# Ocean Floor Features

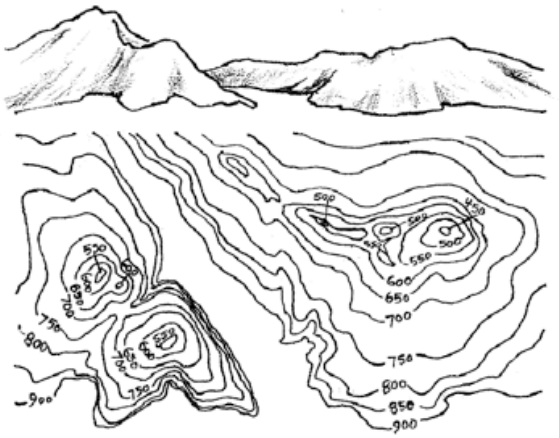
(created by Ardi Kveven, Snohomish High School, Snohomish, WA
and Veronique Robigou, University of Washington)

## Key Concepts

Geologists recognize and have named a wide variety of physical features typical of the earth's ocean floors.

Latitude and longitude provide directions to locate features under the ocean.

Each ocean feature is formed by specific geological activities.



## Background

This lesson comes in two parts. In the first, students label physical features in an imaginary ocean in order to get familiar with typical sea floor structures. In the second, students look for selected features on a real map of the ocean floor. They practice using latitude and longitude to locate the features, a skill that will be useful in later lessons that involve mapping hydrothermal vents. Finally, and most difficult, they use symbols on the map to decipher what geological activity has formed each ocean floor feature.

The real ocean floor map provided with this lesson describes the major sea floor features and the geological activity taking place at each. For additional background information on plate tectonics and terms such as spreading, subduction and faulting see Slippin' and Slidin'- Plate Tectonics and/or The Ocean Floor. Both of these lessons provide more detail on the mechanisms of plate tectonics.

## Materials

Part One: OCEAN FLOOR SNAPSHOT
For each student or team of students:
- Ocean Floor Snapshot
- Student pages (see Teaching Hints for ways to reduce paper use)

Part Two: THE REAL OCEAN FLOOR
For each student or team of students:
- Ocean Floor Map provided in this lesson or any other similar sea floor map (see Teaching Hints for titles and ordering information for commercial sea floor maps)
- Student pages (see Teaching Hints for ideas for ways to reduce paper use)

## Teaching Hints

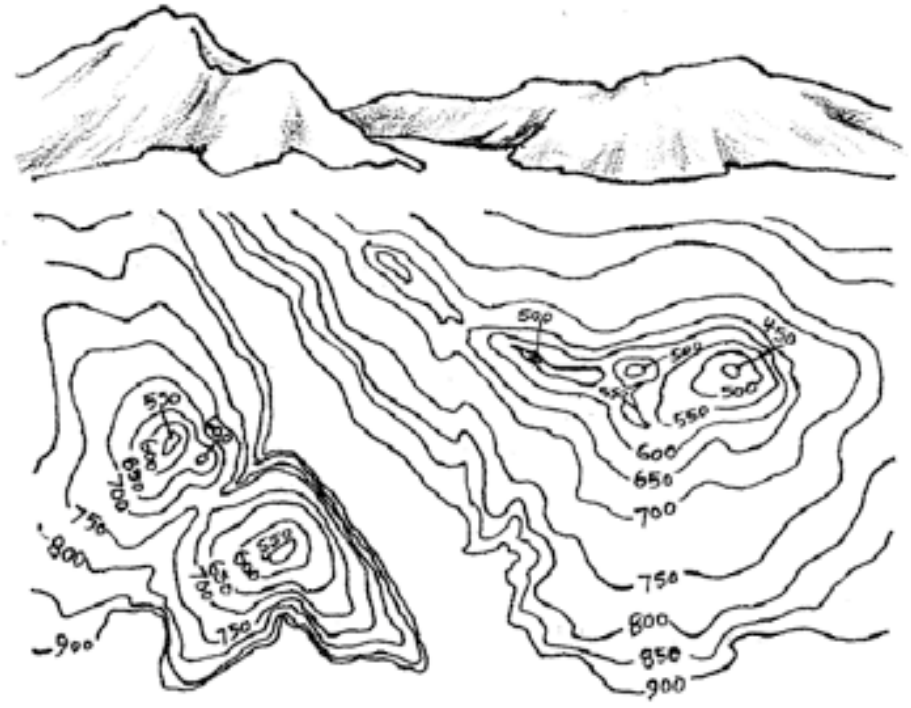
Part One, in which students label features on a generic image of an ocean floor, works best if each student is responsible for labeling a snapshot which he or she may use as a reference later. Allow students to help each other find the structures they need to label.

Part Two, on the other hand, may best be done in student teams. Provide each team with an ocean floor map and allow them to work together to find real ocean features that match some of those from their ocean floor snapshot.

If you wish to avoid photocopying the student pages try the following: For Part One, provide on a chalkboard, poster or overhead transparency the list of features the students are to label on their ocean floor snapshot. The only paper you will need to provide is the Ocean Floor Snapshot. For Part Two, create a transparency of the Ocean Floor Features Table and have the students create a table on their own paper. Model for them how to fill it in. You only need to copy the Real Ocean Floor Map for each team of students or purchase maps for classroom use.

The National Geographic Society has produced excellent sea floor maps. Phone them at 1-800-NGS-Line or shop on the internet at their web site http://www.nationalgeographic.com to order an ocean features map. The selection varies and most cost between $5 and $25 each. Two possible maps to look for to purchase or to borrow from your library are “The Earth’s Fractured Crust,” April 1995 or “The Earth’s Dynamic Crust,” August 1985. These maps contain a wealth of information the students may use to identify the geological activity at work at each physical structure. Science supply catalogs typically offer ocean bottom maps as well.

# Ocean Floor Features




**1) OCEAN FLOOR SNAPSHOT- learning to recognize ocean floor features**

Obtain a copy of the unlabeled Ocean Floor Snapshot. Though this image shows an imaginary ocean, the features shown here are typical of those found in real ocean basins. You will be labeling this picture so that you may use it as a reference in interpreting real ocean floor maps.

2) Begin with the light colored areas. These areas are all above the water. Find these features and label them on your snapshot:

- Mountains
- Volcano
- Bay
- River
- River delta (an area where sediment carried by the river forms a fan)
- Coastal plain (the flat area all along the coast line at the land's edge)
- Island
- Volcanic Island (look for a crater at the island's peak)
- Island arc (several islands lined up in an arc)

3) Now take a look at the dark colored areas. These are all underwater. Find these features and label them on your snapshot:

- Abyssal plain (a large flat area on the sea floor)
- Mid-Ocean Ridge
- Fracture zones (these look like cuts across the mid-ocean ridge)
- Seamount (an underwater mountain standing alone)
- Guyot (another underwater mountain, but with a flat top)
- Trench (look carefully- trenches can be very deep, so they will be shown on the model as a dark shaded area)

## 4) THE REAL OCEAN FLOOR

Now, it's time to find on a map of the real ocean floor some of the ocean features you labeled on your snapshot, but this time you also will try to identify the geological activity happening at each one.

Obtain a copy of the OCEAN FLOOR MAP showing the earth's real ocean basins and a copy of the OCEAN FLOOR FEATURES TABLE. Fill in the table. An example is given below to get you started.

**For example**:

a) Find terrestrial mountains somewhere on your map. In the Ocean Floor Features Table below, write the name of the mountains you find and give their latitude or longitude so you or someone else can find them easily later.

The **latitude** lines run back and forth across the map. The equator is labeled as 0 degrees (0°). Anchorage, Alaska is just north of 60° north, about 62° north. Find the horizontal line closest to the mountains you have chosen and estimate the latitude.

The **longitude** lines run north and south, or up and down, on the map. London, England is at 0°. Chicago, Illinois is at a longitude of 88° west of the 0° line, so we say Chicago is 88° west. Find the longitude line closest to the mountains you have chosen and estimate their longitude.

In the example shown here, the student chose the Andes Mountains and estimated from the map their latitude and longitude.

| FEATURE | NAME | LATITUDE LONGITUDE | GEOLOGICAL ACTIVITY | WHAT IS HAPPENING ? |
|---|---|---|---|---|
| Mountains | Andes | 10°N - 50° S 70° W | | |

b) Finally, look at the symbols on the map at your mountain range. Find out from the map's key what those symbols represent. Write down the geological activity that formed the mountains.

c) In the last space in the table, describe in a few of your own words what is happening to form the mountains. Use the descriptions of geologic activity shown on the map to help you do this.

| FEATURE | NAME \ | LATITUDE & LONGITUDE | GEOLOGICAL ACTIVITY | WHAT IS HAPPENING |
|---|---|---|---|---|
| | | | Subduction | The ocean plate is hitting up against the continental plate and sliding below where it is melting and resurface in volcanoes. |

**Mountain**
Mountains may form where two plates run into each other and the enormous force of the collision folds and compresses the crust (see Collision Zone). They also may form where seamounts and islands are scraped from ocean crust by a continental plate riding over the top (see Accretion Zone). Some mountains are formed by subducted material erupting back to the earth's surface at volcanoes (see Subduction Zone and Volcano). Finally, some mountains form where molten material is surfacing through a Hot Spot (see Hot Spot).

**Mid-ocean Ridge**
The mid-ocean ridge is a vast system of underwater mountain ranges wrapping around the earth and stretching 74,000 kilometers or 46,000 miles. Hot magma seeps and erupts from cracks at the center of these vast ridges known as spreading zones.

**Spreading Zone**
Spreading zones occur along ridges where molten material rises through the ocean floor. This material cools and hardens and forms new oceanic crust. It pushes the existing crustal plate out away from the spreading zone.

**Trench**
Trenches are underwater valleys of phenomenal depth. The deepest, the Mariana Trench, is over 10,700 meters or 35,000 feet deep. Trenches are formed where an oceanic plate, with its dense crust, is sinking below a less dense continental plate in an area known as a subduction zone.

**Subduction Zone**
Subduction zones are areas with tremendous earthquake and volcanic activity as an oceanic and a continental plate meet and slide over and under each other. The less dense continental crust tends to scrape along the top of the oceanic crust. The ocean crust sinks below creating a deep trench. Eventually, the oceanic crust material melts back into molten material and may erupt from volcanoes further inland.

**Collision Zone**
Collision zones occur where two continental plates meet. Neither plate is significantly more dense than the other, so neither sinks. Instead, the two plates collide with tremendous force, usually sending up massive mountain ranges where one or both plates have buckled.

**Accretion Zone**
Sometimes, as continental and oceanic plates meet, the continental crust scrapes off islands and other crust formations from the oceanic plate on which they are riding. These new pieces of land end up attached to the continent, often extending coastlines hundreds or even thousands of kilometers out toward the ocean. The accretions themselves can be massive enough to form mountains or the force of the collision can fold crust material into mountains.

**Fault or Fracture Zone**
A fault zone is an area where two plates are sliding past one another. Earthquakes occur at faults as one or the other plate suddenly moves a few centimeters past the other plate.

**Hot Spot**
Hot spots are areas where molten material erupts from the earth's mantle through the crust. This molten material may form volcanoes or, if less violent, hot springs and geysers.

**Island Arc**
Island arcs form over hot spots. The first island of each island arc formed millions of years before the others as molten material erupted through the hot spot and cooled. The crustal plate gradually shifted and then new material erupted near the first island. This formed a second island. This process continues and develops an arc of islands, the youngest of which is the most volcanically active.

**Volcano or Volcanic Island**
Volcanoes are tall cones built by the eruption of magma, steam and other materials from the earth's mantle. They may form where subducted plate material resurfaces after melting or where hot spots allow molten material to surface. Volcanoes form on land and volcanic islands form in the ocean.

**SEA FLOOR FEATURES TABLE**

| | NAME | LATITUDE & LONGITUDE | GEOLOGICAL ACTIVITY | WHAT IS HAPPENING? |
|---|---|---|---|---|
| Mountains | | | | |
| Volcano | | | | |

| | NAME | LATITUDE & LONGITUDE | GEOLOGICAL ACTIVITY | WHAT IS HAPPENING? |
|---|---|---|---|---|
| Volcanic Island | | | | |
| Island Arc | | | | |

| | NAME | LATITUDE & LONGITUDE | GEOLOGICAL ACTIVITY | WHAT IS HAPPENING? |
|---|---|---|---|---|
| Mid-Ocean Ridge | | | | |
| Fracture Zone | | | | |

| | NAME | LATITUDE & LONGITUDE | GEOLOGICAL ACTIVITY | WHAT IS HAPPENING? |
|---|---|---|---|---|
| Trench | | | | |

**SEA FLOOR FEATURES TABLE (KEY)**

| FEATURE | NAME | LATITUDE & LONGITUDE | GEOLOGICAL ACTIVITY | WHAT IS HAPPENING? |
|---|---|---|---|---|
| Mountains | Examples:<br>Andes- subduction<br><br><br><br>Olympics (Washington state)- accretion<br><br>Himalayas- collision | 10°N - 50° S<br>70°W<br><br><br><br>48° N<br>123°W<br><br>28°N<br>85°E | Subduction, accretion or collision | In subduction, the ocean plate is hitting up against the continental plate and sliding below. The force of the two plates meeting is folding the crust and forcing up mountains. Also, the oceanic crust is melting and some of the melted material is resurfacing in mountain volcanoes. In accretion, continental crust is scraping off seamounts and islands which both impact the crust and fuse to the continent adding mountains. In collision, two plates of equal density meet and the force folds the crust into mountains. |
| Volcano | Example<br><br>Mt. St. Helens (Washington state) | <br><br>46°N<br>122°W | Subduction, or hot spot | In both cases, molten material is surfacing through crust. At a subduction zone, remelted oceanic crust is resurfacing; at hot spots, magma is erupting and forming a cone. |

| FEATURE | NAME | LATITUDE & LONGITUDE | GEOLOGICAL ACTIVITY | WHAT IS HAPPENING? |
|---|---|---|---|---|
| Volcanic Island | Example:<br><br>Tahiti | <br><br>20°S<br>150°W | Hot spot | Mantle material is erupting through a break in the oceanic crust and depositing enough material to form an island. |
| Island Arc | Example:<br><br>Hawaiian Islands | <br><br>20°N<br>155°W | Hot spot | Each island in an island arc is a volcanic island formed at a hot spot. A series of islands forms at an arc because the crustal plate sitting over the hot spot moves. |

| FEATURE | NAME | LATITUDE & LONGITUDE | GEOLOGICAL ACTIVITY | WHAT IS HAPPENING? |
|---|---|---|---|---|
| Mid-Ocean Ridge | Example:<br><br>East Pacific Rise | <br><br>20°N – 50°S<br>110°W | Spreading | Magma is erupting from the mantle and cooling when it hits seawater. This cooled magma hardens, forming new crust. The new crust gradually pushes the existing plates away from the ridge center. |
| Fracture Zone | Example:<br><br>San Andreas Fault, California | <br><br>35°N<br>121°W | Faulting | Two plates are sliding past one another, sometimes moving slowly and other times releasing enormous amounts of pressure as they jerk past each other. |

| FEATURE | NAME | LATITUDE & LONGITUDE | GEOLOGICAL ACTIVITY | WHAT IS HAPPENING? |
|---|---|---|---|---|
| Trench | Example:<br><br>Aleutian trench | 50°N<br>150°W – 150°E (the trench passes from west across the 180° line to east) | Subduction | The ocean plate is hitting up against the continental plate and sliding below. Where the oceanic plate sinks, a deep valley or trench forms. |