantle is the layer between the Earth's crust and core. Sometimes the plates that move in the mantle layer crash together, move apart or slide next to each other.

Convergent Boundaries



A convergent plate boundary is formed by tectonic plates crashing into each other. At these boundaries, the heavier plate can slip under the lighter plate. The dense mantle material turns into magma, or hot liquid rock. The magma rises through the crust to Earth's surface over millions of years. This creates a series of active volcanoes.

At the bottom of the Pacific Ocean, there is a series of deep ocean trenches that run parallel to volcanoes along the Ring of Fire. These create both islands and continental mountain ranges.

Divergent Boundaries

A divergent boundary is formed by tectonic plates pulling apart from each other. Magma wells up in a volcano as the old crust pulls itself in opposite directions. Then, cold seawater cools the magma, creating new crust. The upward movement and eventual cooling of this magma has created high ridges on the ocean floor.

Transform Boundaries

A transform boundary is formed as tectonic plates slide past each other. Parts of these plates get stuck at the places where they touch, causing the rock to break or slip. The plates push forward and cause earthquakes. These areas of slippage are called faults. The majority of Earth's faults can be found along transform boundaries in the Ring of Fire.

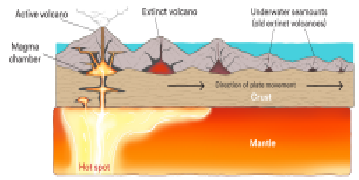
The San Andreas Fault is one of the most active faults on the Ring of Fire. It lies on the transform boundary between the North American Plate and the Pacific Plate. Measuring about 800 miles long and 10 miles deep, the fault cuts through California.

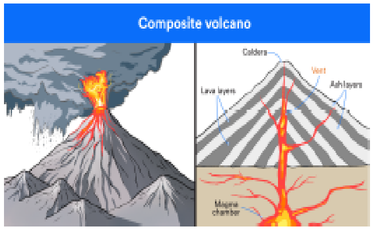
Hot Spots

The Ring of Fire is also home to hot spots, which are high-temperature areas deep inside Earth. As heat rises from a hot spot, it melts the rock above and turns it into magma. The magma often pushes through cracks in the crust to form volcanoes.

Active Volcanoes In The Ring Of Fire

Most of the active volcanoes on the Ring of Fire are found on its western edge. Krakatoa is an island volcano in Indonesia. Beneath Krakatoa, the denser Australian Plate is slipping under the Eurasian Plate. An eruption in 1883 destroyed the entire island. It sent volcanic gas, volcanic ash and rocks as high as 50 miles in the air. A new island volcano, Anak Krakatau, has been forming with minor eruptions ever since.





Mount Fuji is Japan's tallest and most famous mountain. It is also an active volcano. Mount Fuji sits at a "triple junction," where three tectonic plates interact.

The Ring of Fire's eastern half also has a number of active volcanic areas. Mount St. Helens is an active volcano in Washington state. It lies on a weak section of crust, which makes it more likely to erupt. Its historic 1980 eruption lasted nine hours and covered nearby areas in tons of volcanic ash.

Popocatépetl is one of the most dangerous volcanoes in the Ring of Fire. The mountain is one of Mexico's most active volcanoes, with 15 recorded eruptions since 1519. Twenty million people live close enough to Popocatépetl to be threatened by a destructive eruption.

Fast Facts:

Jolting Japan

Japan lies along the western edge of the Ring of Fire. It is one of the most tectonically active places on Earth. As much as 10 percent of the world's volcanic activity takes place in Japan.

Cooling Ring

The Pacific Plate, which drives much of the tectonic activity in the Ring of Fire, is cooling off. Scientists have discovered that the youngest parts (about 2 million years old) are cooling off and contracting at a faster rate than older parts (about 100 million years old). The younger parts of the plate are the most active parts of the Ring of Fire.

Ring of Fire Writing Prompt

"Imagine you are a web designer. A company wants to hire you to create an interactive website to help teach kids about the Ring of Fire. What information from the article could you include in the website?"

How volcanoes formed the Hawaiian Islands

By National Geographic Society, adapted by Newsela staff on 03.09.20
Word Count **784**
Level **980L**

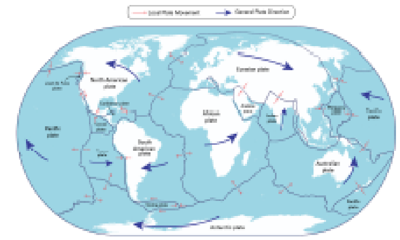
A volcano explodes in Hawaii. Photo by: National Geographic

Hawaii is the world's most remote island population center in the world. The six largest Hawaiian Islands — the Big Island, Maui, Lanai, Molokai, Oahu and Kauai — form a chain of islands running to the northwest.

The islands appear in this pattern because they are situated on a volcanic hotspot. A hotspot is an area in the Earth's mantle where plumes of hot molten rock called magma rise up from the mantle, forming volcanos on the Earth's crust. The crust is the outermost layer of a planet. The mantle is the layer below the crust.

This process happened with the Hawaiian Islands. They formed one after the other as a tectonic plate, the Pacific Plate, slid over a plume of magma, creating a volcano. The tectonic plate continued to move over the hotspot, and the active volcano lost its connection to the hotspot and became inactive. A new active volcano formed from the hotspot.

Understanding Tectonic Plates

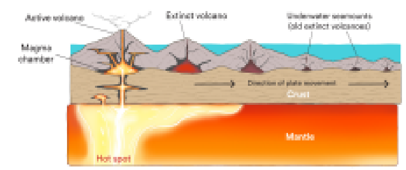


Volcano hotspots can occur in the middle of tectonic plates. That's unlike traditional volcanism, which takes place at plate boundaries. One explanation that scientists have proposed for hotspot volcanism is that it happens near unusually hot parts of the Earth's mantle.

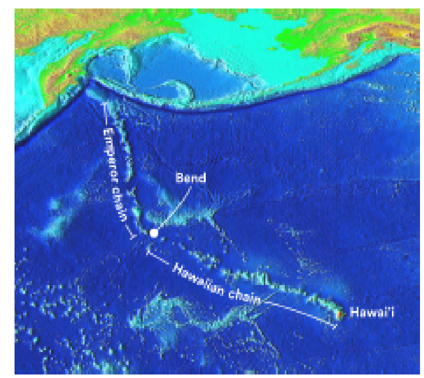
In the case of the Hawaiian Islands, the Pacific Plate is continually moving to the northwest over the Hawaiian hotspot. This movement caused the Hawaiian chain of islands to form. The Pacific Plate is just one of the Earth's roughly 20 tectonic plates. They are constantly in motion. They are responsible for building mountains and activating events like earthquakes.

There are many landforms around the Hawaiian Islands that formed from the same volcanic hotspot. Scientists believe this hotspot has been expelling lava for roughly 70 million years.

How Underwater Volcanoes Form Mountain Chains



Many mountains and landforms created by volcanoes are submerged, or underwater. They're known as seamounts. The Hawaii-Emperor seamount chain extends for more than 6,000 kilometers (3,728 miles) from Hawaii up to the Aleutian Trench in Alaska. Most of the other mountains are underwater. The Hawaiian Islands are the youngest in the chain and its smallest part.



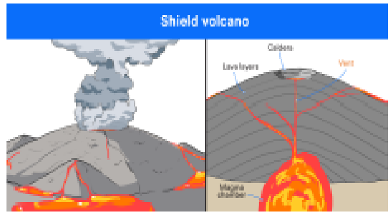
In total, more than 750,000 cubic kilometers (180,000 cubic miles) of lava erupted to form all of the landforms in the Hawaiian-Emperor chain. That's enough to cover the entire state of California in a layer of lava more than 1 kilometer (0.62 mile) thick.

Volcanic Activity Today

Volcanic activity is still occurring on the southern shore of the Big Island, the youngest of the Hawaiian Islands. In 2018, the Kilauea volcano erupted spectacularly. It inundated over 30 square kilometers (30.5 square miles) of the Big Island with lava. The layer of lava was up to 24 meters (79 feet) thick in places. That's taller than a six-story building! Thousands of earthquakes accompanied the eruptions. Nearby residents and staff at the United States Geological Survey's Hawaiian Volcano Observatory near Kilauea were forced to leave and escape.

Kilauea isn't the only volcano on the Big Island. There are also Kohala, Mauna Kea, Hualalai and Mauna Loa. Of these four volcanoes, only Hualalai and Mauna Loa are active.

Kauai is the oldest of the major Hawaiian Islands. It doesn't have any active volcanoes because it's no longer over the Hawaiian hotspot. Instead, the major ecological process occurring there is erosion, which has sculpted Kauai's landforms into beautiful cliffs.



A New Hawaiian Island?

The Pacific Plate moves at a rate of roughly 7 centimeters (2.75 inches) per year — about the rate at which fingernails grow. As long as it continues to move at this rate, new volcanic material is building up over the Hawaiian hotspot. This material will eventually form another Hawaiian island.

This future island is located about 35 kilometers (22 miles) off the southern coast of the Big Island. It already has a name: Loihi. However, don't book a trip there just yet. Loihi is not visible as an island right now. It's still roughly 1,000 meters (3,280 feet) below the surface of the Pacific Ocean. As lava continues to be deposited on Loihi, scientists predict that it will rise above sea level sometime between 10,000 and 100,000 years from now.

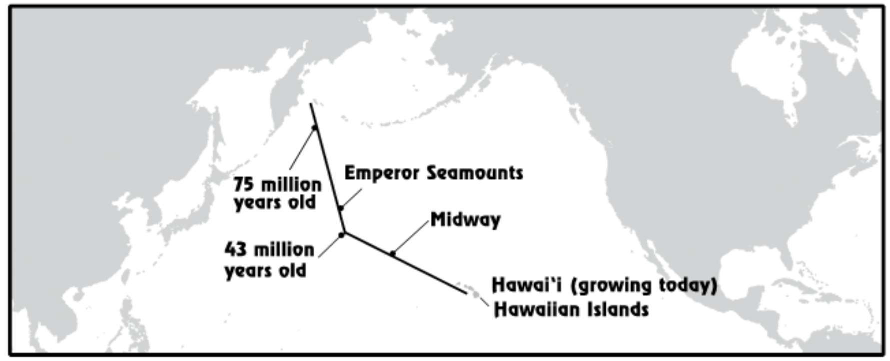
Rate of Plate Movement

Testable Question:

How has the rate of Pacific Plate movement changed over time?

Background Information:

In the early 1960s, J. Tuzo Wilson suggested that volcanic ocean island chains were created when Earth's plates move continuously over a stationary hotspot. The Emperor Seamounts and the Hawaiian Archipelago were formed in this way. Scientists have developed methods for determining the ages of these islands and seamounts. The map shows the Emperor Seamounts and Hawaiian Islands today.



Hypothesis:

During this activity, you will calculate the rate of Pacific Plate movement for different time periods. This will help you learn how the rate of Pacific Plate movement has changed over time. Complete the hypothesis below by writing the correct answer (increasing or decreasing) in the blank.

If the same hotspot formed Suiko, Midway, Kaua'i and Moloka'i, then the rate of Pacific Plate movement is ________________________ over time.

Data: Scientists have collected the following data regarding the age and distance from the hotspot of various islands and seamounts in this chain.

Island or Seamount	Distance from hotspot (km)	Age (Ma)
Moloka'i	290	1.8
Kaua'i	519	5
Midway	2432	28
Suiko	4860	65

Rate of Plate Movement

Analysis of Data:

1. Use the formula (island distance from hotspot ÷ island age) to calculate the rate of movement for each island in the chart, then multiply by .1 to convert from kilometers per million years to centimeters per year. Round your answers to the nearest tenth.

Island	Distance (km) ÷ Age (Ma)	x	Conversion factor	=	Rate (cm/yr)
Moloka'i	290 ÷ 1.8	x	.1	=	
Kaua'i	519 ÷ 5	x	.1	=	
Midway	2432 ÷ 28	x	.1	=	
Suiko	4860 ÷ 65	x	.1	=	

2. Is the rate of movement of the Pacific Plate constant? ____________________________________

3. Follow the directions in the box to calculate the average rate of movement of the Pacific Plate. Write the answer in the space below.

Answer: ____________ cm/yr

Fill in the rate of movement from the chart in question #1, above.

Island	**Rate**
Moloka'i	_______ cm/yr
Kaua'i	_______ cm/yr
Midway	_______ cm/yr
Suiko	_______ cm/yr
Total	_______ cm/yr

To find the average, add the rates of movement for the four islands and divide by the number of islands used in the calculation, in this case 4. Write the average rate of movement in the blank on question #3, above.

Rate of Plate Movement

Conclusion:

Write your conclusion as a complete sentence on the lines below.

____

____

____

Was your hypothesis proved or disproved? Explain your answer.

____

____

____

Further Questions:

1. Using the average rate of movement, how far will the plate move in 100 years? Show your work.

   The total distance the plate will move in 100 years = the Average Rate (from Analysis of Data section) X 100 years.

   Answer: ____________ cm

2. Using the average rate of movement, how far has the plate moved in your lifetime? Show your work.

   Answer: ____________ cm

Permeability and Groundwater

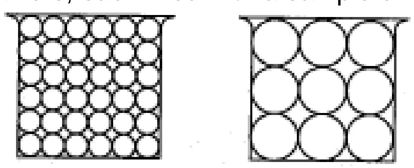
Permeability is the degree to which water or another liquid is able to flow through a material. Different substances such as soil, gravel, sand and asphalt have varying levels of permeability. Materials that are densely packed are less permeable than those that are loosely packed. The **porosity** of the material enables permeability: the more gaps, the more permeable the material.

As the population of the Earth increases and as more development and urbanization occur, more of the Earth's surface is replaced by **impervious** or **non-permeable surface**s such as roads, houses, parking lots, and buildings. The cumulative effect is a reduction in the seepage of water into the ground and an increasing runoff into ditches, streams and detention basins.

Increases in imperviousness, removal of vegetation and soil, gradation of the land surface, and construction of drainage networks all result in higher runoff volumes and shortened runoff time into streams from stormwater (rain, melting snow).

Over time, this new and human-induced movement of pollutants through an area creates the "other" water cycle, sometimes called the urban stormwater cycle. This cycle is a way to describe the journey of rainfall from the atmosphere to the surface of the Earth, over land, and eventually into the terrestrial water system (groundwater, rivers, ocean and estuaries). In this way, pollutants accompany the natural water cycle and are inadvertently spread and able to contaminate other water sources.

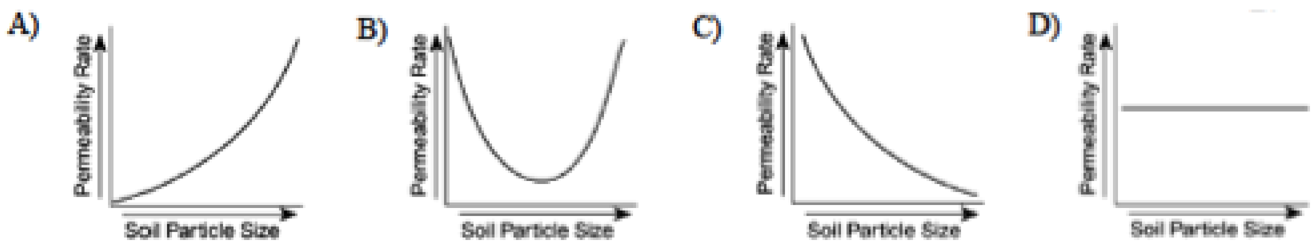
1. The diagrams below represent two containers, each filled with a sample of nonporous particles of uniform size.



Compared to the sample of larger particles, the sample of smaller particles has (choose 2)

a. lower permeability
b. less porosity
c. higher permeability
d. more porosity

2. Which graph best represents the general relationship between soil particle size and the permeability rate of infiltrating rainwater?



3. Rainfall is most likely to infiltrate into soil that is

a. permeable and saturated
b. impermeable and saturated
c. permeable and unsaturated
d. impermeable and unsaturated

4. Water can pass through a sandstone sample because the sample is

a. permeable
b. composed of pebble-sized particles
c. organic in origin
d. well compacted and cemented

5. Sand sediments are usually more permeable than silt sediments because sand grains are

a. larger
b. smoother
c. rounder
d. more soluble

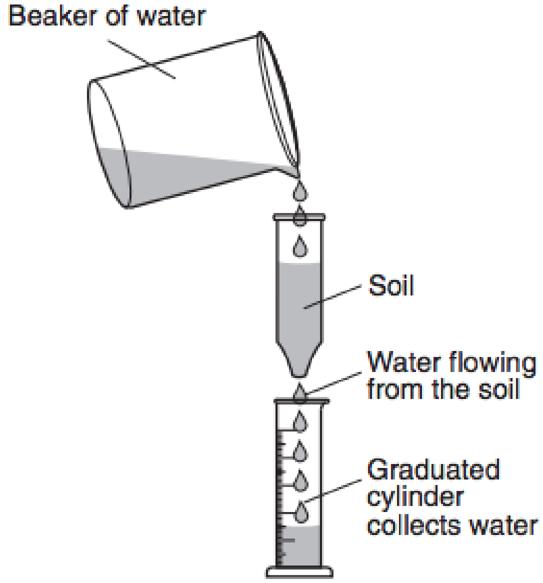
6. Which soil surface has the slowest permeability rate and is most likely to produce flooding?

a. pebbles
b. sand
c. silt
d. clay

7. A paved blacktop parking lot was built on what was once a soil-covered field. This area will now experience increased runoff when rain occurs because the paved parking lot has
   a. less capillarity
   b. greater infiltration
   c. less permeability
   d. greater porosity

Data Analysis and Experimental Design

Examine the experimental set up to determine if the size of soil particles affects the amount of water that flows through soil. The student poured 100 milliliters (mL) of water through four different types of soil. The equipment is shown below.



We got the following results: With gray soil, the average particle size was 2.0 millimeters (mm) and 80 mL of water flowed through. We then used tan soil. Its average particle size was 0.5 mm and 40 mL of water flowed through. With brown soil, 60 mL of water flowed through. Brown soil has an average particle size of 1.5 mm. In our last trial we used black soil. It has an average particle size of 1.0 mm and 50 mL of water flowed through.

8. Using the data table below, organize the results to show the average particle size and the amount of water that flowed through for each type of soil. Be sure to include column headings, data, and units in the table.

Data Table

Soil Color		
gray		
brown		
black		
tan		

9. What is the dependent variable in this experiment?

10. What are two constants in the experiment?

11. What conclusion can be drawn from the data that the students collected?

12.. How could this experiment be improved?

Resort near Disney World in Florida collapses into sinkhole; no one hurt

By Orlando Sentinel, adapted by Newsela staff on 08.13.13
Word Count **703**
Level **1030L**

Buildings collapse into a sinkhole at the Summer Bay Resort on U.S. Highway 192 in Clermont, Florida. Guests had only 10 to 15 minutes to escape. The resort is located about 7 miles east of Walt Disney World. Red Huber/Orlando Sentinel/MCT

ORLANDO, Fla. — First came the cracking sounds. Then windows started blowing out. And before they knew it, guests felt the ground beneath their Lake County resort near Walt Disney World sink into the ground.

The vacationers had only 10 to 15 minutes to escape the collapsing buildings at the Summer Bay Resort. A large sinkhole — about 60 feet in diameter and 15 feet deep — opened in the earth late Sunday, Aug 11. The resort is located about seven miles east of Walt Disney World.

No one was injured. About three dozen resort goers left behind car keys, medication and other personal belongings inside their luxury condominiums as the crumbling buildings were evacuated.

"My heart sunk. I was sick to my stomach," said resort president Paul Caldwell after getting a call about 10:30 p.m. from his staff that the 15-year-old buildings full of guests were sinking into the ground.

Building Buckles Into Ground

Sinkholes are common in land where the rock below the surface can be dissolved by water flowing through the land, according to the U.S. Geological Survey. That type of land is referred to as "karst terrain," and is found in about 20 percent of the country, the science group said.

The states with the most damage from sinkholes tend to be Florida, Texas, Alabama, Missouri, Kentucky, Tennessee and Pennsylvania.

After the windows began to shatter, a guest ran into the street to flag down resort workers, Caldwell said. Firefighters arriving on the scene immediately went door-to-door of building 104, a three-story structure, to help guests escape from the splintering and cracked building frame. The building was sheared nearly in half.

About 20 men, women and children left behind everything they brought to their vacation rental. The American Red Cross came to assist the displaced guests.

Building 104 is connected to a center building that houses an elevator shaft, said Lake County Fire Chief Tony Cuellar. The building buckled into the ground minutes after firefighters got the guests out through the center building, Cuellar said.

All Guests Accounted For

An adjacent building was also evacuated and 16 people had to leave, Cuellar said.

All guests had been accounted for, and no one was injured. Caldwell said they were moved to other buildings on the property.

The east side of the property lost power, but none of the other units were otherwise affected, he said. Firefighters are waiting for engineers to determine the damage the gaping hole caused.

Sinkholes in Florida form as soft limestone below the surface dissolves and collapses with acidic rainwater that runs through the soil. Construction, groundwater pumping and drought followed by heavy rain can speed up the erosion.

The water dissolves limestone, causing sands to move through and form a hole on the surface. It looks like the sand is going through the neck of an hourglass.

Sinkholes cost Florida residents millions of dollars in structural damage and insurance each year.

Sinkhole Swallowed A Man In March

Experts in Lake County recently told the *Orlando Sentinel* the region could expect more collapsing earth. They said that companies that repair sinkholes are seeing an increase in complaints.

Geologists say sinkholes have always been a part of life below the crust in the Sunshine State. But they do not agree if they they are increasing in number.

Sinkholes are notoriously frequent in the Tampa Bay area, where one man suffered a dramatic end in March. A 50-foot-deep sinkhole swallowed 37-year-old Jeffrey Bush while he was sleeping inside his home. The home was condemned, and Bush was declared dead.

Officials investigated a possible sinkhole at another Florida home in June after the homeowner's pool cracked and shifted in the ground. The hole – 40 to 50 feet wide and 30 to 40 feet deep – stabilized.

That hole is only 1-1/2 miles from the 1981 Winter Park sinkhole. The infamous sinkhole swallowed a car dealership and home in its 320-foot-wide and 90-foot-deep opening.

Three years ago, sinkholes collapsed lanes of U.S. Highway 27 in eastern Polk County. And several years before that, a sinkhole that opened up on Scott Lake swallowed enough water to make the shoreline pull back dramatically in a fancy Lakeland-area neighborhood.

Answer the following questions based on the article:

1. What is “karst terrain”?

2. What type of rock is associated with karst terrain?

3. What causes the rock to dissolve?

4. What human activities can accelerate the erosion that occurs beneath the land surface to cause a sinkhole to develop?

5. What natural activities can accelerate the erosion that occurs beneath the land surface to cause a sinkhole to develop?