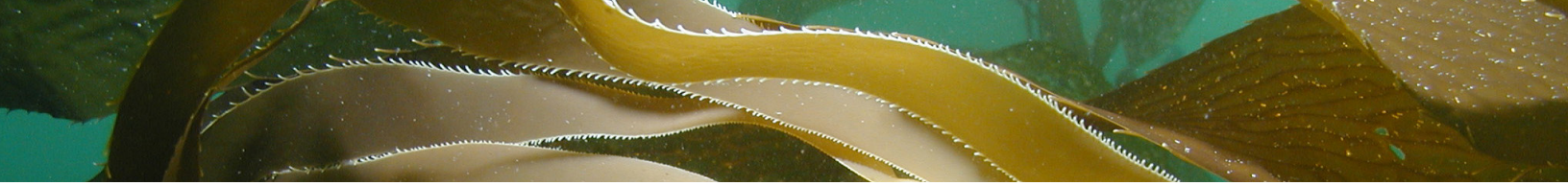
Sea Grant
University of Southern California

Unit One: What Is The Ocean?

Students are usually fascinated with the ocean making it an ideal theme through which to introduce many aspects of science and other disciplines. The vastness and unknown inhabitants of the ocean excite and stimulate student interest! Before we begin this curriculum, we will start by finding out what the student knows and "warming them up" to the subject. A variety of assessment exercises, as well as a fun investigation of their favorite marine animal are the main ways this is done.

Then as we move into Unit One activities we start from the bottom, literally! Students are introduced to basic geology and plate tectonics so they have an understanding of how oceans form. The ocean floor can vary from smooth sandy bottoms to massive canyons and mountain ranges. In addition, coastlines and beaches form and change. Students will not only gain a basic understanding of these topics, but also learn how to map and present this information.

Once the structure of the ocean is completed we start filling the ocean basin with water and investigate its unique nature. Waves, currents and tides are a major part of understanding how the marine environment works. Students will also investigate the special nature of water, sea water in particular. By participating in a variety of activities which focus on these topics the students will gain an appreciation and understanding of the physical aspects of the ocean. Then they will be prepared for Unit 2, to learn about "What lives in the ocean"!



Lesson 1: Exploring Ocean Features

2 - 3 days

Concepts & Objectives

QUESTIONS

- What does the land under the sea look like?
- How do we show land forms on a map?

UNDERLYING CONCEPT

Underwater topography can vary widely, from smooth slopes to elaborate canyons, valleys, and mountains. This topography is not visible at the ocean surface and is usually too deep to easily explore, therefore scientists have created special measuring methods to map the ocean bottom.

SKILLS

- Using a grid
- Problem solving
- Measuring

METHODS

Students will create an “ocean bottom” in a shoe box and use measuring skills to decipher what the underlying structures look like when not visible (from the ocean surface). Additionally, students will use this model in an activity in which they will create simple topographic maps.

Vocabulary & Background

VOCABULARY

- bathymetric mapping: the measurement of depths of water in oceans, seas, and lakes
- continental shelf: the under water border of a continent or an island
- sea mount: a high hill under the sea
- island: land surrounded by water and smaller than a continent
- trench: long cut in the ground
- volcano: a hill or mountain composed wholly, or in part, of ejected material from within the earth. This material is often, but not always, in the form of lava.

BACKGROUND INFORMATION

Sea floors have a variety of features including smooth gradual slopes, mountain ranges, volcanoes, trenches, and sea mounts. On the east coast of the United States the continental shelf generally extends in a gentle slope under the ocean, however the West Coast, especially off of Southern California, is quite different. Here the near shore land under the sea contains deep submarine canyons, underwater mountain ranges, deep trenches and valleys. The submarine canyons look like canyons cut by rivers on land....which they once were! Although Catalina Island is only 21 miles across the San Pedro Channel from the Southern California coast, deep trenches and canyons in the Channel might reach 490 fathoms (2940 feet)...or over a half-mile deep! The underwater topography of this area is complex and fascinating. Since most students think of a simple sloping sandy bottom under the ocean, it is helpful for them to understand the variety of land forms possible, in terms of geological and geographical knowledge, as well as potential habitat variations.

Measuring and mapping the land under water is called bathymetric mapping. Prior to the 1920's oceanographers measured the depth of the ocean using long lines with weights attached that were marked at regular intervals (meters or feet) with knots. The lines were lowered into the ocean until the weight touched the bottom and the depth was noted by the knot mark. Currently, oceanographers use sonar, or sound waves, to measure the ocean bottom. Sound waves are sent from the bottom of a ship toward the ocean floor. By measuring the time it takes the sound to return to the ship (received by a recording device), the ocean depth can be calculated because the speed at which sound travels through water is known (1,454 meters per second). In the following activity the student will do some simplified versions of bathymetric mapping using "depth lines", as well as some simple topographical mapping.

Activity 1: Shoe Box

Review different types of ocean features or introduce them by direct instruction/discussion.

- What is an island, a trench, a sea mount?
- Where are these features located in the ocean?
- If you were an oceanographer, how would you know where these features were located?

ACTIVITY STEPS

1. Using clay or modeling putty, students will work in small groups to construct an ocean bottom inside a shoe box. They need to include at least three different features.
2. When construction is completed, students should cut a card board lid to fit the top of the shoe box.
3. Students draw lines one inch apart on the card board lid in two dimensions to create a grid pattern.
4. Next, tape the lid on top of the shoe box so that other groups cannot see their features.

5. Students will exchange their shoe box for a shoe box from another group to prepare for Part II of this activity. USC Sea Grant Island Explorers
6. Students will create holes at each 1" intersection along one line of the grid pattern. Insert a pipe cleaner ("depth line") into the holes to determine what "the ocean floor" in the shoe box looks like by calculating how deep they can extend the probe. They will be able to decipher various heights of the "underwater topography." They will draw on paper their idea of the shoe box "ocean floor" based on the information on the probes. (Multiple lines of the grid can be probed to get a three-dimensional picture of the ocean bottom.)
7. Remove the lid of shoe box to see if their drawing matches the contour in the shoe box.
8. Return the shoe box to the group which created.
9. Save shoe box ocean floors for topographical mapping activities.

* Note: Students should understand that not every area can be measured and therefore need to create an efficient design for measuring. (This simulates real world scientific research.)

Activity 1: Topo Maps

Create topographical maps from the previous activity.

ACTIVITY STEPS

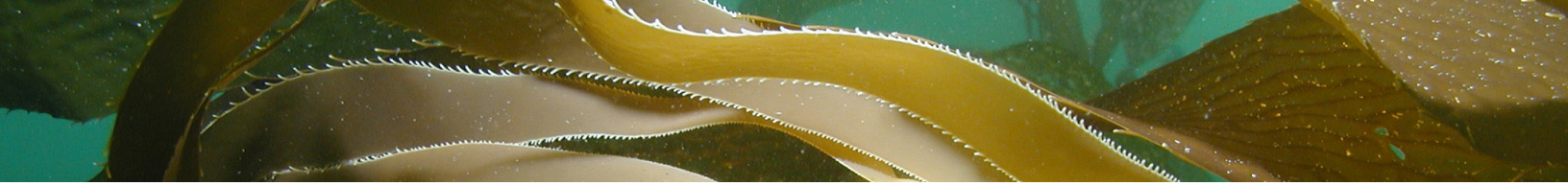
1. Place clear plastic overlay to top of shoe box
2. Pour colored water to depth of 1" and trace the "contour lines" of the water onto the overlay.
3. Continue to add water 1" at a time until they have drawn a simple contour map at 1" intervals.

Extensions

Have a topographical map of Catalina Island (or any topographical map of an area they know or will be visiting) and a list of features to identify. Have students identify valleys, mountains, hills, etc., on the topographical map. Or they can make their own list of formations that they can identify on the map.

INVESTIGATIVE THOUGHTS & QUESTIONS

How can one tell if a feature on a topographic map is an incline or a decline? (Students should study a topographic map to find the answer)



Lesson 2: Sand and Soil Studies

1 class period

Concepts & Objectives

QUESTIONS

- Where does sand come from?
- How is it the same or different from soil?

UNDERLYING CONCEPT

Sand is created from the break down of larger rocks. The type of sand present, for example at a beach, is determined by the geological make-up of the region..

SKILLS

- Observing
- Problem solving
- Measuring
- Comparing

METHODS

Students will collect different samples of sand and soil. They will perform a variety of tests on these samples to learn more about them, especially, how they are alike and different.

OBJECTIVES

Students will be able to:

- Observe various fragments and particular make-up of sand
- Determine if iron is present in a sand sample
- Compare sand and soil samples

MATERIALS NEEDED

- Samples of coastal sand from a local area
- Samples of topsoil from a school yard
- Black or white construction paper depending on samples
- Hand lenses
- A quart jar and lid
- Water

- Magnets
- Scoop or large spoon
- Pen or pencil
- Activity Sheet 1 and 2

Vocabulary & Background

VOCABULARY

- sand: Particles smaller than gravel, but more coarse than silt. Materials are from disintegrated rocks
- soil: The upper layer of the earth which may be dug or plowed and in which plants grow.
- erosion: The process through which a material is gnawed away.

BACKGROUND INFORMATION

Most beach sand is made up of the mineral quartz. It may also contain pieces of broken shells. Sand starts out as large mountain rocks. Erosion by wind and water causes the rocks to be broken into smaller rocks. Over time these smaller rocks wash down rivers and streams until they reach the shore. While soil may contain some sand, it also contains other materials (clay for example) and organic matter which allow plants to grow.

Activity

Create a concept map about the beach, where students can express and organize prior knowledge. This can be done in small groups or as a class. (For further information and examples of concept maps, check out this URL in World Wide Web: www.seagrant.wisc.edu/earthwatch/Teachers/Teacher2. Link to Who We Are click on Education then you will arrive at What is Concept Mapping.) Next, students should create another concept map about the soil.

ACTIVITY STEPS

1. Tell students that they will be exploring an important feature of the beach (sand) and compare and contrast its contents to school soil.
2. Distribute black paper, a hand lens, Activity Sheets 1 and 2, and a smallsample of sand to a group of two students.
3. Have the students pour some of the sand onto their hand. Describe what it feels like.

What it smells like.

4. Next, spread the sand sample on the black construction paper. The black paper provides a nice contrast so students can observe the particles more closely. If the sand sample includes many dark particles, you may want to use a different color paper.
5. Observe particles by noting sizes, shapes, and colors and record on Activity Sheet One. They can also do the following exercises and questions:
   a. Heavy minerals with iron in them will be attracted to a magnet. Touch a magnet to the sand. Are the grains of sand attracted to it?
   b. Look at the grains in a magnifying glass. Do they look the same?
   c. Shell fragments are often more rounded and less jagged-looking. Do you see a shell fragment in the sand? Draw the grains of sand.
   d. Gently blow on the sand. When breezes blow on the beach, what do you think happens to the sand?
   e. Put about 1 inch of sand into a jar. Fill the jar with water, put the lid on tightly, and tip the jar. What happens to the sand?
   f. Shake the jar and watch the sand. This shaking is similar to the constant motion of the waves in the ocean. What happens to the sand?
6. Students should obtain a sample of soil from the school yard and observe various soil particles using the same hand lens and recording this under school soil on Activity Sheet 1.
7. After sand and soil has been investigated, students can complete a Venn diagram comparing and contrasting the two samples on Activity Sheet 2.

DISCUSSION

Students should share their observations and Activity Sheets with the class. The teacher may want to engage in a short discussion using a variety of questions that require students to think critically and make important generalizations about the make-up of sand in their area and how it compares with soil on their school campus.

EVALUATION

- Observation skills from Activity Sheet One.
- Venn diagram comparing and contrasting sand and soil samples (Activity Sheet Two)
- Cooperation and participation with partner.

Extensions

Compare different sand samples from diverse beaches in different states. Use sieves to separate particles from sand that contains shells and larger matter in addition to sand grains.

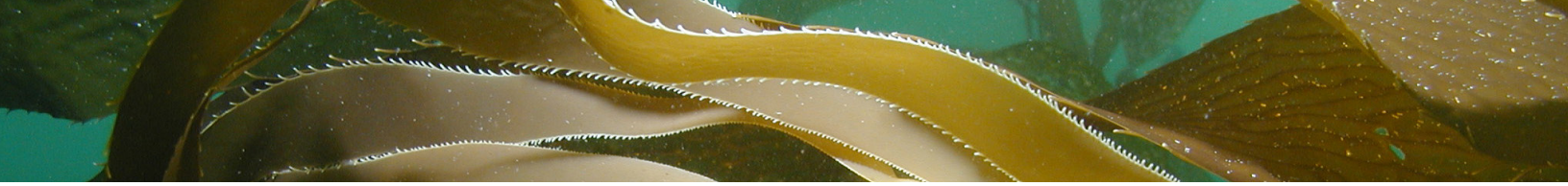
Activity Sheet : Comparing Beach & Sand Topsoil

Use a hand lens to observe soil particles.
Record observations below; size, color, and shape of particles.
Draw pictures when necessary.

	Beach Sand	School Sand
Colors		
Shapes		
Sizes		
Once-living matter		
Other important features found		

Activity Sheet Two: Comparing Sand & Topsoil

What notable differences exist between the soil from the beach and school?
Why do you think there soil types are so different given their position on land?
What additional questions do you have about soil?



Lesson 3: Ride The Waves

20 minutes

Concepts & Objectives

QUESTION

How do waves move across the ocean surface?

UNDERLYING CONCEPT

- The water in any given wave moves up and down, but it doesn't move forward.
- The wave's energy, not the water's is transferred along.

SKILLS

- Modeling
- Labeling
- Measuring

OBJECTIVES

Students will be able to;
- Make a human model of ocean waves
- Use the model to demonstrate how waves behave

MATERIALS NEEDED
- Picture or video of waves

Vocabulary & Background

VOCABULARY

- Crest: The highest point of a wave
- Trough (trawf): The lowest point of a wave
- Wavelength: The distance between two wave crests or troughs
- Wave height: The distance from a wave's trough to its crest

BACKGROUND INFORMATION

Most waves are caused by winds blowing the surface of the water. How long the wind blows,

how hard, and over how big of an area all affect the size of the waves it will produce. Most waves are less than 4 meters (12 feet) high, but much larger waves can form during severe storms.

The highest point on a wave is the crest, and the lowest point is called the trough, as shown here.The distance between two crests is the wavelength. The distance from the trough to the crest is the wave height.

When waves reach shallower regions, the wave troughs drag along the shoreline, but the crests keep going. As a result, the waves jam up, shortening their wavelength and increasing in height. At some point, the wave becomes too tall to hold itself up, and it curls over or "breaks" on the shore.

Underwater earthquakes and volcanoes can result in long, high-speed waves called tsunamis. (These waves are sometimes called tidal waves, although they have nothing to do with tides.)

Such waves can have a wavelength measuring 160 kilometers (100 miles) and speeds up to 800 kilometers per hour (500 miles per hour). Since tsunami's wavelength is so long, the time between waves hitting the shore can be as long as 15-20 minutes. In the open sea, these waves may be only a half-meter (1.5 feet) tall, but when they build up along a shoreline, they reach heights over 30 meters (100 feet) and have great destructive power. Tsunamis occur most often in Japan, Hawaii, and Alaska, due to earthquakes and volcanic activity in the Pacific Ocean.

Activity

INTRODUCTORY QUESTIONS

- Have you seen waves at the beach or in a lake?
- What do you think causes waves? *Wind, earthquakes*

ACTIVITY STEPS

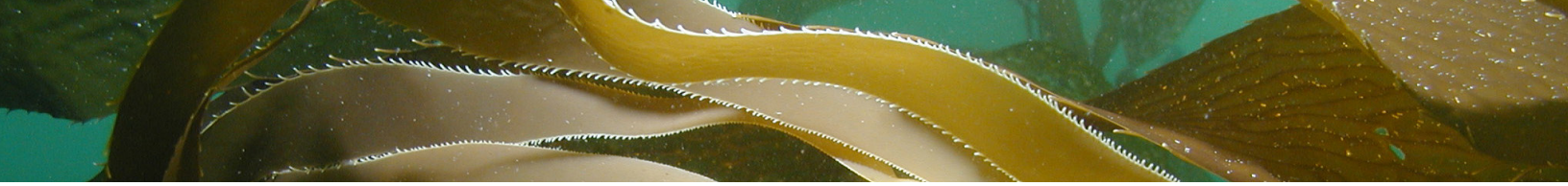
1. 1. Line up your students, side by side, in an open space where they are free to move. Ask them if they have seen people at a sporting event move in sequence to make a "wave." (The first person starts in a crouching position, then stands, reaches high, and crouches down again. Each subsequent person before them in line has partially completed the motions. The result is a rippling wave that runs down the line.) Invite the class to try it. Tell them that they have just become a model of ocean waves.
2. Have the class try different variations, such as fast, slow, high, and low. You might set up scenarios, such as having them imagine a storm is raging at sea, which would suggest that they make fast, high waves.

3. Have them create a wave, and then freeze the motion while you point out different parts of the wave, as described in the Background information (crest, trough, wavelength, wave height). You might have the class line up along the chalkboard, trace the shape of the wave and label it. Have a volunteer make some rough measurements as your wave model tries out different wavelengths and wave heights.
4. Ask: Have you ever noticed that as you make your wave movements, you don't move along sideways? How is that similar to the way an ocean works? Help students see that the water in any given wave moves up and down, but it doesn't move forward. The wave's energy, not the water, is transferred along.
5. Finish the modeling activity by exploring why waves break on the shore and splash up on the beach. You might have students at one end of the line try it by standing on a slightly raised ground (best done outside), crowding the line closer together, reaching the wave crests higher and tipping over (carefully!)
6. Have students make a labeled sketch of a wave. Close by showing the class dramatic pictures or a video of waves in motion, or by demonstrating wave motion in a large shallow pan of water. Float a few small objects remain in position rather than move in the direction of the waves.

Extensions

- Demonstrate how a wave works by having two students hold opposite ends of a long rope and ripple the rope to make waves.
- Invite students to find out more about big waves produced by severe winds.

Adapted from Oceans



Lesson 4: The Moon and Tides

55 minutes

Concepts & Objectives

QUESTION

How does the moon's path affect the tides?

UNDERLYING CONCEPT

Tides are caused by the gravitational pull among the sun, moon, and earth. The size of the tides depends on where the sun and moon are in relation to the earth.

SKILL

- Observation

OBJECTIVE

Students will:

- experience with movement the relationship between the moon and the high and low tides.

MATERIALS NEEDED

- None

Vocabulary & Background

VOCABULARY

- Tide: The periodic rise and fall of the ocean's water level due to the pull of the gravity from the sun and the moon.
- Low tide:The two points in the day when the ocean's level is lowest.
- High tide:The two points of the day when the ocean's level is highest.

BACKGROUND INFORMATION

Tides are caused by a gravitational tug-of-war between the sun, moon, and earth. All objects

exert gravitational pull on each other. The closer they are, or the larger they are, the greater the pull. All of the planets exert some gravitational pull on the earth. However, the pull of the moon and sun are most noticeable because the moon is so close to us and the sun is so big. It takes the earth 365 days to revolve around the sun. As it revolves around the sun, it spins, or rotateson its axis once every 24 hours. At the same time, the moon revolves around the earth once every 29 days. The gravitational pull of the sun holds the earth in orbit, while the gravitational pull of the earth keeps the moon in orbit.

As a result of this gravitational attraction between the earth and the moon, the side of the earth facing the moon is pulled towards it. Solid objects like the ground and buildings are not distorted as much as liquids like the ocean. A bulge of water occurs on the side of the earth facing the moon. As the earth rotates around the sun, centrifugal force causes an equal bulge of water on the opposite side of the earth. Water is pulled away from these two sides of the earth to form these bulges, or high tides. This leaves a depression, or low spot, in the oceans between. These are the areas of low tides.

Most areas of the earth have two high tides and low tides every day. These high and low tides are slightly more than 6 hours apart. In some areas, the high and the low tides are the same. However, the earth is tilted on its axis, so the bulges are sometimes unequal. Because of this, in the Southern California region, one of the high tides each day is higher and one of the low tides each day is lower than the other. It depends on where you are located in the earth's surface whether your high and low tides are semidiurnal (the same tide twice a day) or semi-diurnal mixed (different tides twice a day).

Activity

INTRODUCTION

- Teacher should begin with a discussion of high and low tides.
- How many of you have been to the beach at high and low tides?
- What did you notice about the seashore? *(more rocks, area, and animals can be seen when the tide was 'out' or low, waves and water were further up on the beach when the tide was in or high…)*
- Ask for students ideas on what high and low tides are, and why they occur.

ACTIVITY STEPS

1. Have the class form a circle in a large area. This could be in the classroom, on a lawn, or if necessary, on the playground.
2. The ideal way for students to sit is crossed-legged with hands holding the next person's elbows to form a strong circle. If the class is reluctant to touch, have them kneel "knockkneed" next to each other in a circle.

3. One person is the moon and moves around the outside of the circle. The circle is the waters of the earth. As the moon passes behind the students (water), the waters bulge (lean) toward the moon, and then into the center as the moon passes. As the moon moves, have the students that are opposite the moon lean away from the moon (this represents water bulging out on the opposite side of the earth) and then have them lean into the center as the moon passes.
4. Have the moon stop, and let the class see where the high tides are (next to the moon and at the opposite side of the circle). Then the moon continues to circle. Have the moon stop at several points in the circle and let the class see where the high and low tides are in relation to the orbit of the moon. (Low tide will be at the sides halfway between the high tide bulges.)
5. The moon can then circle the earth several times so the rhythm of the passing of the moon and the bulging of the waters is experienced by the class. Before ten minutes are up, even first and second graders have a feel for how the moon affects the tides.

Extensions

- Have the students make suggestions as to other forms this activity can take.
- Check out the daily tides in the newspaper or on the web and graph their heights for a month.

Background information adapted from the Los Marineros Curriculum Guide (1995), published by the Santa Barbara Museum of Natural History (805) 682-4711