Everblue Education

Sedimentation Exploration

This lesson focuses on some of the physical factors that influence the ocean and how terrestrial (on land) and marine (in the ocean) ecosystems interact. Rivers introduce sediments from the land into the marine environment, which is very important for nutrient cycling in the ocean. This lesson is based on a 2012 paper where scientists used ^{210}Pb (lead-210), a radioactive particle that naturally occurs in sediments, to study how much sediment the Umpqua River carries into the ocean. Students will explore how different kinds of scientists study the ocean, stepping outside of marine biology to explore oceanography, geology, and meteorology, to name a few! They will learn about how water moves sediments from the land into the ocean, how those sediments settle, and how humans can impact the natural system. Anytime you use these methods to ask and answer questions, you are doing science! It doesn't take a special kind of person to be a scientist, just exploration and curiosity.

Everblue is a 501(c)(3) nonprofit dedicated to encouraging ocean-conscious living by increasing scientific literacy. Our online education resources connect current science to daily life, allowing you to learn about the ocean at your fingertips! Stay in touch by following @oceanoeverblue on your prefered social media platform or by visiting our website at www.oceaneverblue.org.

To help us keep the ocean ever blue, please share this program with the teachers and parents you know so we can spread ocean science far and wide. Partnering with marine scientists from around the world who study all parts of the ocean, we've created simple and engaging activities based on recently published papers! These activities connect you and your students to current research while fulfilling education standards for reading, math, science, and writing. Even though the activities are created for grade school, they're fun and informative for parents and siblings, as well! More activities will be available to download for FREE off of our website, with a new activity added every Friday until the end of quarantine.

Research Paper:
Natural and human impacts on centennial sediment accumulation patterns on the Umpqua River margin, Oregon. *Robert A. Wheatcroft, Jeffry C. Borgeld, et al., 2013.*

Grade Level:	Timing:
Elementary School, Grades 1-5	~ 1.5 hours

Materials

- 3 large tupperware containers
- 3 cups
- Water
- Fine sediment (like clay or silt)
- Medium sediment ("typical" garden dirt)
- Coarse sediment (small rocks)
- Dead plant materials
- Scissors
- Tape
- Build-your-own Coastal System cutouts (in appendix)

Next Generation Science Standards

Science & Engineering Practices:	Crosscutting Concepts:	Disciplinary Core Ideas:
Analyzing & interpreting data Using models	Cause & effect Patterns Stability & change	Earth materials & systems Human impacts on earth systems The roles of water in Earth surface processes

Activity Overview

Title of Activity	Learning Cycle Stage	Time
Naming Scientists	Invitation, Exploration	2 - 5 minutes
Sea Scientists	Exploration	10 - 15 minutes
Sediment Exploration	Concept Invention	25 - 30 minutes
Summit to the Sea	Application	15 -20 minutes
Sandy Shores	Application	15 minutes
Forests & Shores	Application	15 minutes
Reflection	Reflection	5 minutes

Appendix Contents

Appendix I Instructor Support	Appendix II Attached Lesson Materials
Glossary Common Questions	Build-Your-Own Coastal System

Activities

Some of the activities in this lesson require some kind of dirt or sand and plant materials. If you do not have access to these, you may choose to skip these activities or use your judgement to use substitutes with materials you have on hand.

Naming Scientists

In the activities to come, students will learn about how different types of scientists study similar systems on Earth. To get students thinking about different types of scientists, students will start by being introduced to how different scientists are named as well as coming up with some of their own branches of science. Any time you read "**say that with me**" in this and the next activity, have the students repeat the **bolded word(s)** with you.

1. What is the first thing that comes to mind when you think about the ocean?

   Students will usually answer "dolphins," "turtles," "sharks," etc. with a few non-living things mixed in. Challenge your students to name multiple things before moving on.
2. All of those things are part of the ocean, *but,* most of those things are alive! As a scientist who studies the things that live in the ocean, you can be called a **marine biologist**. Okay, **say that with me**! Now, let's break that down: "marine" means something that is of the ocean, "bio" means life, and "-ologist" means someone who studies a particular field of science. So, all together, a "marine biologist" means someone who studies life in the ocean!
3. If an "-ologist" is someone who studies or knows a lot about a certain topic, we can all be "-ologists" of some of our favorite things. Name a few of your favorite things and then add the word "-ologist" to create a brand new field of science! Ask your student what questions they would try to answer as this newly named "-ologist".
4. Have students name things they love, like ice cream, soccer, bikes, crayons, etc, and then help them make a new silly scientist like a creamologist, ballologist, bikologist, colorologist, etc. *The goal is to get them laughing and having fun with learning how to name different fields of science!*

Sea Scientists

In this activity, students will learn how all different kinds of scientists can study the ocean, not just marine biologists! Read the following and have them answer the questions, creating a discussion with your students. Remember that any time you read "**say that with me**", have the students repeat the **bolded word(s)** with you.

1. Now, let's try and name some other types of scientists that study the ocean. What else can you think of that is part of the ocean that is *not* alive?
    a. *If students say "waves," "tides," "currents," or anything to do with the movement of the water, read #5.*
    b. *If students say "sand," or anything to do with the seafloor, read #6.*
    c. *If students say "wind," "storms," "sun," or anything to do with weather, read #7.*
    d. *If students say "water," "salt," "oxygen," or anything to do with the composition of seawater, read #8.*
    e. *If students say "scuba diving," "submarines," or anything to do with exploring the ocean, read #9.*
    f. *Have students continue to name things in the ocean until they have read all numbers #5-9, then read #10.*
    g. *If students struggle to come up with any of the above answers, simply offer suggestions and read the corresponding number, then read #10.*
2. Waves, tides, currents, and how seawater moves all fall under the category of **oceanography**! **Say that with me**. Breaking it down, "-ography" stands for any descriptive science. So, an oceanographer is what you are when you describe what is happening in the ocean!
    a. *Additional information:* Technically, there are many different types of oceanographers! The kind of oceanography described above is **physical oceanography**, which uses physics and math to study the complicated movement of water in the ocean. Other types of oceanography include **geological oceanography**, which is described in #6; **chemical oceanography,** which is described in #8; and **biological oceanography**, which is similar to **marine biology** (*Check out Appendix I for more on the difference between marine biology and biological oceanography*).
3. Just like the land has dirt, mountains, and valleys, the bottom of the ocean has sediment, seamounts, and underwater canyons! People who study these are called **marine geologists**. **Say that with me**. We already learned what "marine" and "-ologist" mean, so to figure out what part of the ocean a marine geologist studies, all we have to do is figure out what "geo" means! "Geo" stands for anything related to the ground or the earth,

including the earth at the bottom of the ocean. This type of science is also called **geological oceanography**.

4. The ocean and the weather are very connected! Weather influences how waves and currents move, and on the flip side, the ocean is so powerful and strong that by moving around warm and cold water, the ocean influences our climate! These are called air-sea interactions, and just like the weather people you see on the news telling you if it's going to be sunny or rainy, people who study these interactions are called **meteorologists**. **Say that with me**. We know what an "-ologist" is, and "meteor" means things that have to do with the atmosphere, or weather. So a "meteorologist" is someone who studies weather patterns!
5. Just like our life on land is made possible by the air, life in the ocean is made possible by the water! People who study the makeup of the water are called **marine chemists**. We know that "marine" means of the ocean, and a "chemist" is someone who studies how different substances are made up, how they interact, and how they change. So, a marine chemist is someone who studies the chemistry of the ocean, also called **chemical oceanography**!
6. Just like we need cars to explore the land and spaceships to explore outer space, we need submarines, scuba tanks, and remotely operated vehicles - like underwater robots - to study parts of the ocean that we can't swim to! And, we need **marine engineers** to make these devices for us. An "engineer" is someone who designs and builds machines or structures, so a "marine engineer" is someone who makes equipment that can be used underwater!
7. All of these are examples of people who study the ocean! So, although marine biology is the most well-known field of ocean science, it is just one of many ways people study the ocean. It's important to understand the ocean as a whole ecosystem, not just what lives there! In the next two activities, we will get to practice being oceanographers, meteorologists, and geologists!

Sedimentation Exploration

In this activity, students will get their hands wet learning about how sediment moves and settles in water. The definitions of the blue vocabulary words can be found in Appendix I.

1. Set up a space to learn with three tupperware containers (the largest you have available) and three cups. Preferably, this activity is done outdoors, but if that is unavailable at your home, make sure to set it up on a hard flooring or other area that could get a little wet.
2. Fill the three containers halfway with water.
3. Take the three cups outdoors and collect a small amount of dirt in each. Try to find three different sizes of sediment - fine silt, medium size ("typical" garden soil or sand), and

some coarse size (gravel or small rocks). If only one type is available to you, no worries - this activity can be done with one!

4. Have your student sit by the first tupperware with the cup of fine sediment and read the following:
    a. First, we're going to practice being marine geologists, and study the different types of sediment that can collect on the bottom of the sea!
    b. Many areas of the seafloor are defined by having really soft, fine silt. Think about if you've ever stepped into a squishy lake bed or mudflat! Go ahead and pour your cup of fine dirt into the first tupperware of water, and give it a few gentle swirls.
    c. What did you notice about how the dirt moves in the water? How does it settle? How does it affect the color or transparency of the water?
5. Leave the first tupperware and dirt where they are, have your student sit by the second tupperware with the cup of medium sediment, and read the following:
    a. Lots of marine environments have a sandy bottom, where the sediment isn't squishy or soft, but it's not made up of large sediment grains, either. Think about if you've ever walked on a beach and felt the sand between your toes. Go ahead and pour your cup of medium dirt into the second tupperware of water, and give it a few gentle swirls.
    b. What did you notice this time? How does the medium dirt move differently than the fine dirt? Does it settle more quickly than the fine dirt? How does adding this dirt affect how the water looks?
6. Leave the second tupperware and dirt where they are, have your student sit by the third tupperware with the cup of small rocks, and read the following:
    a. Still other areas of the seafloor is covered with more coarse sediment, made up of tiny rocks and shells. Think about if you've ever walked on gravel, or on a beach with lots of broken shells - ouch! Go ahead and pour your cup of small rocks into the third tupperware of water, and give it a few gentle swirls.
    b. What did you notice with the small rocks? How does it move differently than the fine or medium dirt? Does it stay floating for long, or does it sink? Does it have an effect on the water color?
7. Have the students pick one tupperware to sit by and read the following:
    a. Oceanographers, who we learned about in the first activity, can use sediment to tell how the different tides and currents move in a certain area. Now, you're going to be oceanographers!
    b. Let's pretend we're studying a calm part of the coastline. Imagine a white sand beach with small waves. Take your tupperware and lightly move it back and forth, creating small waves in your tupperware.

    c. Make a few observations! What happens to the sediment? Does it get suspended, or float, in the water, or does it mostly stay on the bottom?
    d. Let's pretend now that we're studying a rough part of the coastline, with big waves and strong currents. Take your tupperware and move it back and forth more vigorously, creating large waves.
    e. Make a few observations of the effects in your mini environments! What happens to the sediment now? Does it become suspended? Does the color, or transparency, of the water change?
8. Give each student a spoon and then read the following:
    a. Now, we're going to try being meteorologists. Let's pretend that a *huge* storm is coming towards your little coastline! Your water and sediment system starts to feel the first bands of the storm, so pick up your spoon and give the water a little stir!
9. While the student is stirring the water, collect another cup of dirt. Then, read the following:
    a. The storm finally makes its way to shore! A huge downpour of rain hits your coastline, and the wind blows the water all around. Stir the water faster with your spoon!
10. While the student is stirring, slowly pour the second cup of dirt into the water, then read the following:
    a. It seems like the rain washed more sediment down through the rushing river into the ocean! What do you notice about the quality of the water now? What do you notice about the transparency of the water?
    b. As meteorologists, we can use measurements like turbidity, or how transparent the water is, to tell us how rough a certain area of water has been recently! It's easy to tell when a strong storm has blown through, because water turbidity increases, which means that there is lots of mixed-up, suspended sediment in the water that makes it less transparent.
    c. We just saw how extra sediment can get washed down rivers into the ocean during big storms. Let's move on to the next activity to see how sediment is washed from the mountains to the ocean!

Summit to the Sea

As we just saw in our last activity, water can move loose sediments around a lot! This is happening on land as well as in the sea, and rivers provide an important link between the two ecosystems. In this activity, we will explore how rivers bring terrestrial sediments into the ocean.

You will find river, mountain and ocean paper models in Appendix II - Attached Lesson Materials

1. For this activity, you can either use dirt from your first experiment, or get a small cup of sugar from your kitchen.
2. Collect three books to make your mountain to river system with. Place them on either the floor or a table - this activity can be done on either!
3. Help your students cut out the river, mountain, and ocean paper models in Appendix II.
4. Fold the corners of the ocean along the dotted lines and tape them together to make a rectangular box.
5. Fold the mountain along the dotted lines and tape the two ends of the triangles together to make a pyramid.
6. Place the mountain on top of one book, and place the ocean next to it on the ground.
7. Fold the edges of the river lengthwise to create a small slide. Place the bottom of the slide inside the ocean, and rest the top of the slide on the book next to the mountain.
8. Read this information to your students:
    a. Most of the sediment in the ocean comes from land-based sources. To learn about marine sediments, we have to start by knowing where they come from! In front of you, there is an imaginary mountain with a river flowing into the ocean. What do you want to name your river?
    b. Now, your river is constantly bringing sediment to the sea, as the minerals and dirt on the mountain and forest erode over time.
    c. Let's pretend that your river is a pretty small one - maybe even a stream. Let's see how much sediment will make its way into your ocean from a small stream and a not-so-tall mountain! Take a spoonful of dirt and place it gently at the top of your river, right by the mountain. Does the whole spoonful of dirt slide down into your ocean, or is some left in the river? How long does it take for the dirt to make it from the mountain to the ocean?
    d. Now, let's imagine that your river is a larger river, like the Umpqua River in Oregon. The Umpqua River is a small mountainous river system, so though it is bigger than your stream, it's still a smaller river. Place one more book under your mountain, and place another small spoonful of dirt at the top of your new river! Does all of this sediment make it to the sea? Does it slide faster or slower than in your stream?
    e. Lastly, let's imagine your river is a huge river, like the Columbia River in between Oregon and Washington State! Place one more book under your mountain, so your mountain is tall on three books and your river is steep! Place a small spoonful of dirt at the top of this new river, and make some observations! What changed when we made the rivers "bigger" by making them steeper? How much dirt ended up in your ocean?

Forests & Shores

We humans can make big changes to how both ocean and forest ecosystems work and interact by removing parts of these systems. There are lots of things that we use every day which are made from natural resources, or things that we take from nature. Can you think of any examples?

> *Students may list things like water, food, minerals, etc. This activity focuses on the environmental effects of logging, so if the students don't come up with 'trees', 'paper', etc. guide them towards these items*

Paper is a big resource we rely on every single day! Some of the paper we use is recycled from old paper, but a lot comes from new trees. We also use trees for building houses, boats, furniture, and other important items. To get all this wood, trees are removed from forests. This is called logging. In this activity, we'll explore the effects that logging can have on the ocean.

1. First things first, we're heading outside! Help students to collect some loose soil, enough to make two small mounds.
2. Next, students need to collect some plant matter. This could be dead leaves, lawn clippings, weeds pulled from the garden or sidewalk, whatever you have available! Alternatively, a chunk of sod with roots intact and soil left tangled in the roots could also be used, if you have access to ground you can dig. Plastic mesh or cheesecloth can also be used as a substitute for plant material.
3. Empty out two of your tupperware containers from earlier if you have not already. Have students make two piles with the dirt they've collected; one of just dirt (representing a logged forest) in one container and one with the plant material mixed into the dirt (representing an unlogged forest with the roots of trees still growing through the soil) in the other container, and gently pat down their piles. These will be their coastal "mountains"
    a. NOTE - *If using a chunk of sod, just make one pile of only dirt. The sod will be the other "mountain."*
4. Ask students which pile they think represents a logged forest.
    a. Why do they think that? What is different about the two piles?
    b. What do the plants in the one pile represent?
5. Read the following information to your students:
    a. Any time that it rains, some amount of sediment is going to be carried down the mountain by the water and into rivers, which will then take the sediment out to the ocean. It even affects solid rock, carrying away small pieces over time! This is a natural process called weathering.
    b. Which of the "mountains" you have constructed do you think will experience more weathering (lose more dirt) when it rains? Why?

6. Time to put your predictions to the test! Using a water bottle or other vessel, slowly pour water over each of the piles (if there are multiple students they can do this simultaneously).
7. Compare how the two piles responded to the “rain”. Which pile lost more sediment? (The pile of only dirt should be the one that loses a lot of dirt while the other pile should lose only a little bit.) Why did this happen?

Activity review:

This model shows us how important the roots of plants are for keeping the top layer of soil in place! If a forest, especially one in a steep, mountainous area, has lots of trees removed by logging, lots of sediment will run off into rivers, streams, and eventually the ocean. This sediment will settle onto the bottom, but as we saw in our second activity, it can take a while for sediments to settle.

- How might animals that live in rivers and the ocean be affected when there is a lot of sediment in the water? Imagine what it would feel like if there were lots and lots of dust in the air.

Aquatic organisms can get hurt when there is a lot of sediment in the water. It makes it hard to see, which makes it harder to find food. It also clogs their gills and makes it hard for them to get enough oxygen, just as you would have a hard time breathing with a lot of dust in the air. It’s important to log forests the right way and only take some of the trees, so that there are enough left behind that their roots can keep the soil in place! There are many different types of “-ologists” who study the best way to log forests.

Reflection

As you and your student are cleaning up, talk to your student about what you just did together. Here are some guiding questions to help shape your conversation.

- ➢ What was your favorite part of our activities today?
- ➢ What is something that you learned about sediments and water?
- ➢ Did you notice any patterns during our activity today?
- ➢ What is something you wonder about what we did today?
- ➢ What surprised you the most during our activities today?

Appendix I - Instructor Support

Glossary

- Anthropogenic - caused by humans or their activities.
- Erode - the gradual process by which hard-packed dirt and rocks wear away, often forming new sediment.
- Fluvial - deposited by a river or stream.
- Logging - activity of felling trees to cut and prepare the timber.
- Marine - used to describe something that is of, in, or related to the ocean.
- SARs - sediment accumulation rates. This describes the rate - an amount of sediment over an amount of time - of sediment being deposited in a certain area.
- Sediment - any particulate matter that can be transported by the flow of water and is eventually deposited as a layer of solid particles on the bottom of a body of water. Sand, dirt, mud, and silt are all examples of sediment.
- Suspension - sediment is "suspended" in the water column when it is disturbed by a current and "floats" in the water momentarily before sinking back down to the bottom.
- Terrestrial - used to describe something that is of, on, or related to dry land.
- Transparency - (in this context) degree of clearness or cloudiness of the water.
- Turbidity - the term scientists use to describe the amount of sediment suspended in the water; also related to transparency of the water, or how clear or cloudy the water is.
- Weathering - wearing away. The slow breakdown of rocks and soil.

Common Questions

What's the difference between marine biology and biological oceanography?

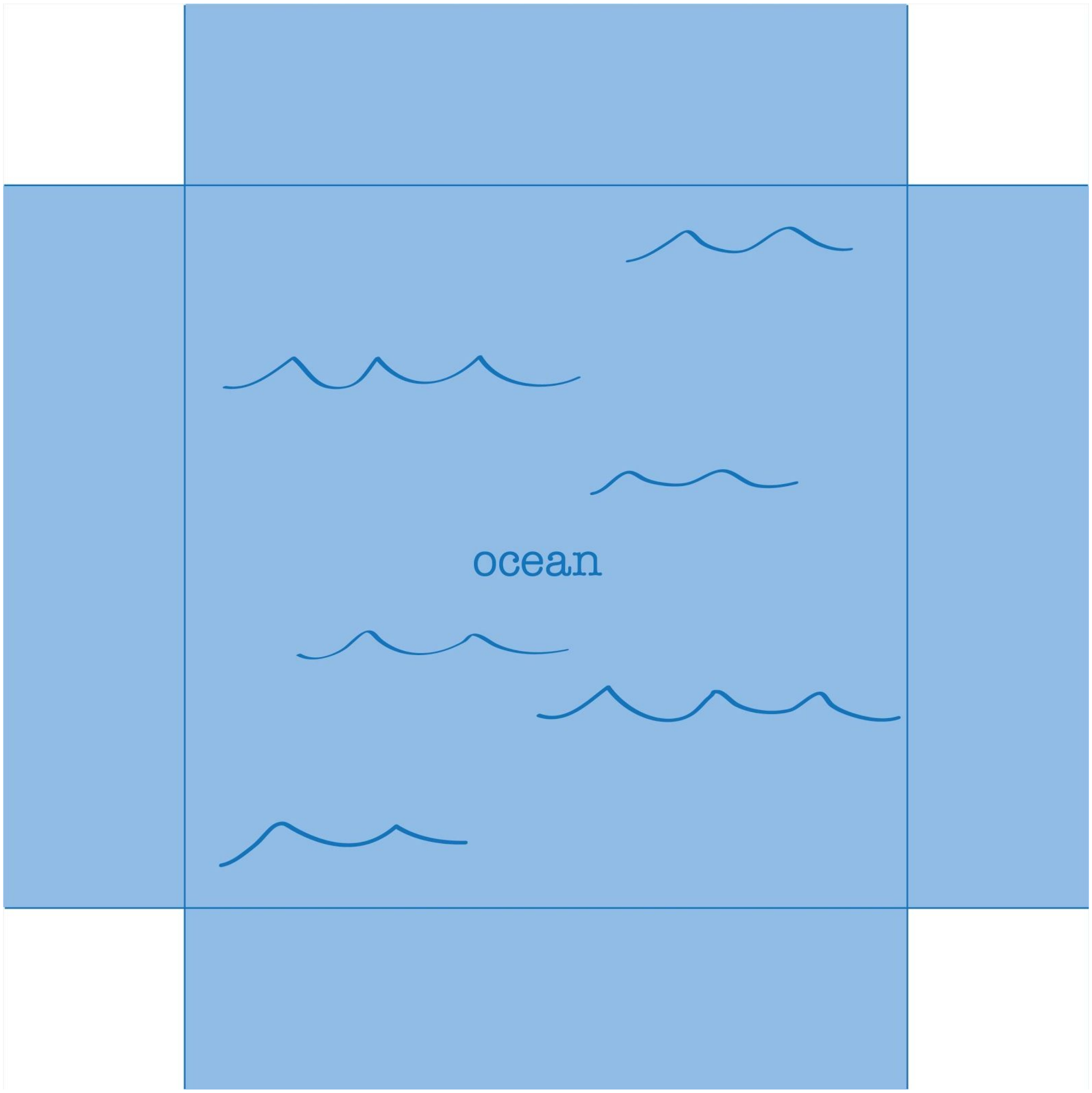
Marine biology and biological oceanography both study the living organisms in the ocean ecosystem, but study them in different ways. Marine biology typically emphasizes learning about the living organisms, while biological oceanography looks at how those organisms interact with the nonliving parts of the ecosystems like ocean currents, water chemistry, etc. Both approaches are very important to learn about all of the mysteries that are held in the ocean.

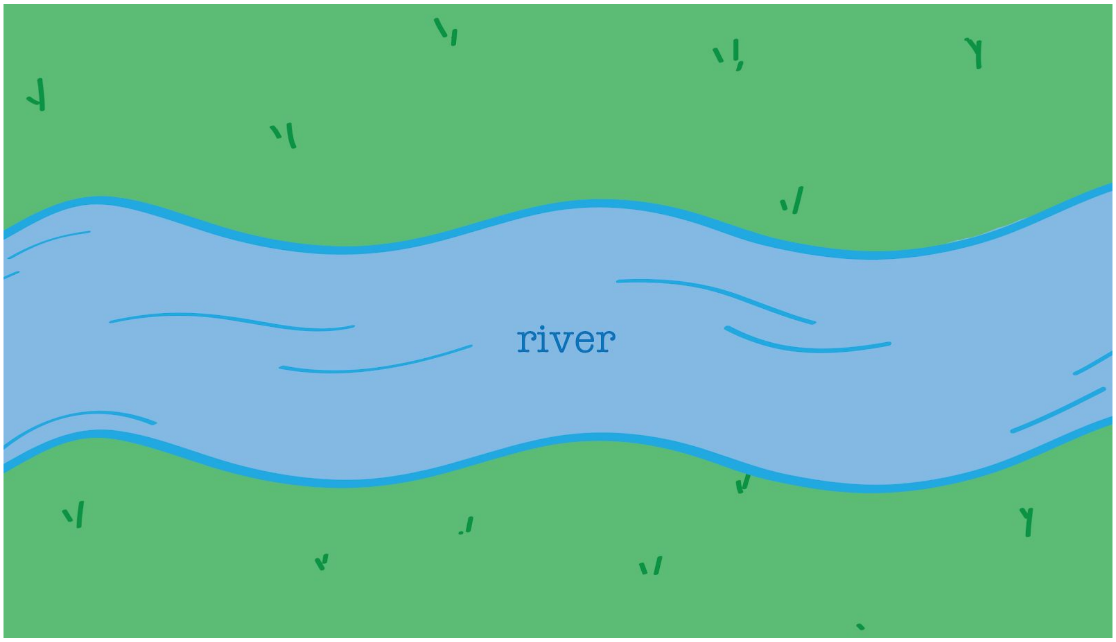
How do scientists measure sediment?

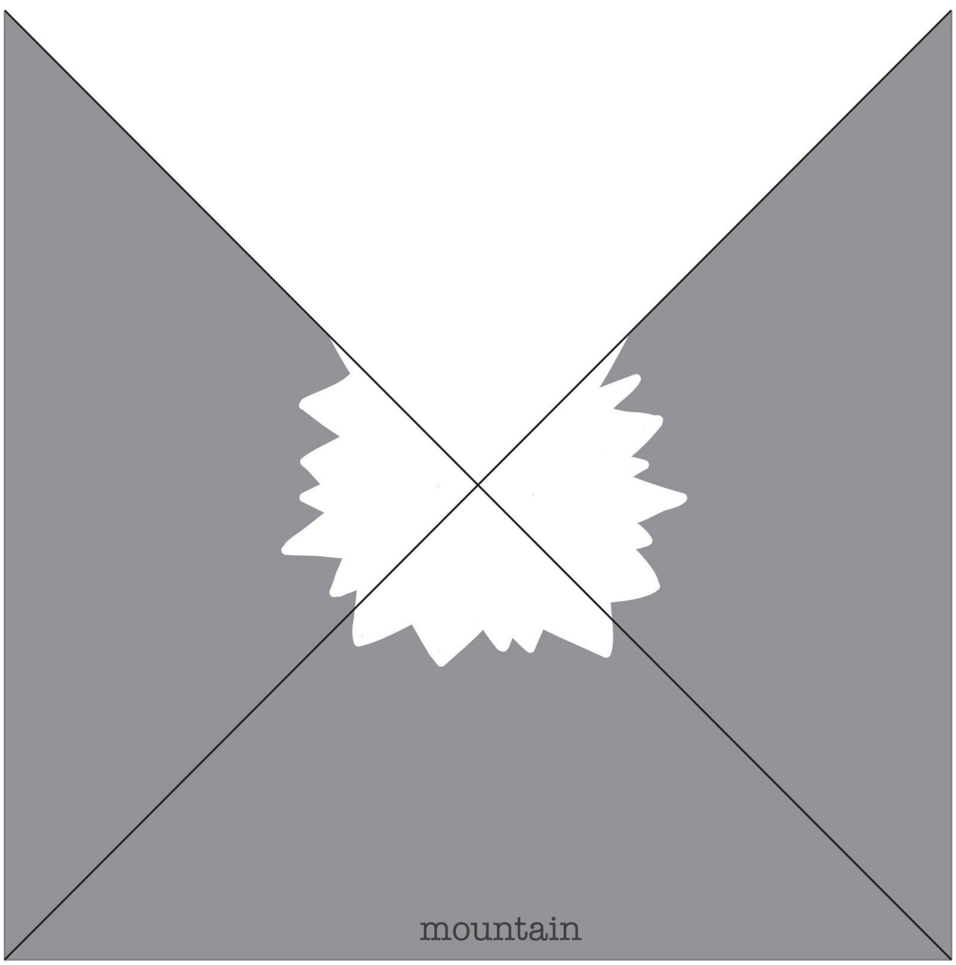
Marine geologists and geological oceanographers study and quantify patterns of sediment accumulation rates (SARs - see definition above) to determine how much sediment is dumped into the ocean from rivers, and how it is shifted by ocean movements. One way they can do this is by using radioactive isotopes in the sediment to see how old the sediments are and how long they have been in their current location. This is another one of the "-ologies" called **geochronology**.

Appendix II - Attached Lesson Materials

Build-Your-Own Coastal System Cutouts




river


mountain