II. *World Map - Label the Ocean basins*

A. Review the *I can* statements once again, distribute the Student Worksheet *World Map*, and have students label the ocean basins. Walk around the classroom and check for understanding and accuracy.

B. After students have labeled their world map with the ocean names, engage students in discussion with the following questions:

1. Which Ocean is the largest? (*Pacific*)
2. Which Ocean is between North America and Europe? (*Atlantic*)
3. Which Ocean is bordered by Africa, Asia, and Australia? (*Indian*)

C. Develop the concept that the Ocean is one big system. Refer to the Ocean Literacy Essential Principles to aide in this discussion. http://www.coexploration.org/oceanliteracy/documents/OceanLitChart.pdf
All answers are "yes" but responses may lead to class discussion

1. Are the ocean basins connected?
2. Does the ocean and life in the ocean shape the features of the Earth?
3. Is the ocean a major influence on weather and climate?
4. Does the ocean make Earth habitable?
5. Does the ocean support a great diversity of life and ecosystems?
6. Are the ocean and humans interconnected?
7. Is the ocean largely unexplored?

III. *Coordinate Mapping Longitude and Latitude*

Note: This activity should not be the first introduction to Longitude and Latitude. The background for this activity is in another content area.

A. Show the PowerPoint, *Where is Hawai'i?*, and using the notes on each slide to teach the lesson. Tell students to take notes in their journals. Have ready copies of the map of your county taken from the power point for each student. Don't hand out until called for in the PowerPoint.

B. Explain the connection between the word *long*, as it relates to longitude lines running vertical north and south (One trick for remembering: Think of the "O" as a globe, where the "l" wraps around the O, pole to pole), and contrast this with latitude lines, which run horizontally, east and west, parallel to the equator. Latitude is degrees above (N) or below (S) the Equator; longitude is distance east or west of the prime meridian. Both are measured in terms of the 360 degrees (symbolized by °) of a circle. Imaginary lines of latitude and longitude intersect each other, forming a grid that covers the Earth and helps us locate points on it.

C. The latitude and longitude of a point are called its coordinates. If you know the coordinates, you can use a map to locate any point on Earth. (Adapted from National Geographic's *Exploring Your World: The Adventure of Geography)*

D. Have students identify the places listed on the *State of Hawai'iCounty Locations* for their county or island. You may also choose other coordinates for students to identify. You may also delete or include more information on the student worksheets depending on time available for the exercise.

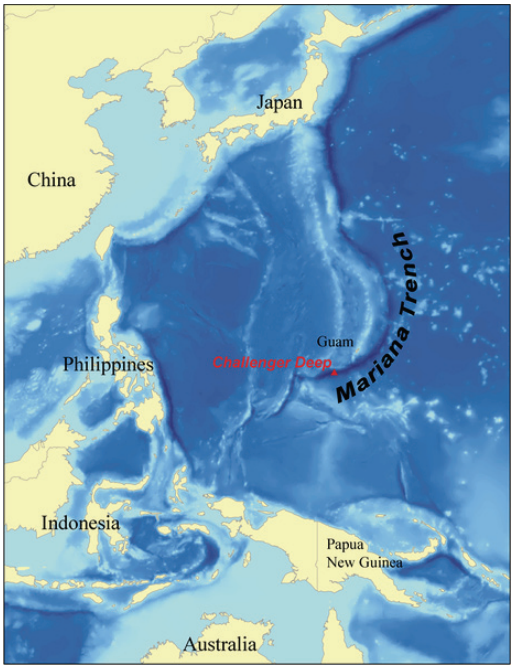
Extended Activity:

As an extra activity, students could go on Google Maps and type in a set of locations on their table to get a up close look of that exact location. For example Honolulu N21° 18.733' W157° 50.747' will pull up the middle of Punchbowl on the Google map. Using other numbers they could find the exact location of their school or home.

LESSON 1 Student Reading

The Earth's Ocean Basins

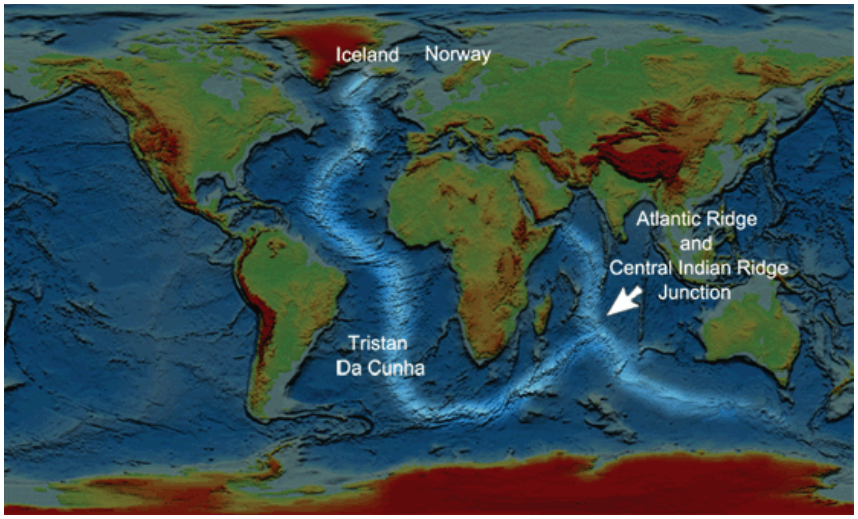
The five ocean basins from largest to smallest are: the Pacific, Atlantic, Indian, Southern, and Arctic.

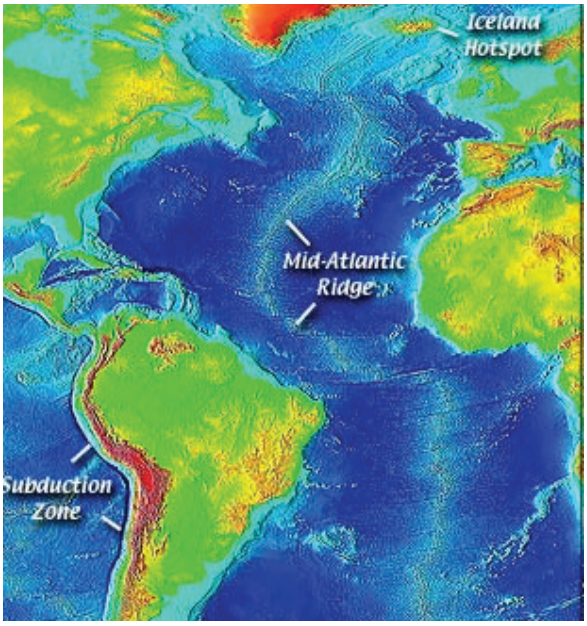


The Pacific Ocean is the largest and deepest ocean in the world. It covers 63,800,000 square miles (165,200,000 square km), a third of the Earth's surface. The Pacific Ocean is bigger than all of the Earth's continents combined. The Pacific was named by Ferdinand Magellan, the Portuguese explorer who found the Pacific very peaceful (**pacifique**, in French) for most of his journey from the Straits of Magellan to the Philippines. In contrast to its name, the islands of the **peaceful ocean** are often slammed by devastating typhoons and hurricanes. The countries that border the Pacific, or the Pacific Rim, often experience volcano eruptions and Earthquakes.

The Pacific Ocean is also home to the lowest point on Earth and deepest part of the Ocean known as the Mariana Trench, an area that is 35,800 feet (10,911 meters) below sea level. There are 25,000 Pacific islands in the Pacific Ocean — more than in any other ocean.

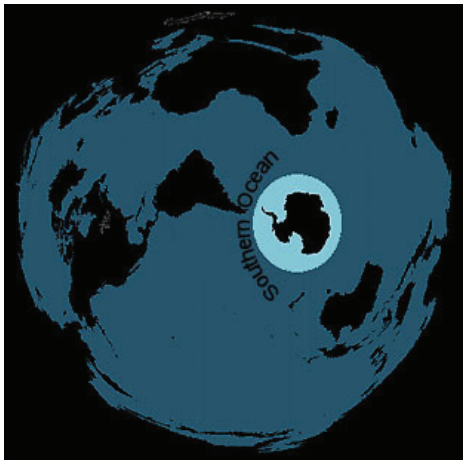
The Indian Ocean is the third largest in the world, makes up approximately 20 percent of the Earth's water surface, and covers approximately 28,356,000 square miles (73,441,700 square kilometers). The deepest spot, south of Java, is 25,344 feet (7,725 meters). Some other geographical features of the ocean include small islands around the continental rims such as Madagascar (the world's fourth largest island), Comoros, Seychelles, Maldives, Mauritius, Sri Lanka, and Indonesia. Underneath the surface of the Indian Ocean lies the convergence of the African, Indian, and Antarctic plates. The Y-shaped branches of the Mid-Oceanic Ridge mark this convergence.





The Atlantic Ocean is the second-largest ocean. Its name is derived from the **Sea of Atlas** in Greek mythology. This ocean covers approximately one-fifth of the entire global ocean. The Atlantic Ocean covers approximately 31, 530,000 square miles (81, 662, 000 square kilometers). Its average depth is approximately 14,000 feet (4,270 meters). The deepest part of the Atlantic Ocean is the Puerto Rico Trench, which is 28, 374 feet deep (8,648 meters). Below the surface, the ocean floor has an S-shape basin that extends north to south. A giant submarine mountain range, called the Mid-Atlantic Ridge, extends from Iceland in the north to approximately 58° south latitude. A rift valley, or valley formed by faults, extends along most of the length of the Mid-Atlantic ridge. This ridge is less than 8,858 feet (2,700 meters) deep in many places, with mountain peaks that rise up to form islands above water. Some of these islands include: Greenland, Iceland, Great Britain, Ireland, the Azores, the Madeira Islands, the Canaries, Cape Verde Islands, Newfoundland, Bermuda, West Indies, Ascension, St. Helena, Falkland Islands, and South Georgia Island. The coasts of the Atlantic are marked with numerous bays, gulfs, and seas, including the Caribbean Sea, the Gulf of Mexico, Gulf of St. Lawrence, Mediterranean Sea, Black Sea, North Sea, Baltic Sea, and the Norwegian-Greenland Sea.

The Southern Ocean (Antarctic) is the world's fourth-largest body of water. It encircles Antarctica and is actually divided among the Atlantic, Indian, and Pacific Oceans. Most people of North America and Continental Europe have no name for the area, and regard the area as parts of the Atlantic, Pacific, and Indian Oceans simply extending to Antarctica. However, because mariners have long referred to this area as the **Southern Ocean,** the International Hydrographic Organization accepted it as an ocean in 2000. This ocean is predominantly deep water, averaging 13,000-16,500 feet (4,000–5,000 meters) deep, and includes the Antarctic continental shelf, an unusually deep and narrow shelf surrounding the Antarctic continent with a steep edge 1,300-2,625 feet (400–800 meters) deep, which is more than 885-2,200 feet (270–670 meters) deeper than average continental shelves. The South Sandwich Trench is the lowest part of the southern ocean at 24,000 feet.



The Arctic Ocean lies at the top of the world and covers approximately 3,662,000 square miles (9,485,100 square kilometers). Its greatest depth is 17,880 feet (5,450 meters). The topography of the Arctic Ocean bottom varies. It consists of fault-block ridges, abyssal plains, and the ocean basin has an average depth of 3,406 feet (1,038 meters) due to the continental shelf on the Eurasian side. Ice covers most of the Arctic Ocean year round. If the ice melts, salinity and subfreezing temperatures vary.

LESSON 1 The Earth's Ocean Basins

Name: _____ Date: _____

Directions: Read the description of each ocean and then label the name of the ocean basins on the World Map.

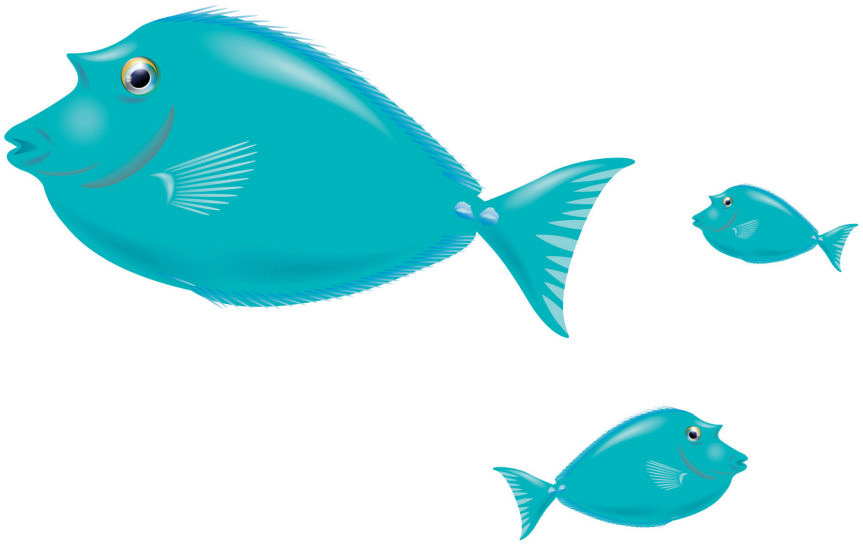
Arctic Ocean - an ocean around the North Pole, bordering northern Europe, Asia, and North America. It is the smallest ocean.

Atlantic Ocean - an ocean bordering western Europe, western Africa, Antarctica, and eastern North and South America.

Indian Ocean - an ocean bordering eastern Africa, southern Asia, western Australia, and Antarctica.

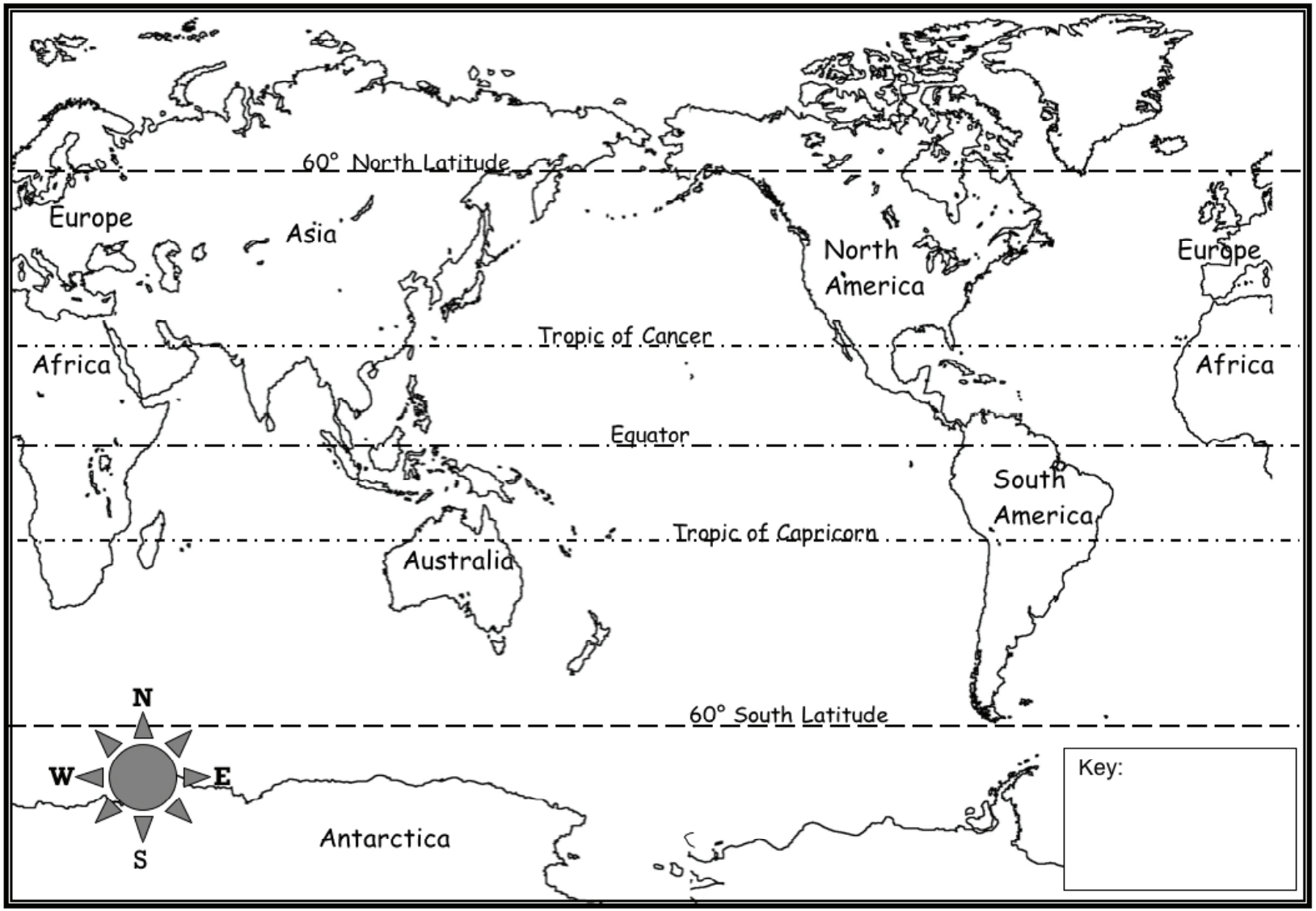
Pacific Ocean - an ocean bordering eastern Asia, northeastern Australia, Antarctica, and western North and South America. It is the biggest ocean.

Southern Ocean - the ocean bordering Antarctica and extending from 60 degrees south latitude.



LESSON 1 World Map

Name: _____ **Date:** _____



LESSON 1

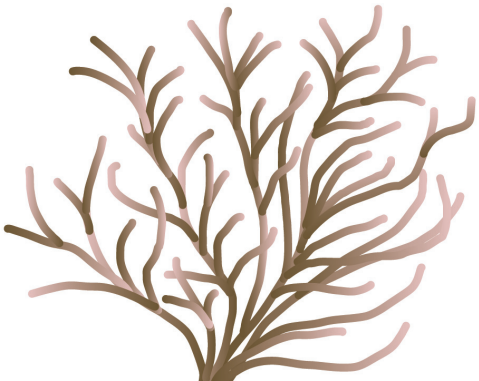
Coordinate Mapping Longitude and Latitude

Name: _____ **Date:** _____

State of Hawai‘i, County of *Kaua‘i*

Directions: Using the map on the following page fill in the location name using the coordinates provided.

Location	Latitude	Longitude
Pu‘uwai	N21° 53’ 54”	W160° 11’ 32”
	N22° 02’ 03”	W159° 46’ 12”
	N21° 58’ 06”	W159° 42’ 43”
	N21° 56’ 19”	W159° 38’ 56”
	N21° 55’ 35”	W159° 31’ 36”
	N21° 54’ 14”	W159° 27’ 59”
Līhu‘e	N21° 58’ 40”	W159° 22’ 04”
	N22° 04’ 29”	W159° 19’ 04”
Anahola	N22° 08’ 33”	W159° 18’ 47”
	N22° 12’ 35”	W159° 24’ 32”
	N22° 12’ 08”	W159° 29’ 59”
	N22° 10’ 28”	W159° 39’ 20”



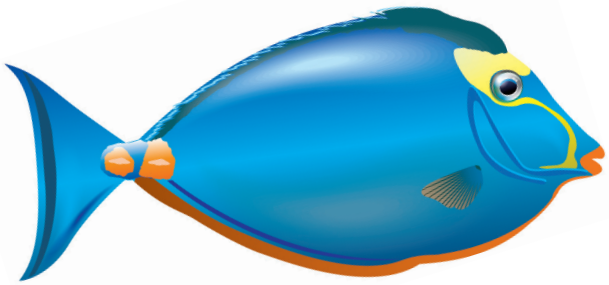
LESSON 1 Teacher Answer Key
Coordinate Mapping Longitude and Latitude

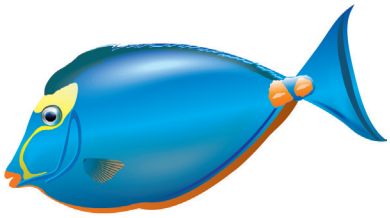
Name: _____ **Date:** _____

State of Hawai‘i, County of *Kaua‘i*

Directions: Using the map on the following page fill in the location name using the coordinates provided.

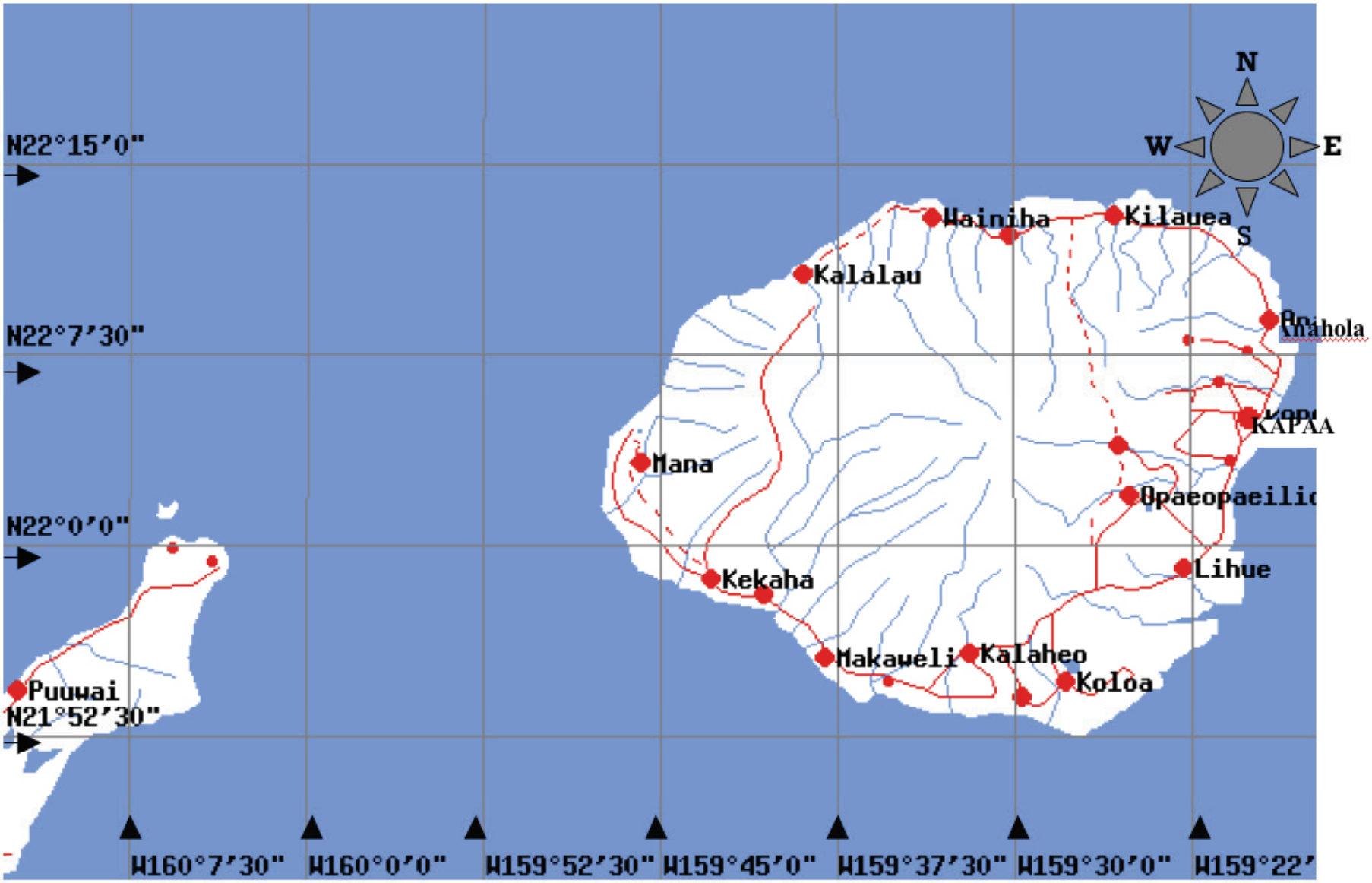
Location	Latitude	Longitude
Pu‘uwai	N21° 53’ 54”	W160° 11’ 32”
Mana	N22° 02’ 03”	W159° 46’ 12”
Kekaha	N21° 58’ 06”	W159° 42’ 43”
Makaweli Landing	N21° 56’ 19”	W159° 38’ 56”
Kalāheo	N21° 55’ 35”	W159° 31’ 36”
Kōloa	N21° 54’ 14”	W159° 27’ 59”
Līhu‘e	N21° 58’ 40”	W159° 22’ 04”
Kapa‘a	N22° 04’ 29”	W159° 19’ 04”
Anahola	N22° 08’ 33”	W159° 18’ 47”
Kīlauea	N22° 12’ 35”	W159° 24’ 32”
Hanalei	N22° 12’ 08”	W159° 29’ 59”
Kalalau	N22° 10’ 28”	W159° 39’ 20”





LESSON 1 Kaua‘i County Map

Name: _____ **Date:** _____



LESSON 1

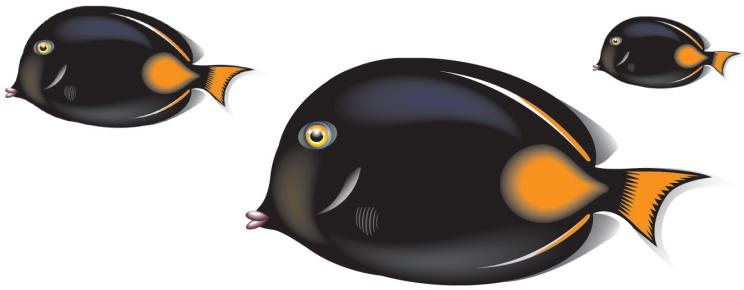
Coordinate Mapping Longitude and Latitude

Name: _____ **Date:** _____

State of Hawai‘i, County of *O‘ahu*

Directions: Using the map on the following page fill in the location name using the coordinates provided.

Location	Latitude	Longitude
Honolulu	N21° 18’ 05”	W157° 51’ 01”
	N21° 24’ 54”	W157° 48’ 04”
	N21° 20’ 48”	W157° 43’ 07”
Kailua	N21° 23’ 56”	W157° 44’ 11”
	N21° 29’ 00”	W158° 04’ 13”
	N21° 36’ 26”	W157° 54’ 28”
	N21° 40’ 38”	W157° 56’ 53”
	N21° 22’ 45”	W157° 55’ 53”
Maunalua Bay	N 21° 16’ 19”	W157° 40’ 50”
	N21° 23’ 40”	W157° 58’ 16”
	N21° 34’ 29”	W158° 16’ 49”
	N21° 26’ 28”	W158° 11’ 12”



LESSON 1 Teacher Answer Key
Coordinate Mapping Longitude and Latitude

Name: _____ Date: _____

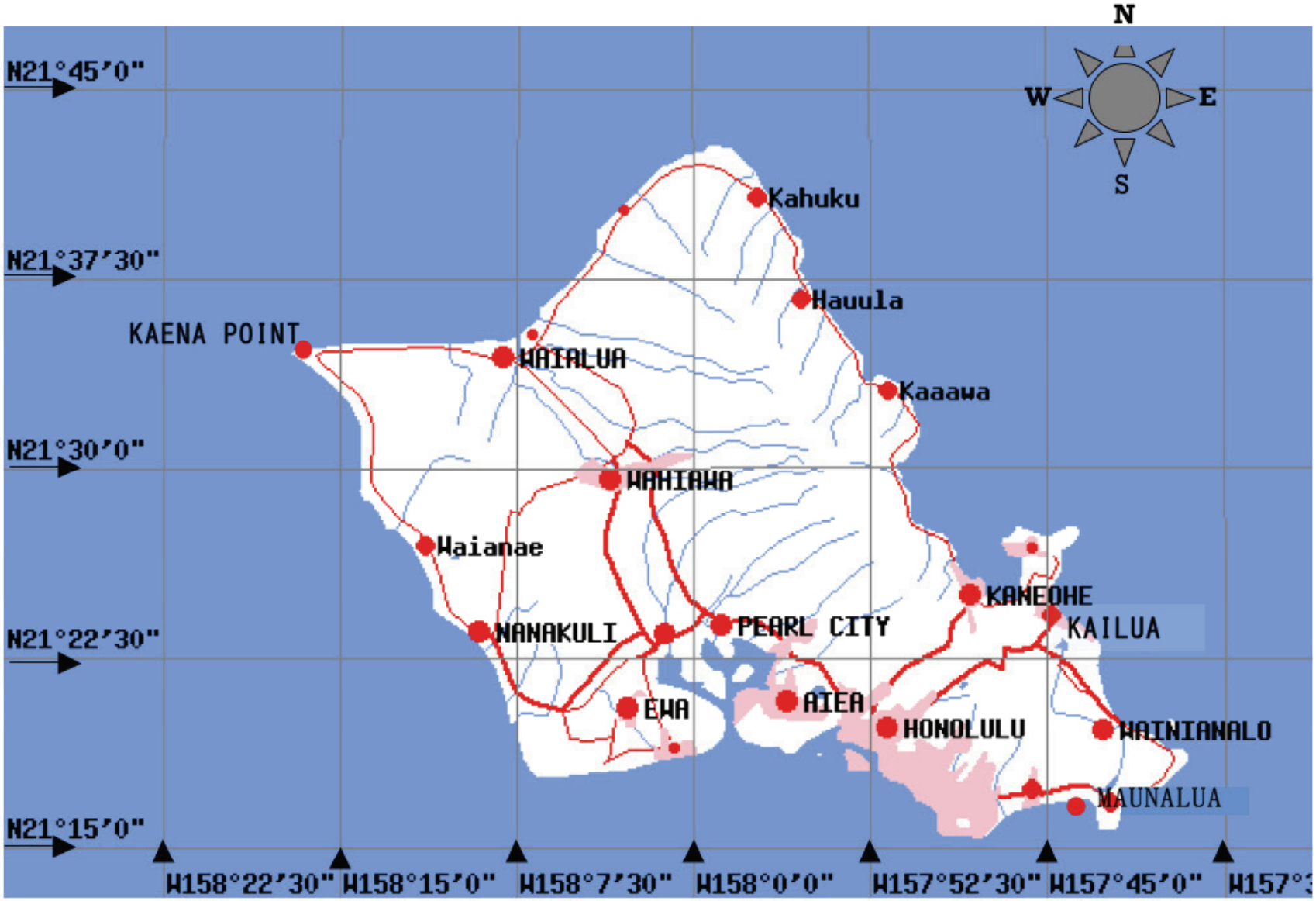
State of Hawai‘i, County of *O‘ahu*

Directions: Using the map on the following page fill in the location name using the coordinates provided.

Location	Latitude	Longitude
Honolulu	N21° 18’ 05”	W157° 51’ 01”
Kāne‘ohe	N21° 24’ 54”	W157° 48’ 04”
Waimānalo	N21° 20’ 48”	W157° 43’ 07”
Kailua	N21° 23’ 56”	W157° 44’ 11”
Wahiawā	N21° 29’ 00”	W158° 04’ 13”
Hau‘ula	N21° 36’ 26”	W157° 54’ 28”
Kahuku	N21° 40’ 38”	W157° 56’ 53”
‘Aiea	N21° 22’ 45”	W157° 55’ 53”
Maunalua Bay	N 21° 16’ 19”	W157° 40’ 50”
PearlCity	N21° 23’ 40”	W157° 58’ 16”
Ka‘ena Point	N21° 34’ 29”	W158° 16’ 49”
Wai‘anae	N21° 26’ 28”	W158° 11’ 12”

LESSON 1 O‘ahu County Map

Name: _____ Date: _____



LESSON 1

Coordinate Mapping Longitude and Latitude

Name: _____ **Date:** _____

State of Hawai‘i, County of Maui

Directions: Using the map on the following page fill in the location name using the coordinates provided.

Location	Latitude	Longitude
Kalaupapa	N21° 11’ 23”	W156° 59’ 00”
	N21° 05’ 22”	W157° 01’ 13”
	N21° 04’ 24”	W156° 47’ 33”
	N21° 09’ 26”	W156° 44’ 22”
	N20° 49’ 37”	W156° 55’ 14”
	N20° 47’ 08”	W156° 59’ 08”
	N21° 00’ 01”	W156° 39’ 20”
	N20° 52’ 29”	W156° 40’ 45”
	N20° 48’ 42”	W156° 37’ 20”
	N20° 55’ 50”	W156° 31’ 41”
Wailuku	N20° 53’ 16”	W156° 30’ 06”
	N20° 55’ 13”	W156° 18’ 31”
	N20° 52’ 01”	W156° 18’ 22”
	N20° 46’ 36”	W156° 19’ 33”
	N20° 42’ 20”	W156° 21’ 21”
	N20° 39’ 14”	W156° 26’ 33”
	N20° 35’ 57”	W156° 25’ 14”
	N20° 45’ 20”	W155° 59’ 13”
	N20° 42’ 09”	W155° 59’ 57”
Kīpahulu	N20° 39’ 11”	W156° 03’ 20”

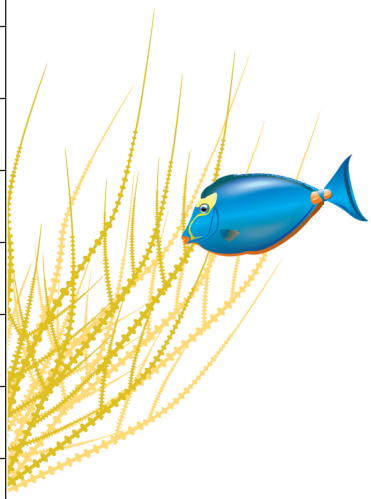
LESSON 1 Teacher Answer Key
Coordinate Mapping Longitude and Latitude

Name: _____ Date: _____

State of Hawai‘i, County of Maui

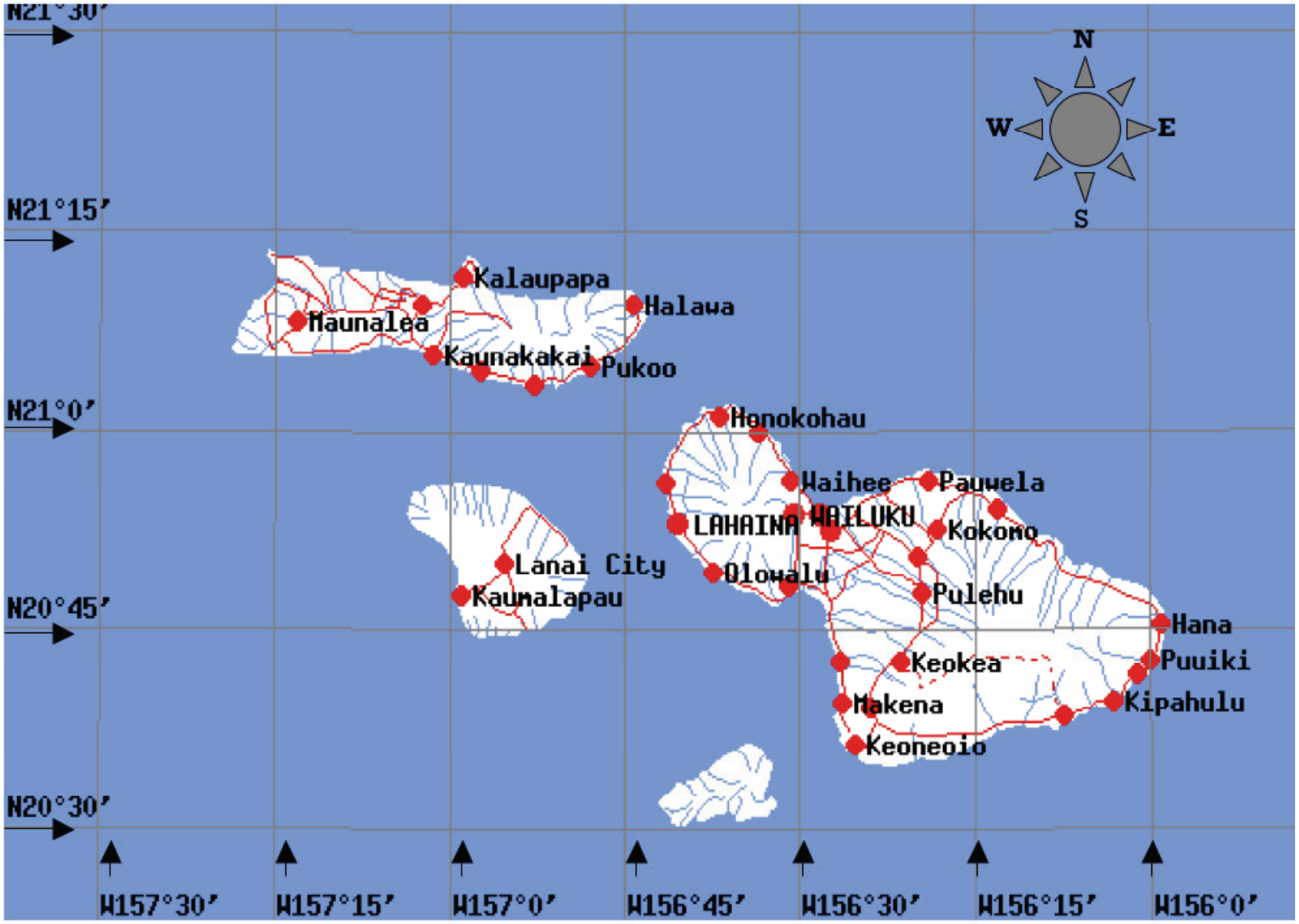
Directions: Using the map on the following page fill in the location name using the coordinates provided.

Location	Latitude	Longitude
Kalaupapa	N21° 11’ 23”	W156° 59’ 00”
Kaunakakai	N21° 05’ 22”	W157° 01’ 13”
Puko‘o	N21° 04’ 24”	W156° 47’ 33”
Hālawa	N21° 09’ 26”	W156° 44’ 22”
Lāna‘i City	N20° 49’ 37”	W156° 55’ 14”
Kaumalapau	N20° 47’ 08”	W156° 59’ 08”
Honokōhau	N21° 00’ 01”	W156° 39’ 20”
Lahaina	N20° 52’ 29”	W156° 40’ 45”
Olowalu	N20° 48’ 42”	W156° 37’ 20”
Waihe‘e	N20° 55’ 50”	W156° 31’ 41”
Wailuku	N20° 53’ 16”	W156° 30’ 06”
Pa‘uwela	N20° 55’ 13”	W156° 18’ 31”
Kokomo	N20° 52’ 01”	W156° 18’ 22”
Pūlehu	N20° 46’ 36”	W156° 19’ 33”
Kēōkea	N20° 42’ 20”	W156° 21’ 21”
Mākena	N20° 39’ 14”	W156° 26’ 33”
Keone‘ō‘io	N20° 35’ 57”	W156° 25’ 14”
Hāna	N20° 45’ 20”	W155° 59’ 13”
Pu‘uiki	N20° 42’ 09”	W155° 59’ 57”
Kīpahulu	N20° 39’ 11”	W156° 03’ 20”



LESSON 1 Maui County Map

Name: _____ **Date:** _____



LESSON 1

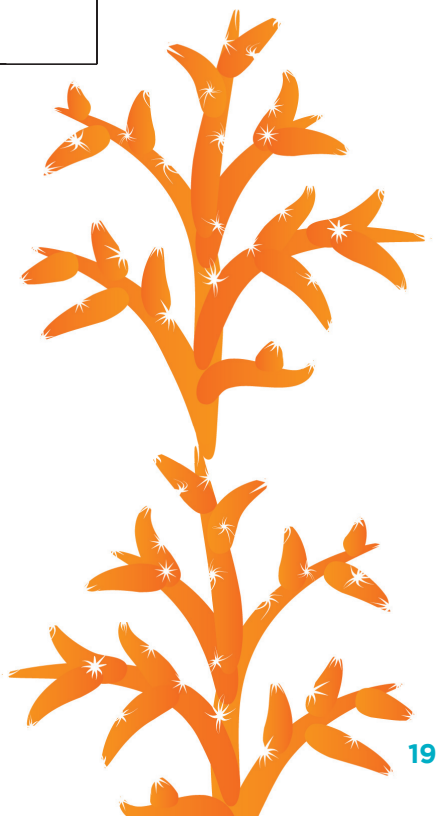
Coordinate Mapping Longitude and Latitude

Name: _____ **Date:** _____

State of Hawai‘i, North Half of County of *Hawai‘i*

Directions: Using the map on the following page fill in the location name using the coordinates provided.

Location	Latitude	Longitude
Māhukona	N20° 11’ 05”	W155° 54’ 01”
	N19° 51’ 21”	W155° 55’ 18”
	N19° 38’ 21”	W155° 59’ 35”
	N19° 25’ 05”	W155° 52’ 48”
	N19° 29’ 46”	W154° 56’ 56”
Mountain View	N19° 33’ 09”	W155° 06’ 20”
	N19° 43’ 33”	W155° 05’ 22”
	N19° 52’ 16”	W155° 07’ 02”
	N19° 58’ 31”	W155° 13’ 07”
	N20° 04’ 46”	W155° 28’ 11”
	N19° 59’ 49”	W155° 33’ 26”



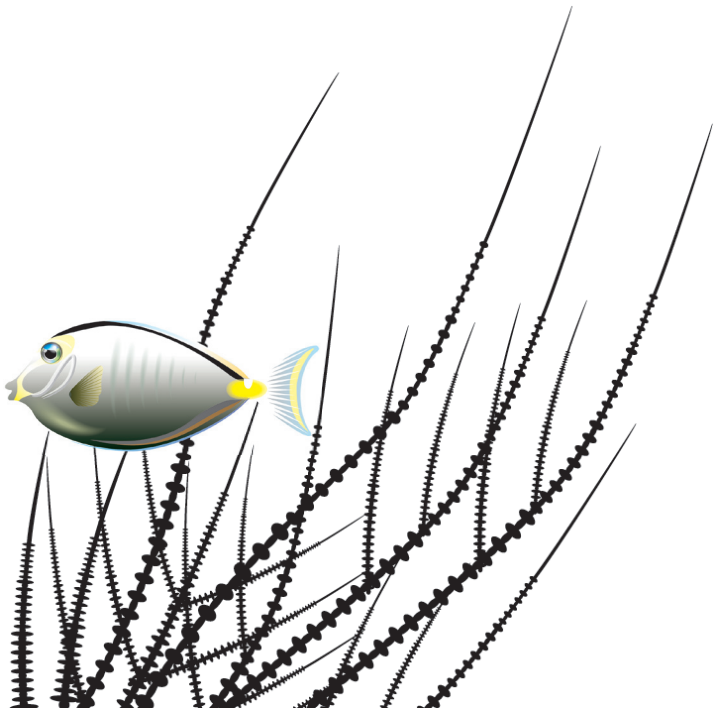
LESSON 1 Teacher Answer Key
Coordinate Mapping Longitude and Latitude

Name: _____ **Date:** _____

State of Hawai‘i, North Half of County of *Hawai‘i*

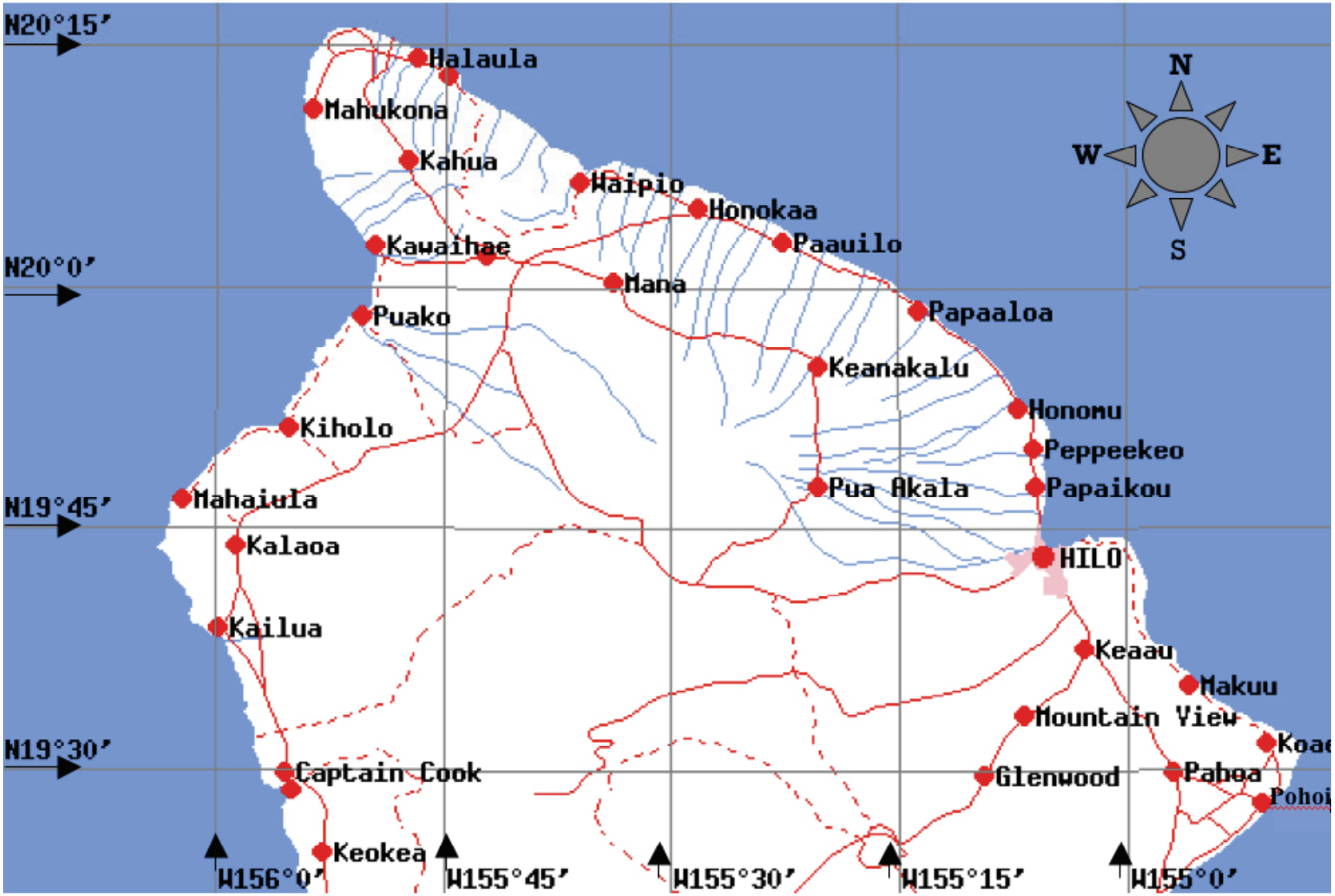
Directions: Using the map on the following page fill in the location name using the coordinates provided.

Location	Latitude	Longitude
Māhukona	N20° 11’ 05”	W155° 54’ 01”
Kīholo	N19° 51’ 21”	W155° 55’ 18”
Kailua	N19° 38’ 21”	W155° 59’ 35”
Kēōkea	N19° 25’ 05”	W155° 52’ 48”
Pāhoa	N19° 29’ 46”	W154° 56’ 56”
Mountain View	N19° 33’ 09”	W155° 06’ 20”
Hilo	N19° 43’ 33”	W155° 05’ 22”
Honomū	N19° 52’ 16”	W155° 07’ 02”
Pāpa‘aloa	N19° 58’ 31”	W155° 13’ 07”
Honoka‘a	N20° 04’ 46”	W155° 28’ 11”
Mānā	N19° 59’ 49”	W155° 33’ 26”



LESSON 1 North Hawai'iCounty Map

Name: _____ Date: _____



LESSON 1

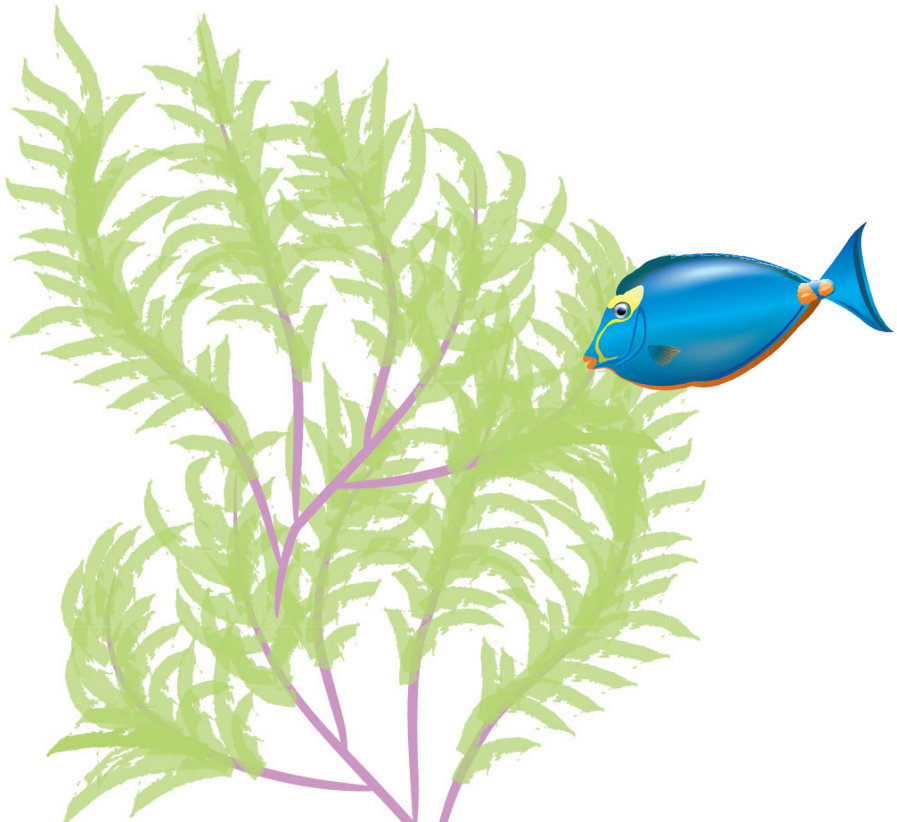
Coordinate Mapping Longitude and Latitude

Name: _____ **Date:** _____

State of Hawai‘i, South Half of County of *Hawai‘i*

Directions: Using the map on the following page fill in the location name using the coordinates provided.

Location	Latitude	Longitude
Kailua	N19° 38’ 21”	W155° 59’ 34”
	N19° 12’ 27”	W155° 51’ 50”
	N18° 58’ 16”	W155° 36’ 40”
	N19° 20’ 16”	W155° 00’ 39”
Glennwood	N19° 29’ 14”	W155° 09’ 04”
	N19° 33’ 09”	W155° 06’ 19”
	N19° 29’ 46”	W154° 56’ 56”
	N19° 43’ 33”	W155° 05’ 21”
	N19° 47’ 27”	W156° 01’ 38”



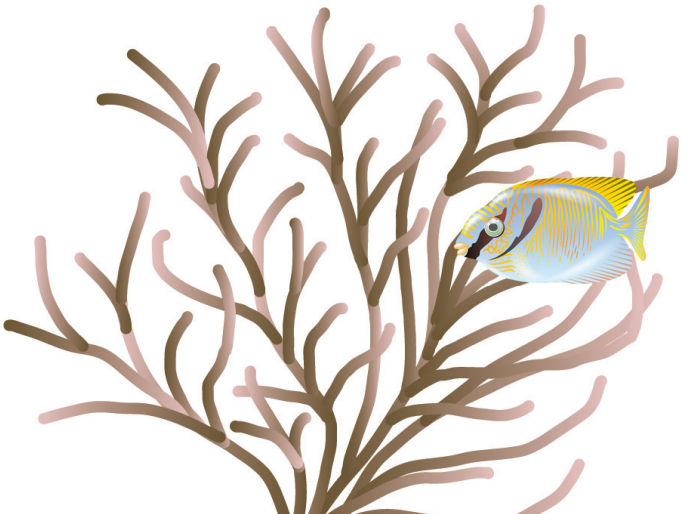
LESSON 1 Teacher Answer Key
Coordinate Mapping Longitude and Latitude

Name: _____ Date: _____

State of Hawai‘i, South Half of County of *Hawai‘i*

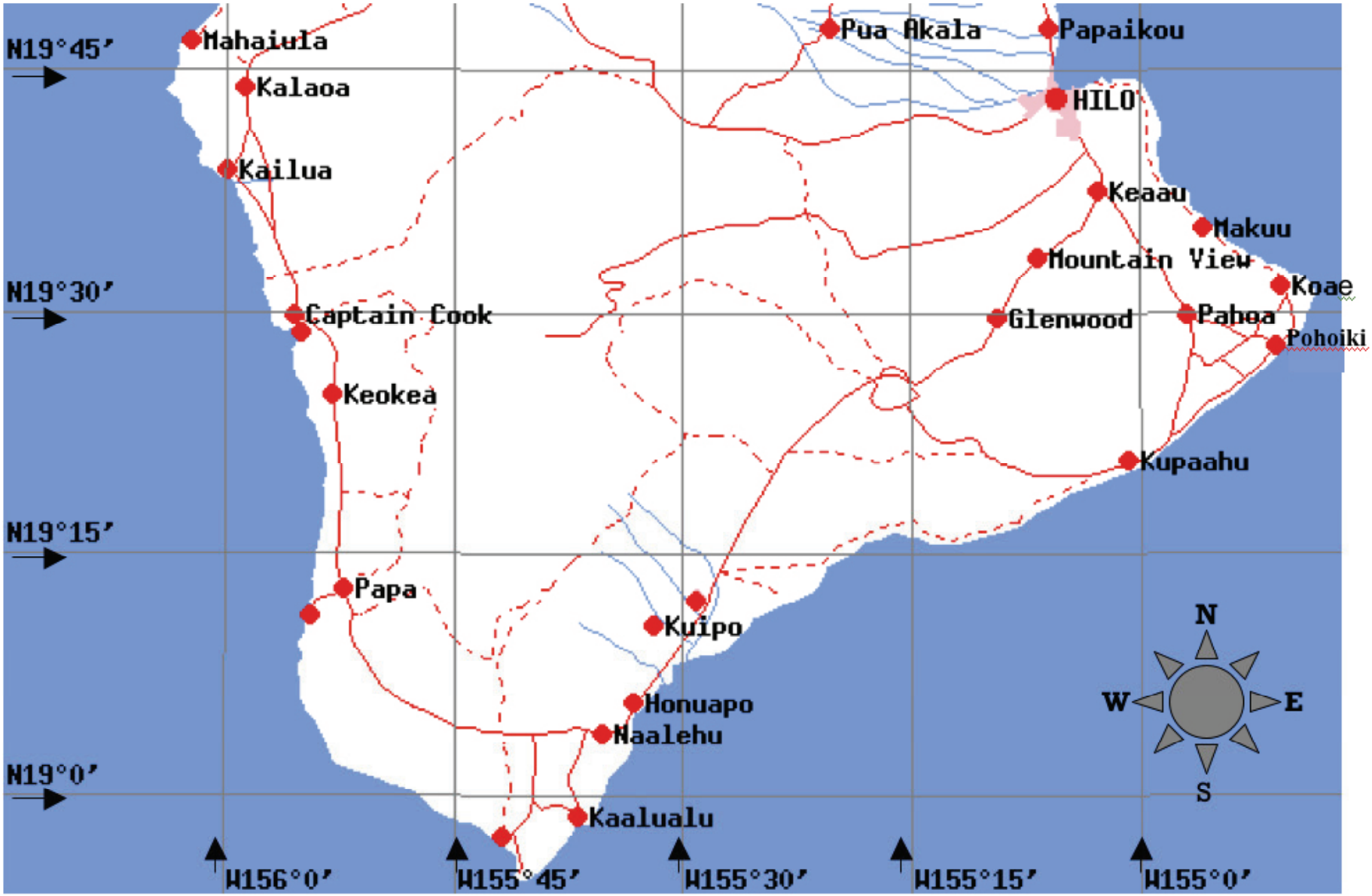
Directions: Using the map on the following page fill in the location name using the coordinates provided.

Location	Latitude	Longitude
Kailua	N19° 38’ 21”	W155° 59’ 34”
Pāpā	N19° 12’ 27”	W155° 51’ 50”
Ka‘alu‘alu	N18° 58’ 16”	W155° 36’ 40”
Kupa‘ahu	N19° 20’ 16”	W155° 00’ 39”
Glennwood	N19° 29’ 14”	W155° 09’ 04”
Mountain Vew	N19° 33’ 09”	W155° 06’ 19”
Pāhoa	N19° 29’ 46”	W154° 56’ 56”
Hilo	N19° 43’ 33”	W155° 05’ 21”
Mahai‘ula	N19° 47’ 27”	W156° 01’ 38”



LESSON 1 South Hawai‘iCounty Map

Name: _____ Date: _____



LESSON 2 Into the Deep

Lesson at a Glance

Students pose questions about the ocean floor and make a prediction about what they think the ocean floor might look like and the kinds of Earth materials that make up the ocean floor. They learn about the continental slope, continental rise, abyssal plain, mid ocean ridge, trench and much more.

Lesson Duration

Two 45-minute periods

Essential Question(s)

What would the world look like if all the water were drained out?

Key Concepts

- Each ocean has specific and unique features.
  In the Pacific Ocean, the largest ocean, the Hawaiian Islands and the Northwest Hawaiian Islands form distinctive geographic features.
- An ocean basin's size, shape, and features (such as, trenches, mid-ocean ridges, abyssal plains) vary due to the movement of Earth's crust.

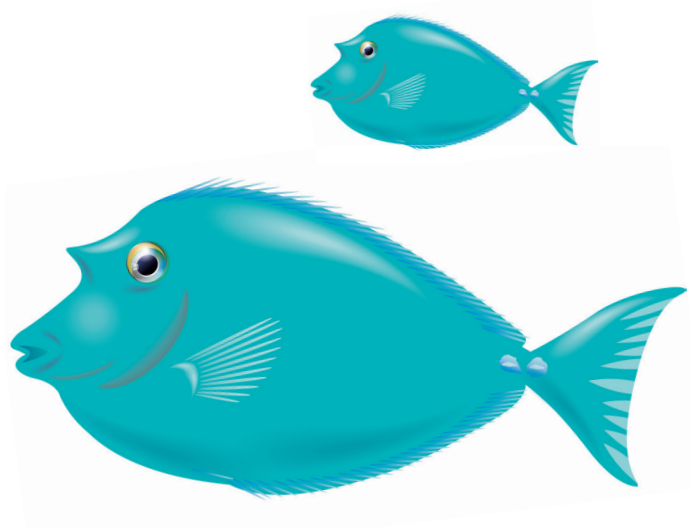
Related HCPSIII Benchmark(s):

Social Studies: SS 4.7.2 Collect, organize, and analyze data to interpret and construct geographic representations.

Science: SC 4.1.1 Describe a testable hypothesis and an experimental procedure.

Instructional Objectives

- I can read and understand a simple bathymetric map (underwater map).



Assessment Tools

Benchmark Rubric:

Topic		World In Spatial Terms	
Benchmark SS.4.7.2		Collect, organize, and analyze data to interpret and construct geographic representations	
Rubric			
Advanced	**Proficient**	**Partially Proficient**	**Novice**
Collect, organize, and analyze data to interpret and construct geographic representations, with accuracy	Collect, organize, and analyze data to interpret and construct geographic representations, with no significant errors	Collect, organize, and analyze data to interpret and construct geographic representations, with a few significant errors	Collect, organize, and analyze data to interpret and construct geographic representations, with many significant errors
Topic		Scientific Inquiry	
Benchmark SC.4.1.1		Describe a testable hypothesis and an experimental procedure	
Rubric			
Advanced	**Proficient**	**Partially Proficient**	**Novice**
Create a testable hypothesis and an experimental procedure to test it	Describe a testable hypothesis and an experimental procedure	Identify, with assistance, a testable hypothesis and an experimental procedure	Recognize, with assistance, a testable hypothesis or an experimental procedure

Assessment/Evidence Pieces

- **Student Worksheet:** *Into the Deep*

Materials Needed

Teacher	Class	Group	Student
Method to project PowerPoint	- Copy of Features of the Ocean Floor for student reference. - Computer and projector	- Small whiteboard - Dry erase marker - eraser	- Student Worksheet: *Into the Deep* - Student Worksheet: *Features of the Ocean Floor* - Student Worksheet: Blank World Feature map for labeling

Instructional Resources

Teacher Reading: *Into the Deep*
Student Worksheet: *Into the Deep*
Student Worksheet: *Features of the Ocean Floor*
PowerPoint: *Ocean's Draining*
PowerPoint: *Map Game*
Supplemental Resource: *Ocean Geography Interactive Game*

Student Vocabulary Words

abyss: the bottom of the deep ocean below the continental shelf, usually deeper than 13,000 feet (4,000 meters).
abyssal plain: very deep, flat ocean floor covered with a thin layer of sediment.
bathymetry: depth measurement to determine the contours of the ocean floor.
bathymetric map: maps that show depths below sea level (also called charts).
canyon: a deep narrow gorge with steep sides. An underwater canyon is called a *submarine canyon.*
continental rise: the gently inclined region of ocean floor between the base of the continental slope and the abyssal plain.
continental slope: the steep incline between the continental shelf and the abyssal zone.
contour line: a line on a map representing an imaginary line on land or bottom of the sea that has the same elevation or depth along its entire length.
contour interval: the difference in elevation or depth between contour lines.
gorge: a deep narrow valley with cliff walls.
mid-ocean ridge: a chain of undersea mountains in every ocean that circles the Earth like the seam of a baseball for nearly 37,000 miles (59,545 kilometers).
ridge: a long narrow rise in the seafloor with steep sides and a bumpy shape.
seamount: a volcanic peak or mountain that is underwater.
sediment: debris deposited on the ocean floor.
submarine canyon: a deep, underwater valley sliced into the continental margin.
trench: narrow deep cuts in the ocean floor.
topographic map: a map that shows physical features of elevation above sea level.

Lesson Plan

Lesson Preparation

- Make copies of the Student Worksheet *Into the Deep* and *Features of the Ocean Floor*, one per student.
- Preview PowerPoint *Ocean's Draining* and *Map Game*, make arrangements to project them.
- Preview an interview with John Wiltshire of NOAA's Hawai'i Undersea Research Laboratory (HURL) regarding another technology used to explore undersea environments at http://www.Earthsky.org/interviewpost/water/john-wiltshires-undersea-laboratory-explores-expanding-Hawai'i
- **Preview the interactive piece** *Ocean Geography and Geology* **to be completed at the end of Step III.**

I. *Teaching the Lesson*

A. Begin the lesson by telling the students that they are going to take an imaginary dive into the deep, dark depths of the ocean.

1. Engage students in a conversation about forming a hypothesis.
   i. What is a hypothesis?
   ii. What is the role of the hypothesis in a scientific investigation?
   iii. What is the difference between a hypothesis and a procedure?
2. Distribute the student worksheet, *Into the Deep.*
3. Ask students to think of questions they have concerning the deep ocean, and to record their questions in their worksheet. Model the idea of posing a question and forming a testable hypothesis using starters such as: *If the water were to drain from the ocean basin, then what would be left would be .... , because....* During this quiet journey to the depths, students will sketch in their journal a picture of what they think the ocean depths may look like.
4. After 10–15 minutes of quiet reflecting and sketching, have students share their sketches.

B. Show PowerPoint *Ocean's Draining.* Now that students have had a chance to see what the Earth looks like with no ocean water pass out the Student Worksheet, *Features of the Ocean Floor.* Have students spend a few moments to review the picture. Go over the vocabulary on page 2 of the worksheet with them.

II. *Map Game*

A. Show the first several slides of PowerPoint *Map Game.* This will help introduce the vocabulary *topographic map* and *bathymetric map*, and show an example of each.

B. The PowerPoint will be part of the game, instructions and quiz questions are provided within. Divide the class into 4-6 teams, depending on the number of small whiteboards available to the class. Distribute to each team: one white board, one dry erase marker, an eraser. Students may use paper if whiteboards are not available.

1. Quiz questions are listed in the slide notes section of the PowerPoint. These questions pertain to topographic maps, bathymetric maps, ocean floor features, and importance of ocean covering so much of the Earth.
2. Each group will write their answer on the white board and hold it up for the teacher to see.
3. The first group to answer correctly receives a point.
4. The group with the most points at the end is the winning group.

III. *The Ocean Floor*

A. Have students revisit their hypothetical drawing they did at the beginning of this activity by completing the second page of the *Student Worksheet: Into the Deep*. Using the *Features of the Ocean Floor* and the other maps, have students compare to their drawings. Have students do a new revised drawing based on what they have learned. Use the following guiding questions to stimulate discussion or have students do a writing exercise about what they have learned:

1. Were you surprised that the ocean floor is not flat?
2. What are your biggest "ah-ha's" about the ocean floor?
3. How is your drawing different/same as what you saw?
4. What kind of underwater features were the Hawaiian Islands before they broke through the ocean's surface?
5. Based on what you learned, what are your wonderings about the ocean floor?

B. In order to reinforce the student learning have the class work in pairs on the computer using the *Ocean Geography and Geology Interactive Game.*

LESSON 2 Teacher Reading

Into the Deep

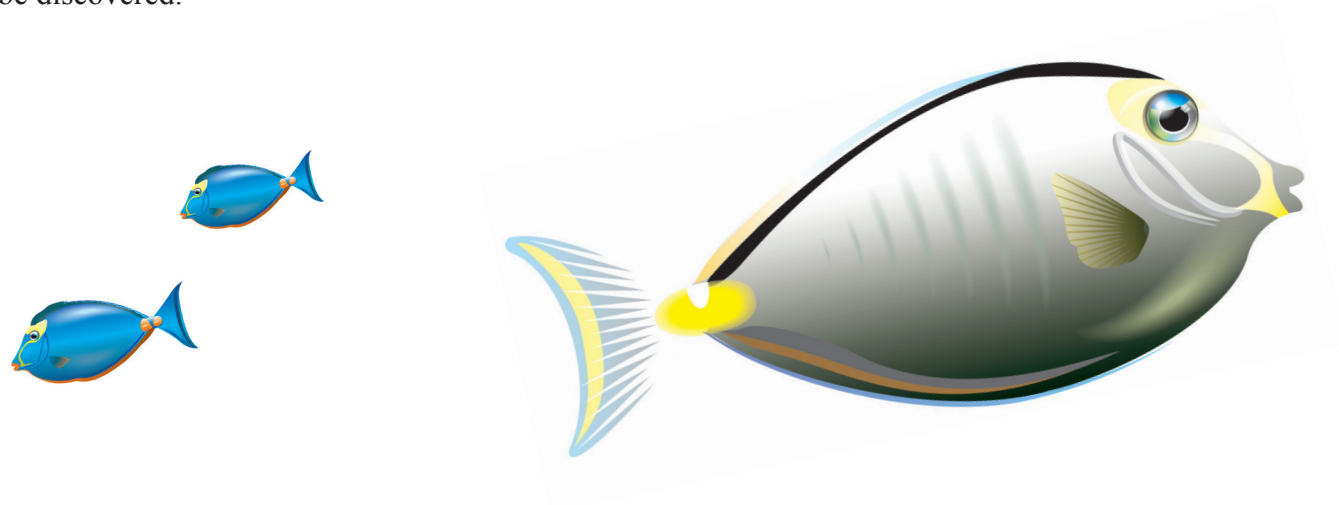
A map is a flat model of our Earth drawn to scale. Topographic maps are used to represent elevations above sea level. Because we can easily see geographic landforms above sea level, it is much easier to map landforms and identify their locations. However, since the ocean floor is not visible, it is very difficult to map. Underwater, or bathymetric, maps are used to represent depths below sea level. Because of the difficulties and limitations in technology, the exploration of deep ocean geographic features remains a challenge to scientists. Even today, much of the ocean floor remains unmapped.

Ocean geography, as it was known in the past, is no longer limited to coastline studies. Technological advances today are slowly allowing studies of the deep ocean realm. The development, in the last 10–20 years, of sophisticated technologies for ocean data collection and management hold tremendous potential for mapping and interpreting the ocean environment. Although mapping remains a fundamental component of ocean floor investigation, deep ocean geographic exploration is also essential in the collection of rocks and sediments that give scientists insights on the ocean environment and resources. There is an excellent interactive bathymetric map of the Hawaiian Islands that would be good to show the students or to have them go to the site themselves. http://www.soest.Hawaii.edu/HMRG/Multibeam/online/

The mid-ocean ridge is the largest and most striking feature on the planet. This ridge is 43,500 miles (70,000 kilometers) long, and runs throughout the world's five ocean basins. The Mid-Atlantic Ridge began as a small crack in the Earth's crust is now a giant undersea mountain range. As magma rises to escape along this ridge, new crust is formed and seafloors spread. Over millions of years, there is evidence that tectonic plates shift thus contributing to the theory of continental drift.

Trenches are now known to be related to subduction zones, places where a plate of oceanic *lithosphere* dives beneath another plate of either oceanic or continental lithosphere. Ocean trenches are found around the edge of the Pacific Ocean and the northeastern Indian Ocean; minor trenches occur in the Caribbean and near the Falkland Islands.

Ocean trenches represent the deepest parts of the ocean floor. The world's deepest trench is the *Mariana Trench*, which has a depth of 36,201 ft (11,034 m). Because at depths below 3.6 mi (6 km), there is no light and very high water pressure, some unusual organisms have been found in the deep ocean and likely many more are yet to be discovered.



LESSON 2 Into the Deep - Page 1

Imagine that you are taking a journey to the bottom of the ocean. Try to answer the following question:

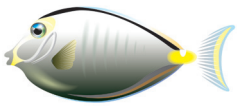
1. If the water were drained out of the ocean, what would it look like? Form your hypothesis stated as an If… then… because statement.

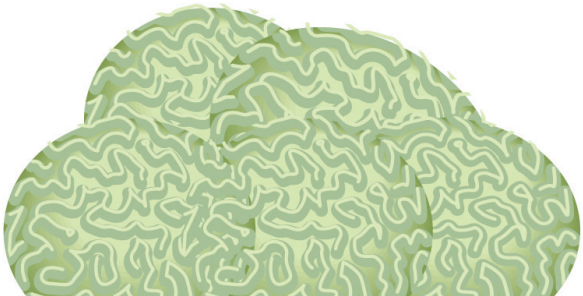
_____

_____

_____

2. Draw a picture of what you think the bottom of the ocean might look like:



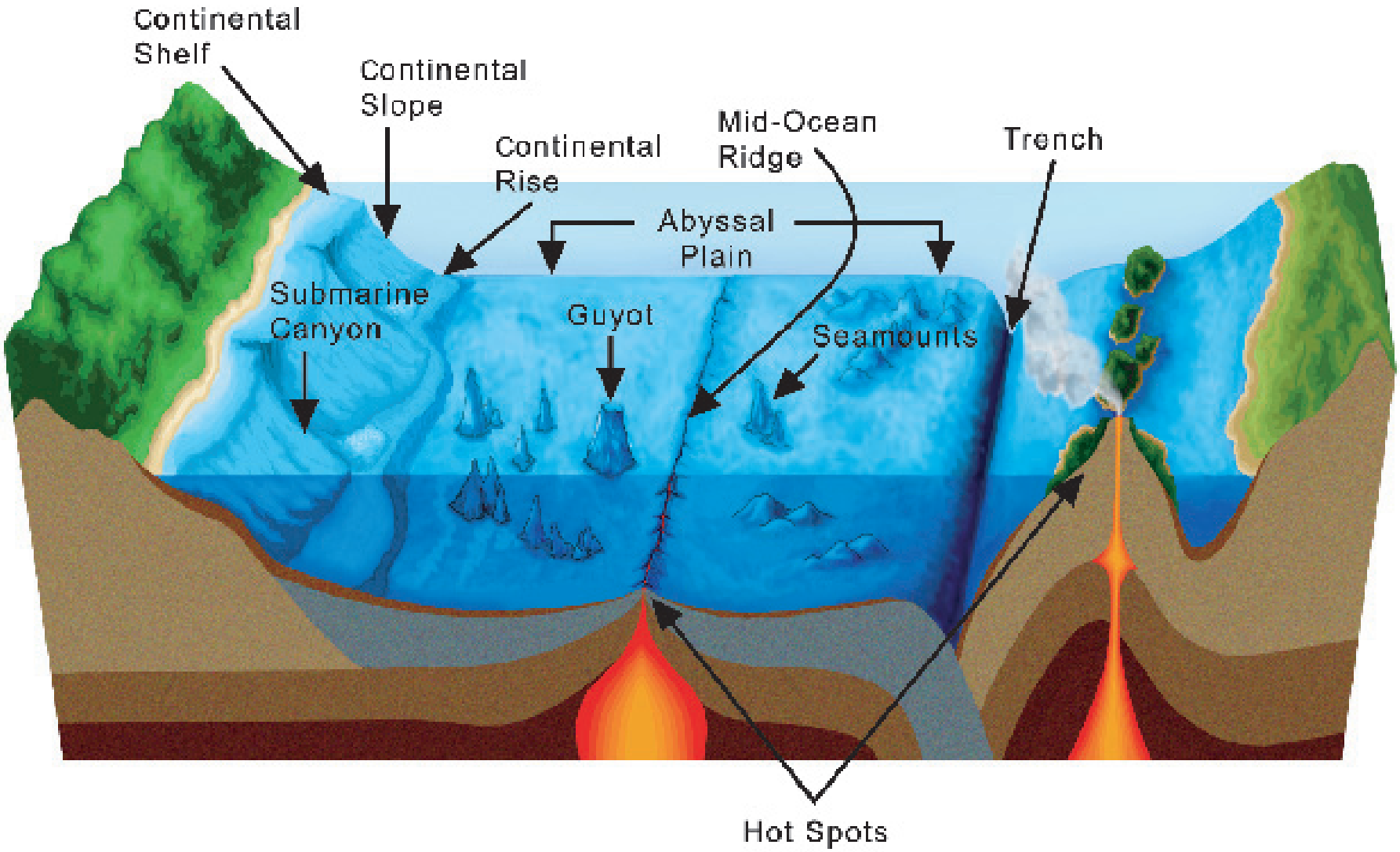


LESSON 2 Into the Deep - Page 2

3. Based on what I have learned, I now think the bottom of the ocean will look like…

4. Explain what you learned about the bottom of the ocean. Was your hypothesis supported? Why or why not?

LESSON 2 Features of the Ocean Floor - Page 1



LESSON 2 Features of the ocean floor - Page 2

Student Vocabulary

abyss: the bottom of the deep ocean below the continental shelf, usually deeper than 13,000 feet (4,000 meters).

abyssal plain: very deep, flat ocean floor covered with a thin layer of sediment.

continental rise: the gently inclined region of ocean floor between the base of the continental slope and the abyssal plain.

continental shelf: the zone bordering a continent, extending from the line of permanent underwater immersion to the depth at which there is a marked or rather steep descent to the great depths.

continental slope: the steep incline between the continental shelf and the abyssal zone.

guyot: submerged, flat-topped seamount.

hot spots: fixed areas of isolated volcanic activity usually found under continents and ocean basins, in the center of plates, and at the mid-ocean ridges.

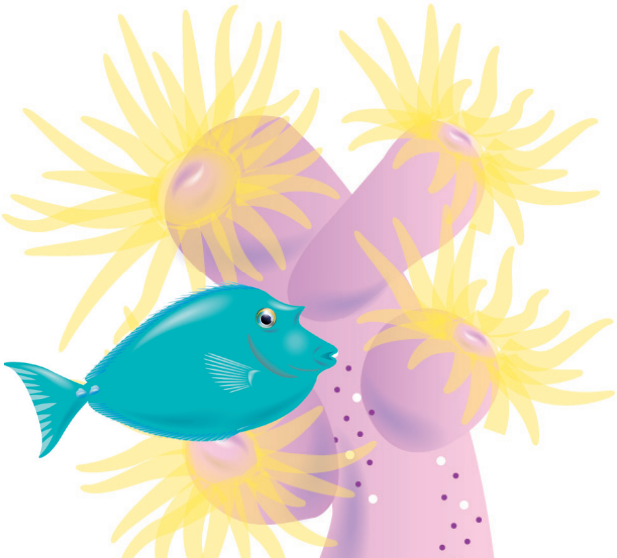
mid-ocean ridge: a chain of undersea mountains in every ocean that circles the Earth like the seam of a baseball for nearly 37,000 miles (59,545 kilometers).

seamount: a volcanic peak or mountain that is underwater.

sediment: debris deposited on the ocean floor.

submarine canyon: a deep, underwater valley sliced into the continental margin.

trench: narrow deep cuts in the ocean floor.



LESSON 3 A Moving Crust

Lesson at a Glance

Students are introduced to plate tectonics in this lesson. In Lesson 2, they discovered that the ocean bottom is not flat when they viewed bathymetric maps showing representations of different ocean geologic features, and the geographic location of some of the most prominent underwater features. In this lesson, they learn how some of the features of the ocean bottom are formed. Students watch a demonstration, and conduct a simple experiment of their own to learn more about seamounts, ridges, trenches, and submarine canyons. They will also play a concentration game to reinforce the concepts of slow and fast processes that shape and reshape the surface of the Earth.

Lesson Duration

Two 45-minute periods

Related HCPSIII Benchmark(s):

Science: SC 4.8.1 Describe how slow processes sometimes shape and reshape the surface of the Earth.

Science: SC 4.8.2 Describe how fast processes (e.g., volcanoes, earthquakes) sometimes shape and reshape the surface of the Earth.

Essential Question(s)

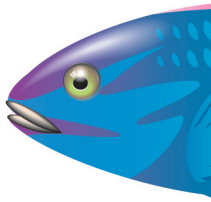
How do fast and slow processes shape and reshape the geologic features of the ocean floor?
How are earthquakes and volcanoes related to ocean geology?

Key Concepts

- The Earth's crust is made of approximately a dozen large tectonic plates and numerous smaller plates.
- Tectonic plates move slowly on top of hot flowing magma.
- In other locations where these plates move away from each other (divergent), hot molten magma rises, forming ridges.
- In instances where plates meet (convergent), many things may happen: deep trenches form, volcanic activity, earthquakes, and some of the world's largest mountain peaks, longest mountain chains, and deepest rift valleys are formed.

Instructional Objectives

- I can describe how slow and fast processes in the Earth's crust shape and reshape the surfaces of the Earth.
- I can explain how earthquakes and volcanoes relate to ocean geology.
- I can use symbols to label underwater geographic features on my world map.



Assessment Tools

Benchmark Rubric:

Topic		Forces that Shape the Earth	
Benchmark SC.4.8.1		Describe how slow processes sometimes shape and reshape the surface of the Earth	
Rubric			
Advanced	**Proficient**	**Partially Proficient**	**Novice**
Use evidence to explain how slow processes have shaped and reshaped the surface of the Earth	Describe how the shaping and reshaping of the Earth's land surface is sometimes due to slow processes	Provide examples of the shaping and reshaping of the Earth's land surface due to slow processes	Recognize that the shaping and reshaping of the Earth's land surface is sometimes due to slow processes

Topic		Forces that Shape the Earth	
Benchmark SC.4.8.2		Describe how fast processes (e.g., volcanoes, earthquakes) sometimes shape and reshape the surface of the Earth	
Rubric			
Advanced	**Proficient**	**Partially Proficient**	**Novice**
Use evidence to explain how fast processes have shaped and reshaped the surface of the Earth	Describe how the shaping and reshaping of the Earth's land surface is sometimes due to fast processes	Provide examples of the shaping and reshaping of the Earth's land surface due to fast processes	Recognize that the shaping and reshaping of the Earth's land surface is sometimes due to fast processes

Assessment/Evidence Pieces

- **Student Worksheet:** *A Moving Crust*

Materials Needed

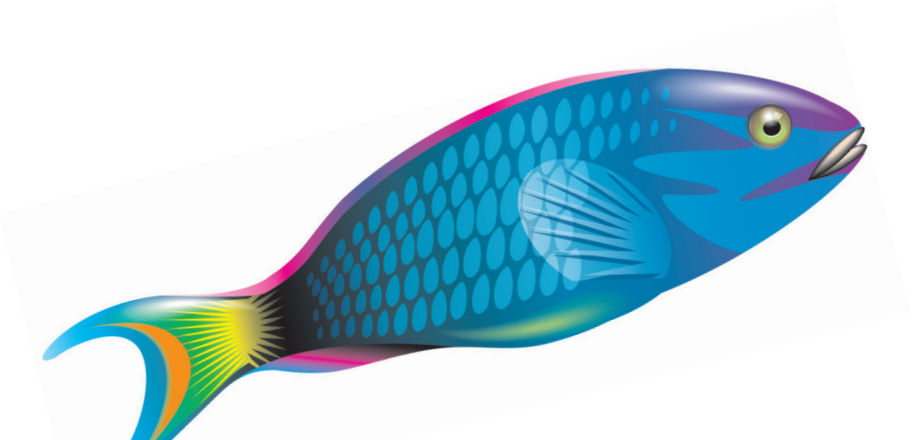
Teacher	Class	Group	Student
- Overhead projector - Cutout of tectonic plates - Scissors - 1 set of tangrams or use pattern provided - 1 can of shaving cream (no gel) - Safety goggles	None	- Transparency cutouts of Earth's plates (triangles to represent plates) - Shaving cream (1 can per four students) - Sponges and paper towels for cleaning - Drawing paper, drawing supplies - World map, safety goggles, large plastic plates or trays, waxed paper or Saran Wrap to protect desk surfaces - One set of A Moving Crust Concentration Game	- Student Worksheet: Student Vocabulary - Student Worksheet: A Moving Crust - Student Worksheet: Moving Crust Crossword Puzzle (Enrichment Activity) - Student Worksheets: Divergent and Convergent Plates Enrichment Activity

Instructional Resources

PowerPoint Presentation: *Plate Tectonics*
PowerPoint Presentation: *Geologic History of a Volcano in the Pacific*
PowerPoint Presentation: *Plate Boundaries Around the World*
Teacher Reading: *The Earth's Plates* – 2 copies- one copy on paper and one copy on a transparency for overhead demonstration. Or cut triangles from the transparency for the demonstration.
Student Reading: *Plate Tectonics*
Student Worksheet: *Student Vocabulary*
Student Worksheet*: A Moving Crust Pre-Assessment*
Student Worksheet*: A Moving Crust Post-Assessment*
Student Worksheet: *A Moving Crust Concentration Game*
Student Worksheet: *Moving Crust Crossword Puzzle*
Teacher Answer Key: *Moving Crust Crossword Puzzle*
Student Worksheet: *Divergent and Convergent Plates Activity Seafloor Spreading-Divergent Plates*
Teacher Answer Key: *Divergent and Convergent Plates Activity Seafloor Spreading-Divergent Plates*
Student Worksheet: *Divergent and Convergent Plates Activity Subduction-Convergent Plates*
Teacher Answer Key: *Divergent and Convergent Plates Activity Subduction-Convergent Plates*
Supplemental Resource: *Ocean Geography and Geology Interactive Game*

Student Vocabulary Words

abyss: the bottom of the deep ocean below the continental shelf, usually deeper than 13,000 feet (4,000 meters).
abyssal plain: the nearly flat portion of deep-ocean floor. About 75 percent of the deep ocean is abyssal plain.
basalt: a type of tough volcanic rock that makes up most of the ocean's basins, mid-ocean ridges, and plates.
convergent plate movement: when two plates collide (at a convergent plate boundary), some crust is destroyed in the impact, and the plates become smaller. The results differ, depending upon what types of plates are involved.
divergent plate movement: seafloor spreading is the movement of two oceanic plates away from each other (at a divergent plate boundary), which results in the formation of new oceanic crust (from magma that comes from within the Earth's mantle) along a mid-ocean ridge.
magma: molten, mobile, rock material, deep under the Earth's crust.
mid-ocean ridge: a chain of undersea mountains in every ocean that circles the Earth like the seam of a baseball for nearly 37,000 miles (59,545 kilometers).
mantle: the zone within the Earth, from below the crust to the core, made up of semi-molten rock upon which the Earth's tectonic plates float.
plates: huge, mobile rock slabs of varying sizes and thickness that form the Earth's crust.
rift: an opening or fissure. In geology, a large rift is caused mainly by lateral movement.
seamount: an isolated volcanic peak that rises at least 3,280 feet (1,000 meters) from the seafloor.
tectonics: a study of the building and changing of the Earth's crust.



Lesson Plan

Lesson Preparation

- Review the Science Background provided in the Unit's Overview and the Teacher Reading.
- Prepare copies of the Student Worksheets.
- Copy the vocabulary onto chart paper. Include a picture/diagram, where appropriate, next to the vocabulary word. You may choose to photocopy the Student Vocabulary included in this lesson.
- Have a copy of Teacher Reading: *The Earth's Plates* and scissors to cut them. Make sure that you have an overhead projector handy and enough shaving cream (not the gel kind) for each group of students. (Approximately one can for every four students.)
- Cut triangles from transparencies to represent the Earth's plates for the groups.
- Prepare cards for *A Moving Crust Concentration Game*. Reprint, laminate and cut game cards, one set for each group of 4 to 5 students.
- Preview PowerPoints *Plate Tectonics, Geologic History of a Volcano in the Pacific* and *Plate Boundaries Around the World*. Make arrangements to project them.
- **Preview the interactive piece** *Ocean Geography and Geology* **to be completed at the of Step V.**

I. *Introducing the Lesson*

Begin the lesson by distributing a copy of the Student Worksheet for lesson 3, A *Moving Crust*, and asking the students to write, or draw, how they think the underwater mountain ranges were formed. As they finish writing their predictions, distribute the student vocabulary terms, or have students write them down.

II. *Teacher Demonstration with Overhead Projector*

A. Explain to students that the Earth is not one solid ball. The Earth is comprised of plates of rock of various sizes that make up the Earth's crust. Show PowerPoint *"Plate Boundaries Around the World."* Leave the PowerPoint up on the screen as a point of reference as you continue this portion of the lesson. The *Mid-Ocean Ridge* they marked on their world map in the previous lesson marks one of these plate boundaries. The *plates* float above hot liquid magma, whose heat makes them come together (convergent), move apart (divergent), and slide past each other (transformed). Sometimes, the plates come together until one plate sinks under the other to be recycled in the magma; both deep ocean trenches and high mountains are formed in the process.

B. Explain to the students that the movement of the plates are considered slow processes overall. However, an earthquake or volcanic eruption is considered a fast process when it happens.

C. Show the PowerPoint *Plate Tectonics* to the students. Hand out copies of the *Divergent and Convergent Plates Activity* sheets to each student. Have them fill in the sheets as they view the PowerPoint.

D. Hold up a transparency copy (preferably color) of Teacher Resource: *The Earth's Plates.*

E. Cut the plates apart and lay them on the overhead.

F. Discuss ocean spreading and *divergent plates* – move the North American and Eurasian divergent plate away from each other. Explain that, when this happens, magma rises up, forming new ocean floor and mid-ocean ridges**.**

G. Next, slide the Pacific Plate and the North American plate laterally (transformed boundaries). This represents the San Andreas Fault, a geological fault line that moves in a northwest–southeast direction through the state of California.

H. To represent a convergent plate, show the Pacific Plate moving under the Philippine Sea Plate. This convergence will cause deep trenches, such as the Mariana Trench.

III. *Student Activity-Tectonic Plates and Shaving Cream*

(Comment to teacher: This could be done as a teacher demo instead of student activity.)

A. Have students split into pairs and clear their desk surface.

B. Distribute two triangles from the transparency cut outs set to each group.

C. Circulate around room, squirting ¼ can shaving cream onto each group's desk; explain that below the Earth's crust is magma, or molten lava. The shaving cream represents the magma.

D. Have students lay their two triangles from the transparency cut outs on top of the shaving cream so that they form a square.

E. Ask students to, very *slowly*, push down and gently pull the two triangles apart to represent divergent plates.

- What did you see happening as the plates moved apart? *(shaving cream filled up in between, making a ridge.)*

F. Next, have students scrape their shaving cream into a clean pile to work with again. Place the transparency cut out triangles back on top to form a square. This time, have students push one of the triangles down and under the other.
   - What did you see happening when your plates converged, or slid underneath one another? *(A small ridge and trench formed.)*

G. Engage students in a short debate to discuss whether these are fast or slow processes. *(It is relative)*

H. Using a sponge, paper towels, and clean water, have students wash their desks clean. Shaving cream is a good cleaning agent.

IV. *Volcanoes PowerPoint and Student Activity-Modeling Origins of Seamounts using Shaving Cream*

A. Explain to students that the Hawaiian Archipelago was formed by a hot spot. Most hot spots are located along divergent plate boundaries with a few at the mid ocean ridge and some away from plate boundaries. The most notable hot spot is found beneath the Big Island. As the plates move away from the hot spot, new islands are formed. The farther away from the hot spot, the older the island. Coral reefs form around these islands as they settle and erode and become seamounts.

B. Show students the *Geologic History of a Volcano in the Pacific* PowerPoint. Have students take notes.

C. Teacher Demonstration: Origins of Seamounts

D. Make, or purchase, a framed window screen and one can of shaving cream
   1. Review the concept of plate tectonics. Make sure that students understand the different volcanic activities: slow, oozing lava at seafloor spreading ridges, and active volcanoes (seamounts) at hot spots or subduction zones.
   2. Demonstrate how volcanic eruptions at a hot spot produced the Hawaiian Islands archipelago. Procedures:
      a. Invite two students to come up front and hold the screen, which represents the *plate*.
      b. Holding the shaving cream can under the screen, gently squirt a small amount of foam out as the students move the screen very slowly over the shaving cream can.
      c. As the screen moves over the can, small mounds (seamounts) will form on top of the screen. Make 4–6 mounds to show how a chain of seamounts is formed.
      d. Discuss with students whether volcanic activity is a fast or slow process.

V. *A Moving Crust Concentration Game*

A. The concentration game reinforces students understanding of slow and fast processes that sometimes shape and reshape the surface of the Earth. Students will match the information on a card with its example.

B. Students could create more information cards and examples to add to the collection of game cards. Keep in mind that a process that is considered as a fast process, may take thousands of years. The seamount, *Lōʻihi*, will take thousands of years before it surfaces as an island, however, eruptions at its surface underwater are constantly reshaping the surface of the Earth. Therefore, volcanoes and hot spots are fast processes.

C. If time permits have students work in pairs on the computer using the *Ocean Geography and Geology Interactive Game* to reinforce learning.

VI. *Pre/Post Assessment*

A. As a Post Assessment, have students draw pictures to match the definition of divergent and convergent plates on page 2 of their worksheet, *A Moving Crust*. Also, have the students write a brief description on the lines at the bottom of their pictures. (LA.3.1.3)

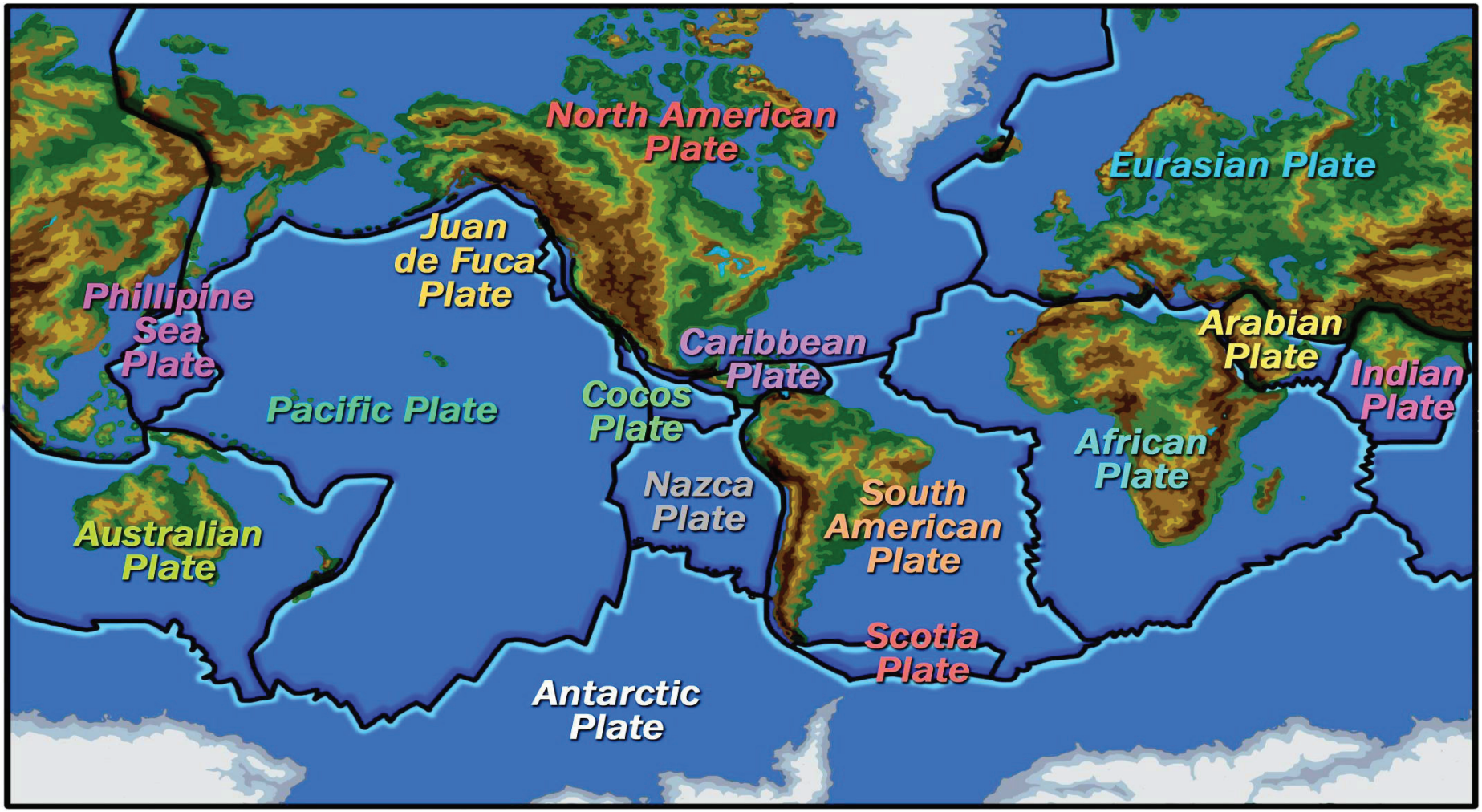
B. As students complete their drawings, they may work on coloring and labeling their world map in their portfolio from previous lessons.

Extended Activities

Students review terms and definitions by completing the crossword puzzle in class or as homework.

Teacher Reading: The Earth's Plates:

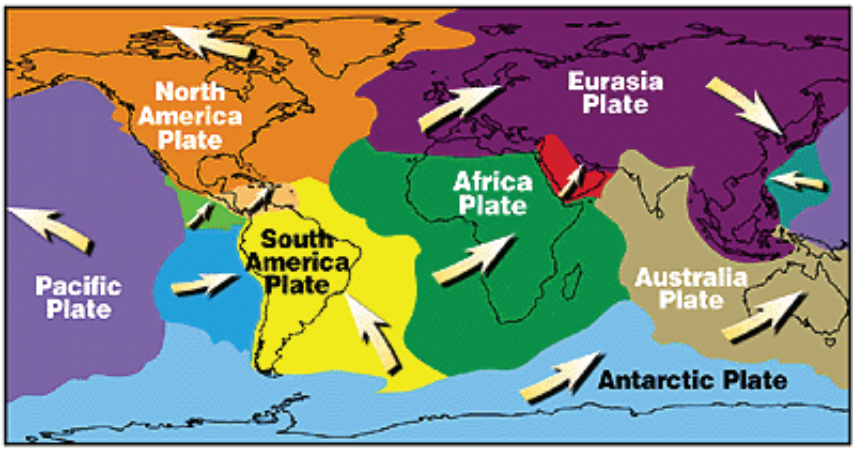
Blow up to full page, cut apart the major plates for demonstration III. C



LESSON 3 Student Reading

Plate Tectonics

The term **plate tectonics** refers to how the Earth's surface is made up of plates. In geology, a **plate** is a large slab of rock, while **tectonics** is a word of Greek origin meaning *to* **build.** According to this theory, the Earth's crust is made up of plates on which the continents and ocean rests. These plates are continually shifting because the surface beneath them — the hot, soft mantle — is moving slowly like a conveyor belt, driven by heat and other forces at work in the Earth's core. The plates are moving approximately 1 centimeter (0.5 inches) to 15 centimeters (6 inches) per year in different directions. This map shows the major tectonic plates that make up the Earth's crust and the directions in which they are moving.



Map adapted from NOAA

Vents, Volcanoes, and Earthquakes

The Earth's tectonic plates can move apart, collide, or slide past each other. The Mid-Ocean Ridge system — the Earth's underwater mountain range — arises where the plates are moving apart. As the plates move apart, the seafloor cracks. Cold seawater seeps down into these cracks, becomes super-heated by magma, and then bursts back out into the ocean, forming hydrothermal vents. As the plates move farther apart, magma from the Earth's mantle fills the gap, sometime leading to the eruption of undersea volcanoes. This process, called **seafloor spreading**, is how new seafloor is formed.

Conversely, when tectonic plates meet at a **convergent boundary**, the force causes Earthquakes, mountains to rise, and deep trenches to form. When the edge of one plate is forced under another — a process called **subduction** — the crust of the sinking plate is destroyed as it remelts in the hot mantle. When the edges of one plate slides past another plate – along a **transform boundary** – crust is neither created nor destroyed. The current continental and oceanic plates include: the Eurasian Plate, Australian-Indian Plate, Philippine Plate, Pacific Plate, Juan de Fuca Plate, Nazca Plate, Cocos Plate, North American Plate, Caribbean Plate, South American Plate, African Plate, Arabian Plate, the Antarctic Plate, and the Scotia Plate. These plates consist of smaller sub-plates.

LESSON 3 Student Vocabulary

abyss: the bottom of the deep ocean below the continental shelf, usually deeper than 13,000 feet (4,000 meters).

abyssal plain: the nearly flat portion of deep-ocean floor. About 75 percent of the deep ocean is abyssal plain.

basalt: a type of tough volcanic rock that makes up most of the ocean's basins, mid-ocean ridges, and plates.

convergent plate movement: when two plates collide (at a convergent plate boundary), some crust is destroyed in the impact, and the plates become smaller. The results differ, depending upon what types of plates are involved.

divergent plate movement: seafloor spreading is the movement of two oceanic plates away from each other (at a divergent plate boundary), which results in the formation of new oceanic crust (from magma that comes from within the Earth's mantle) along a mid-ocean ridge.

magma: molten, mobile, rock material, deep under the Earth's crust.

mid-ocean ridge: a chain of undersea mountains in every ocean that circles the Earth like the seam of a baseball for nearly 37,000 miles (59,545 kilometers).

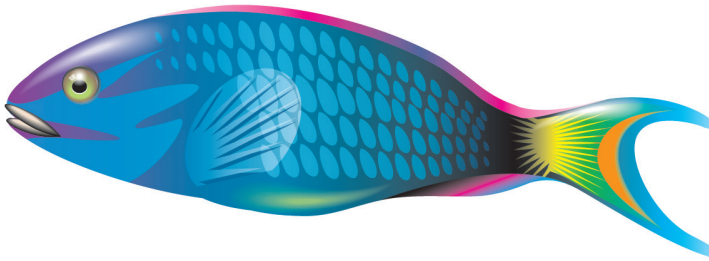
mantle: the zone within the Earth, from below the crust to the core, made up of semi-molten rock upon which the Earth's tectonic plates float.

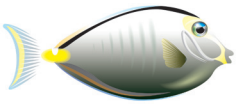
plates: huge, mobile rock slabs of varying sizes and thickness that form the Earth's crust.

rift: an opening or fissure. In geology, a large rift is caused mainly by lateral movement.

seamount: an isolated volcanic peak that rises at least 3,280 feet (1,000 meters) from the seafloor.

tectonics: a study of the building and changing of the Earth's crust.





LESSON 3 A Moving Crust Pre-Assessment

Name:_____ **Date:** _____

Question:
What might be some ways tectonic plates move? What do you think happens when tectonic plates move?

I think that this is what happens when tectonic plates move…

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

LESSON 3 A Moving Crust - Post Assesment

Directions: Draw a picture to illustrate each term:

1. Convergent plate boundary (plates meet)

2. Divergent plate boundary (plates pull apart)

Are convergent and divergent plate movements a fast or slow process and why?

_____

_____

_____

_____

LESSON 3 A Moving Crust Concentration Game

Directions: Reprint, laminate, and cut game cards, one set for each group of 4 to 5 students. Match the information on a card with its example.

Erosion caused by the wind is a slow process. An example of this are the dunes found at **Great Sand Dunes National Park** in Colorado.

Great Sand Dunes National Park

http://www.nps.gov/grsa

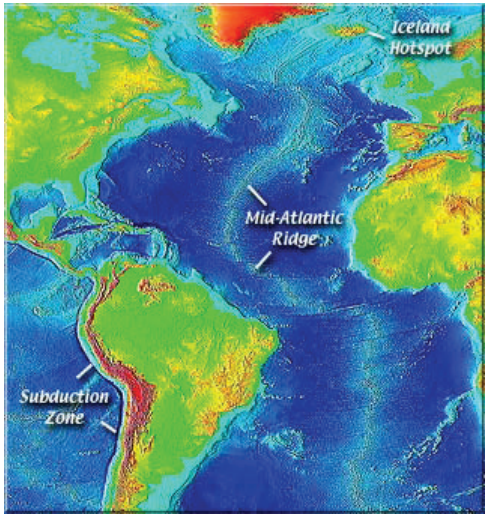
Erosion caused by water is a slow process. An excellent example of this is the **Grand Canyon** formed by the Colorado River in Northern Arizona.

Grand Canyon

http://www.nps.gov/grca/naturescience/index.htm

Plate movements are slow processes. When two plates pull apart their boundaries are called divergent boundaries. At these boundaries magma pours out to form ridges. An excellent example of this is the **Mid Atlantic Ridge.**

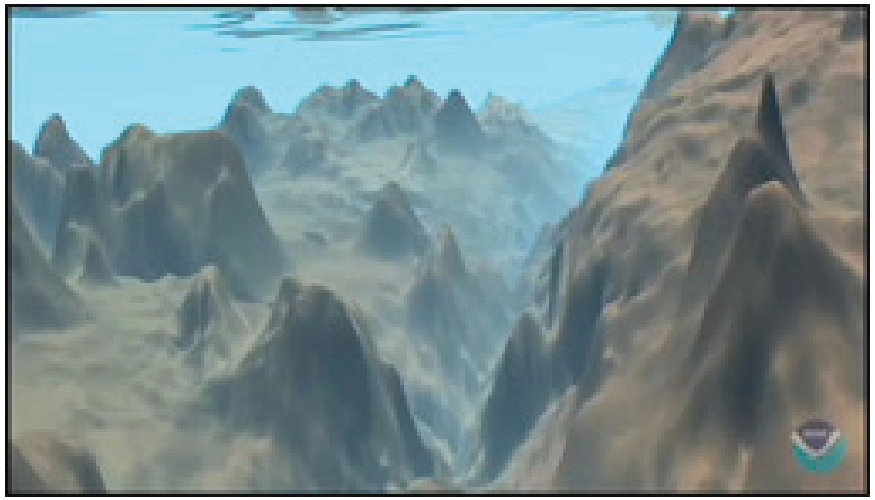
Mid Atlantic Ridge



http://geomaps.wr.usgs.gov/parks/pltec/noaaMidAtlanticRidgeL.jpg

Plate movements are slow processes. When two plates come together the plate with the greater mass sinks under the plate with less mass. Trenches are formed at these convergent boundaries.
An example is the **Marianas Trench.**

Marianas Trench



http://www.ngdc.noaa.gov/mgg/image/marianas.html

Plate movements are slow processes. When plates converge they sometimes form fold mountains. The India Plate crushed into the Eurasian Plate forming the **Himalayas,** which continues to rise 5mm each year.

Himalayas

http://www.free-slideshow.com/stock-photos/nepal/nepal-austere-himalayas.jpg

Plate movements are slow processes. When plates slide by each other laterally they are called transform boundaries.
An excellent example of this is the **San Andreas Fault,** which runs through California.

San Andreas Fault

http://www.scienceclarified.com/images/uesc_05_img0243.jpg

Volcanic eruptions are fast processes. They can quickly reshape the surface of the Earth. An example is the eruption of **Mt. St. Helens.**

Mt. St. Helens

www.usgs.gov

Earthquakes are fast processes. They can quickly reshape the surface of the Earth. An example of cracks caused by a M7.2 Earthquake at the **Hilina Pali Road in Hawai‘i Volcanoes National Park,** 11/29/75.

Hilina Pali Road

http://hvo.wr.usgs.gov/

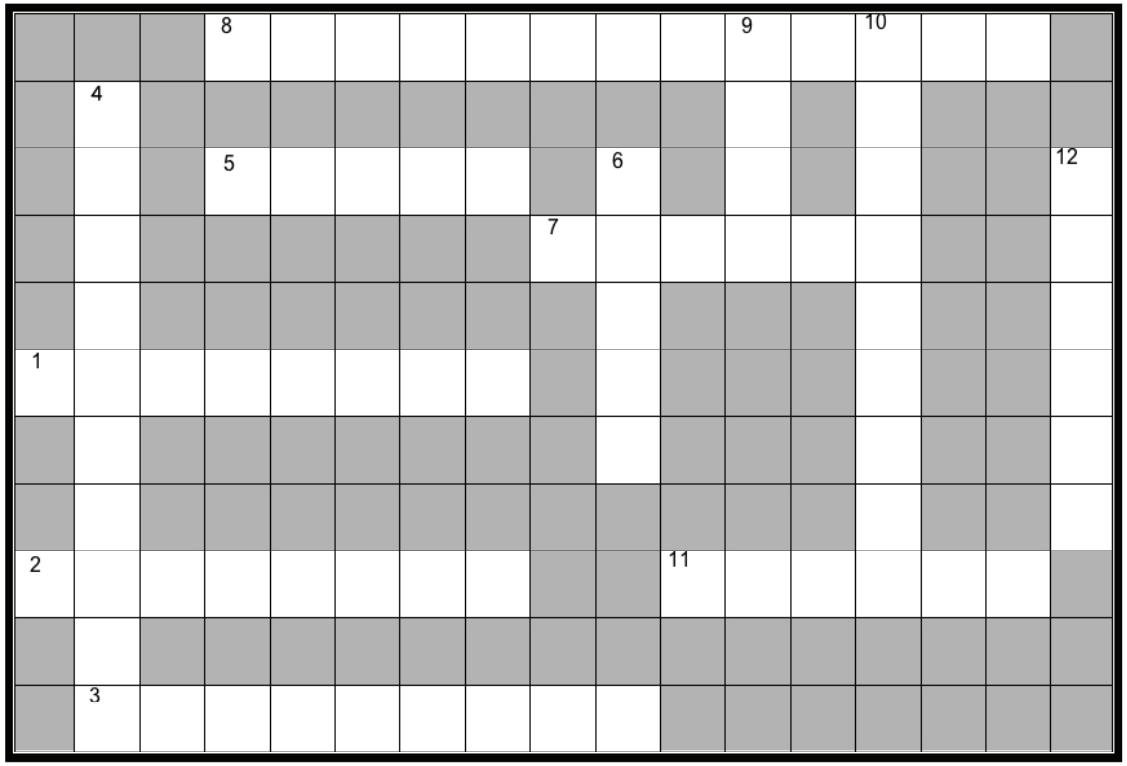
Although erosion is a slow process, erosion caused by ocean waves can sometimes happen quickly.
An example is the sea arches that formed where lava entered the sea and the waves carved cliff and sea arches.
Sea Arches along the Puna coast of the Hawai‘i Volcanoes National Park.

Sea Arches - Puna Coast of the Hawai'i Volcanoes National Park

http://www.ngdc.noaa.gov/

LESSON 3 Moving Crust Crossword Puzzle

Name: _____ **Date:** _____



ACROSS

1. A mountain peak on the ocean floor that does not reach the surface of the water.
2. The bottom or floor of the ocean.
3. The study of the structure of the Earth's surface.
5. The bottom of the deep ocean below the continental shelf, usually deeper than 13,000 feet (4,000 meters)
7. The layer of the Earth between the crust and the core.
8. A mid-ocean chain of undersea mountains that circle the Earth like the seam of a baseball.
11. Huge rock slabs that form the Earth's crust.

DOWN

4. Plate movement when two plates move toward each other.
6. Hot molten rock deep below the Earth's surface.
9. A crack in the Earth's surface between two divergent plates.
10. Plate movement when two plates move away from each other.
12. A type of tough volcanic rock that makes up most of the ocean's basins, mid-ocean ridges, and plates.

LESSON 3 Moving Crust Crossword Puzzle Teacher Answer Key

			8 M	I	D	O	C	E	A	N	9 R	I	10 D	G	E	
	4 C										I		I			
	O		5 A	B	Y	S	S		6 M		F		V			12 B
	N							7 M	A	N	T	L	E			A
	V								G				R			S
1 S	E	A	M	O	U	N	T		M				G			A
	R								A				E			L
	G												N			T
2 S	E	A	F	L	O	O	R			11 P	L	A	T	E	S	
	N															
	3 T	E	C	T	O	N	I	C	S							

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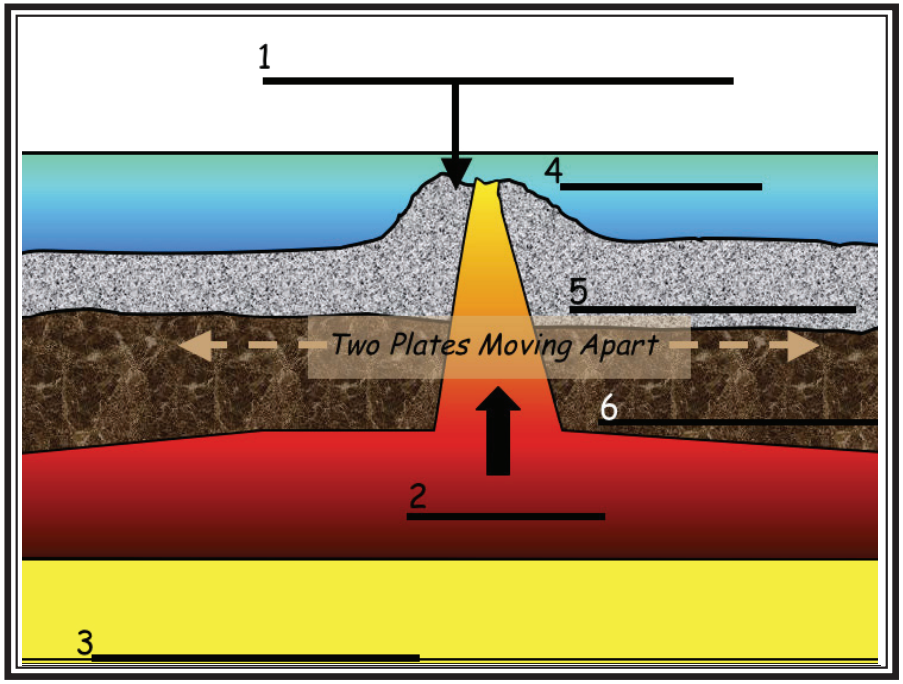
LESSON 3 Divergent and Convergent Plates Activity Seafloor Spreading Divergent Plates

Directions: Read the definitions and label the diagram of the seafloor.

lower mantle (semi-rigid) – the deepest parts of the mantle, just above the core
magma – molten rock within the Earth's mantle. In the seafloor spreading, magma moves up to the crust
ocean – large bodies of water sitting atop the ocean's crust
oceanic crust – thin parts of the Earth's crust located under the oceans
oceanic ridge – mountain range where Earth's tectonic plates are gradually moving apart
upper mantle (rigid) – the uppermost part of the mantle, part of the lithosphere



LESSON 3 Divergent and Convergent Plates Activity Seafloor Spreading Divergent Plates - Teacher Answer Key

Name: _____ **Date:** _____

Directions: Read the definitions and label the diagram of the seafloor.

lower mantle (semi-rigid) – the deepest parts of the mantle, just above the core
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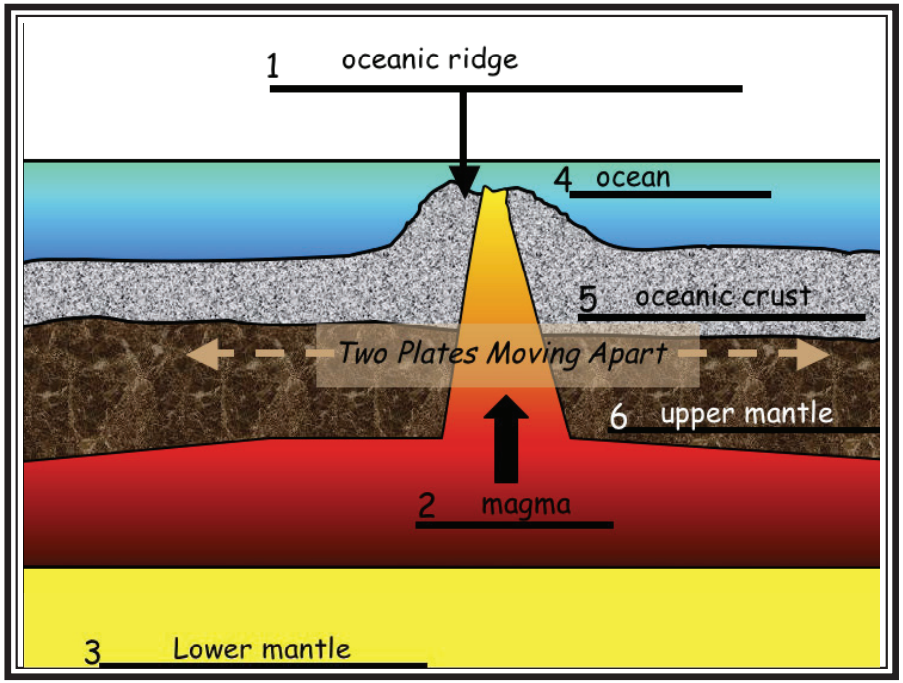
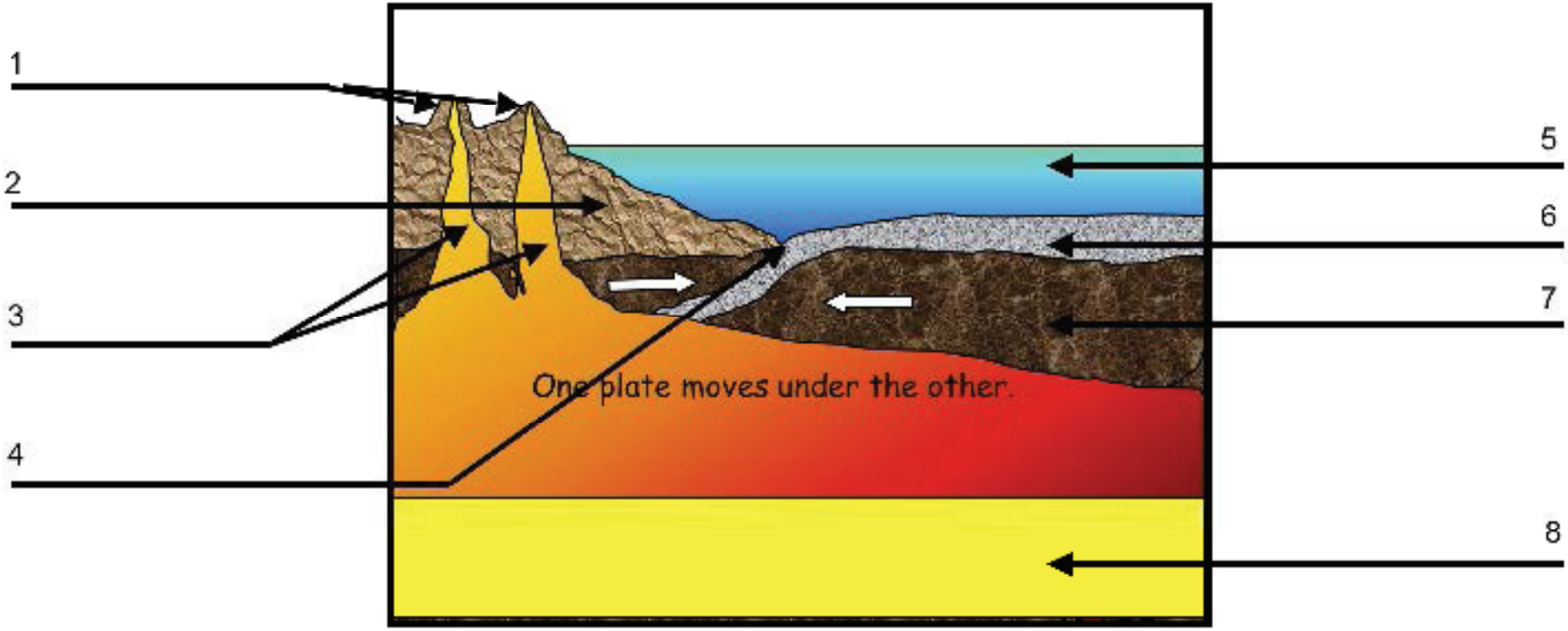


LESSON 3 Divergent and Convergent Plates Activity Subduction Convergent Plates

Directions: Read the definitions and label the diagram of the seafloor.



Directions: Cut in half and distribute one list of definitions to each student.

Lesson 3
Subduction – Convergent Plates

Read the definitions and use them to label the diagram of the convergent plates.

1. **Continental crust –** thick layers of the Earth's crust not located under the ocean
2. **Lower mantle –** the deepest parts of the mantle
3. **Magma –** molten rock in the Earth's mantle that moves from the asthenosphere to the crust
4. **Ocean –** large bodies of water sitting on the oceanic crust
5. **Oceanic crust –** thin layers of the crust under the ocean
6. **Subduction zone –** the place where one part of the Earth's crust is pushed under another plate
7. **Upper mantle –** the top part of the mantle
8. **Volcanoes –** places in the Earth's surface where magma erupt

Lesson 3
Subduction – Convergent Plates

Read the definitions and use them to label the diagram of the convergent plates.

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4. **Ocean –** large bodies of water sitting on the oceanic crust
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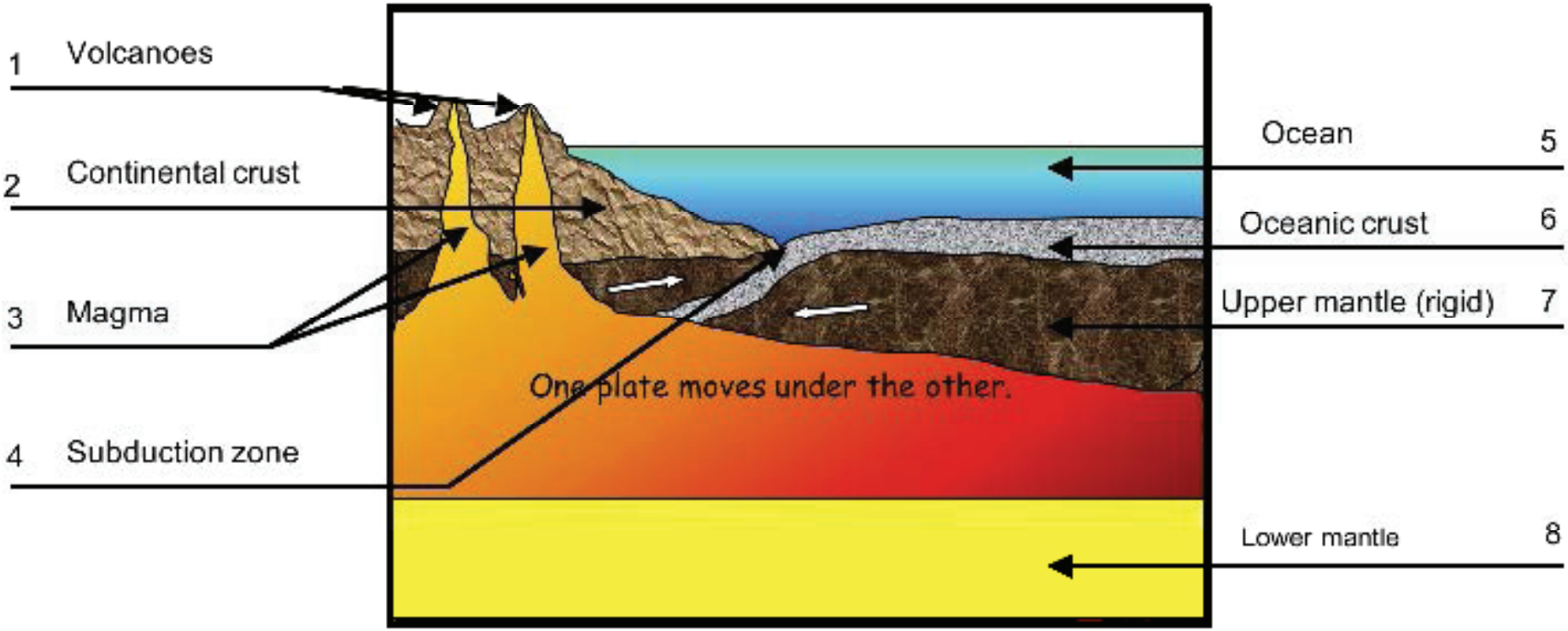
LESSON 3 Divergent and Convergent Plates Activity Subduction Convergent Plates - Teacher Answer Key

Name: _____ **Date:** _____

Directions: Read the definitions and label the diagram of the convergent plates.



CULMINATING LESSON

Ocean Floor Geology

Lesson at a Glance

After a short review of the different geological formations found on the ocean floor, students construct three-dimensional models of the ocean floor's specific geological features. Students imagine what it might be like from the edge of a continent down to the deepest part of the ocean. Student groups cooperatively design their own ocean using modeling clay or dough. Although clay models are suggested, students may choose other representations, such as, Paper Mache or Plaster of Paris.

Lesson Duration

Two to four 45-minute periods over two weeks

Essential Question(s)

What are the major features of the ocean?

Key Concepts

The ocean floor has many geologic features formed through fast and slow processes around the globe.

Instructional Objectives

- I can identify features of the ocean floor formed through fast and slow processes.
- I can locate an ocean feature on a global map.
- I can present my model to the class.

Related HCPSIII Benchmark(s):

Science: SC 4.8.1 Describe how slow processes sometimes shape and reshape the surface of the Earth.

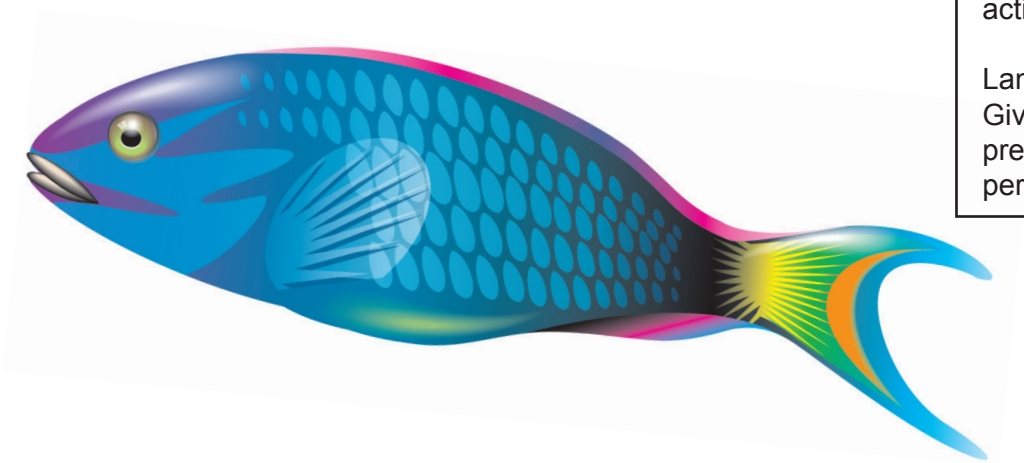
Science: SC 4.8.2 Describe how fast processes (e.g., volcanoes, earthquakes) sometimes shape and reshape the surface of the Earth.

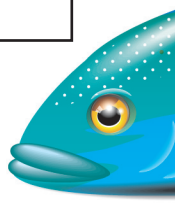
Social Studies SS.4.7.2 Collect, organize, and analyze data to interpret and construct geographic representations.

Math: MA 4.8.1 Use ordered pairs to plot points on a coordinate grid.

Language Arts LA.4.6.1 Participate in grade-appropriate oral group activities.

Language Arts: LA.4.6.2 Give short, informal presentations to inform or persuade



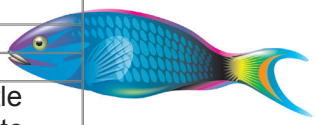


Assessment Tools

Benchmark Rubric:

Topic		Forces that Shape the Earth	
Benchmark SC.4.8.1		Describe how slow processes sometimes shape and reshape the surface of the Earth	
Rubric			
Advanced	**Proficient**	**Partially Proficient**	**Novice**
Use evidence to explain how slow processes have shaped and reshaped the surface of the Earth	Describe how the shaping and reshaping of the Earth's land surface is sometimes due to slow processes	Provide examples of the shaping and reshaping of the Earth's land surface due to slow processes	Recognize that the shaping and reshaping of the Earth's land surface is sometimes due to slow processes

Topic		Forces that Shape the Earth	
Benchmark SC.4.8.2		Describe how fast processes (e.g., volcanoes, earthquakes) sometimes shape and reshape the surface of the Earth	
Rubric			
Advanced	**Proficient**	**Partially Proficient**	**Novice**
Use evidence to explain how fast processes have shaped and reshaped the surface of the Earth	Describe how the shaping and reshaping of the Earth's land surface is sometimes due to fast processes	Provide examples of the shaping and reshaping of the Earth's land surface due to fast processes	Recognize that the shaping and reshaping of the Earth's land surface is sometimes due to fast processes
Topic		World In Spatial Terms	
Benchmark SS.4.7.2		Collect, organize, and analyze data to interpret and construct geographic representations	
Rubric			
Advanced	**Proficient**	**Partially Proficient**	**Novice**
Collect, organize, and analyze data to interpret and construct geographic representations, with accuracy	Collect, organize, and analyze data to interpret and construct geographic representations, with no significant errors	Collect, organize, and analyze data to interpret and construct geographic representations, with a few significant errors	Collect, organize, and analyze data to interpret and construct geographic representations, with many significant errors
Topic		Coordinate Geometry	
Benchmark MA.4.8.1		Use ordered pairs to plot points on a coordinate grid	
Rubric			
Advanced	**Proficient**	**Partially Proficient**	**Novice**
Use ordered pairs to plot points on a coordinate grid, with accuracy	Use ordered pairs to plot points on a coordinate grid, with no significant errors	Use ordered pairs to plot points on a coordinate grid, with a few significant errors	Use ordered pairs to plot points on a coordinate grid, with many significant errors
Topic		Discussion and Presentation	
Benchmark LA.4.6.1		Participate in grade-appropriate oral group activities	
Rubric			
Advanced	**Proficient**	**Partially Proficient**	**Novice**
Participate in grade-appropriate oral group activities, in a highly effective way	Participate in grade-appropriate oral group activities	Participate in grade-appropriate oral group activities, in a limited way or in a way that only partially facilitates the group's work	Participate very little in grade-appropriate oral group activities or participate in a way that does not facilitate the group's work



Topic		Discussion and Presentation	
Benchmark LA.4.6.2		Give short, informal presentations to inform or persuade	
Rubric			
Advanced	**Proficient**	**Partially Proficient**	**Novice**
Give creative, short, highly effective informal presentations to inform or persuade	Give short, informal presentations to inform or persuade	Give short, informal presentations that are somewhat informative or persuasive	Give short, informal presentations that do not inform or persuade

Assessment/Evidence Pieces

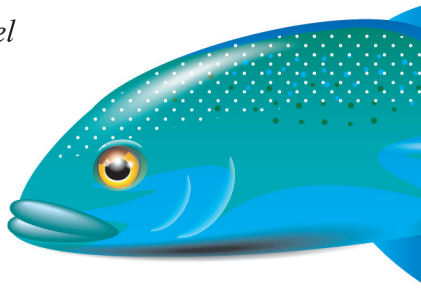
- **Assessment Tool:** *Self Assessment*

Materials Needed

Teacher	Class	Group	Student
- Computer to show images of ocean floor http://www.learningdemo.com/noaa/lesson15.html - Modeling clay or play dough - Clear plastic food containers, rectangular-shaped and deep (shoe box size), (one for every 2–3 students) - Blue cellophane paper - Rubber bands - Toothpicks and Post-it notes	SAFETY: Use caution. Please advise students on the safe use of the toothpicks and the	- One clear plastic container - Enough modeling clay or dough for students to create their own 3-D model of ocean floor representing different geological features - Tooth picks and Post-it notes to make labels for the model - Plastic knife for cutting and sculpting - Blue cellophane paper and clear tape to cover top of model	- Assessment Tool: *Self Assessment*

Instructional Resources

Teacher Resource: *Video on Internet at:*
http://www.learningdemo.com/noaa/lesson15.html
Student Worksheet: *Self Evaluation – Rubric Checklist Ocean Geography Model*



Student Vocabulary Words

archipelago: a large group of islands.
abyssal plain: very deep, flat ocean floor covered with a thin layer of sediment.
bathymetry: depth measurement to determine the contours of the ocean.
bathymetric map: maps that show depths below sea level (also called charts).
canyon: a deep, narrow gorge with steep sides. An underwater canyon is called a **submarine canyon.**
continental rise: the gently inclined region of ocean floor between the base of the *continental slope* and the *abyssal plain*.
continental slope: the steep incline between the continental shelf and the abyssal zone.
contour line: a line on a map representing an imaginary line on land, or bottom of the sea, that has the same elevation or depth along its entire length.
contour interval: the difference in elevation or depth between two contour lines.
mid-ocean ridge: a chain of undersea mountains in every ocean that circles the Earth like the seam of a baseball for nearly 37,000 miles (59,545 km).
ridge: a long, narrow rise in the seafloor with steep sides and a bumpy shape.
seamount: a volcanic peak or mountain that is underwater.
trench: narrow deep cuts in the ocean floor.
topographic map: a map that shows physical features of elevation above sea level.

Lesson Plan

Lesson Preparation

- Collect clear plastic containers for creating the 3-D model of the ocean floor.
  - A. Send home a letter to parents a week in advance requesting shoebox-size clear plastic containers for this class exercise.
- Arrange to have a computer and projector available for viewing images at http://www.learningdemo.com/noaa/lesson15.html
- If you are not using store quality modeling clay or play dough, you may use one of the following recipes:

Traditional Play Dough

- 1 cup flour
- 1 cup warm water
- 1 teaspoons cream of tartar
- 1 teaspoon oil
- 1/4 cup salt
- food coloring – a few drops

Mix all ingredients, adding food coloring last. Stir over medium heat until smooth. Remove from pan and knead until blended smooth. Place in plastic bag or airtight container when cooled.

Salt Dough Recipe

- 1 cup flour
- 1 cup salt
- 1-1/2 cups hot water (from tap)
- 2 teaspoons vegetable oil (optional)

Mix the salt and flour together, then gradually add the water until the dough becomes elastic. (Some recipes call for 2 teaspoons of vegetable oil at this point.) If your mixture turns out too sticky, simply add more flour. If it turns out too crumbly, add more water. Knead the dough until it's a good consistency.

I. *Reviewing Ocean Floor Images and Concepts*

A. Show the images of the submarine geological features presented in the lesson 2, *Features of the Ocean Floor* Worksheet on page 48.

B. Review the different geologic features previously discussed, including seamount, trench, mid-ocean ridges, continental shelf, and submarine canyon.

II. *Creating 3-D Ocean Floor Models*

A. Show students the expectations and rubric for the 3-D model, and discuss the evaluation criteria.

B. Divide the class into groups of three, and assign each group either a tectonic plate movement (divergent, convergent, and transformational) or an ocean floor feature (seamount, trench, mid-ocean ridge, guyot, submarine canyon, abyss, continental shelf, etc) to create with the clay or dough.

C. Assign each student one of these cooperative learning roles: Materials/Starter, Director, Presenter/Checker.

D. Have the Materials person get one clear food container, a large section of clay or play dough, toothpicks, Post-it notes and plastic knives for sculpting.

E. Allow one full class period for students to create their ocean floor models. Have the groups make a draft of their model on paper before actually creating the model.

F. Once students have molded their underwater scene, ask them to double-check the rubric/checklist to make sure they have included all the features listed, and that all the features are labeled.

G. Cover the container with blue cellophane paper, and secure the cellophane with clear tape.

III. *Sharing Ocean Floor Models*

A. Invite each group to come to the front of the classroom to share their model, pointing out the different features they have on their ocean floor.

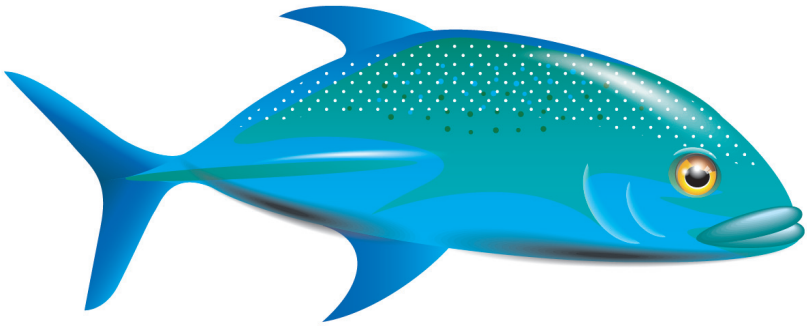
B. Students must describe the feature, their thoughts on whether it was created by a fast or slow process and the global location in terms of latitude and longitude of a famous ocean feature they showcase, if there is a famous one.

C. After all groups have pEarth resented their models, ask the students to Think, Pair, Share:

   a. How are the ocean bottom features similar to land features we know?

D. Display the ocean boxes on a bookshelf for students to examine.

E. Pass out the Self Evaluation Rubric Checklist and have students fill it out.

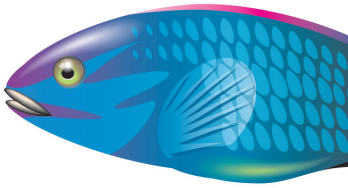


CULMINATING LESSON Self Evaluation

Rubric Checklist – Ocean Geography Model

Name: _____ **Date:** _____

Put a checkmark next to the way you feel about your work

OBJECTIVE	WOW!	YES!	ALMOST	NO
Created a 3-D model of a plate tectonic movement or ocean floor feature.				
Identified whether fast or slow processes were involved in the movement or creating the feature.				
Identified latitude and longitude of where the process or a famous one of our ocean feature is found.				
Contributed effectively to the oral group activity.				

What did we do well, what needed improvement, and what would we do differently to improve?