Senior High School

DepED
DEPARTMENT OF EDUCATION

Earth Science for STEM

Quarter 2 – Module 6:
Seafloor Spreading

ALTERNATIVE DELIVERY MODE
ADM

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Quarter 2 – Module 6: Seafloor Spreading
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Introductory Message

This Self-Learning Module (SLM) is prepared so that you, our dear learners, can continue your studies and learn while at home. Activities, questions, directions, exercises, and discussions are carefully stated for you to understand each lesson.

Each SLM is composed of different parts. Each part shall guide you step-by-step as you discover and understand the lesson prepared for you.

Pre-tests are provided to measure your prior knowledge on lessons in each SLM. This will tell you if you need to proceed on completing this module or if you need to ask your facilitator or your teacher's assistance for better understanding of the lesson. At the end of each module, you need to answer the post-test to self-check your learning. Answer keys are provided for each activity and test. We trust that you will be honest in using these.

In addition to the material in the main text, Notes to the Teacher are also provided to our facilitators and parents for strategies and reminders on how they can best help you on your home-based learning.

Please use this module with care. Do not put unnecessary marks on any part of this SLM. Use a separate sheet of paper in answering the exercises and tests. And read the instructions carefully before performing each task.

If you have any questions in using this SLM or any difficulty in answering the tasks in this module, do not hesitate to consult your teacher or facilitator.

Thank you.

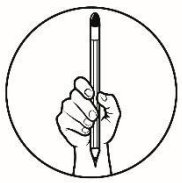
What I Need to Know

This module was designed and written with you in mind. It is here to help you master the Seafloor Spreading. The scope of this module permits it to be used in many different learning situations. The language used recognizes the diverse vocabulary level of students. The lessons are arranged to follow the standard sequence of the course. But the order in which you read them can be changed to correspond with the textbook you are now using.

The module is composed of discussions and activities on how seafloor spread.

After completing this module, you are expected to:

1. discuss the process of seafloor spreading; and
2. explain how the convection currents in the earth's interior make the seafloor spread.
3. describe the three evidence that seafloor is continuously spreading.



What I Know

Read and analyze the following questions/statements. Choose and write the letter that best describes the following statements in a sheet of paper.

1. Which of the following supports the theory of seafloor spreading?
    a. continuous mountain chains
    b. correlation of rock layers
    c. crustal age
    d. magnetic reversal

2. Why were magnetic patterns found on the ocean floor puzzling?
    a. No rocks were magnetic.
    b. They showed alternating bands of normal and reversed polarity.
    c. They did not show alternating bands of normal and reversed polarity.
    d. All rocks were magnetic.

3. How did scientists discover that rocks farther away from the mid-ocean ridge were older than those near it?
    a. by mapping rocks on the sea floor using sonar
    b. by measuring how fast sea floor spreading occurs
    c. by determining the age of rock samples obtained by drilling on the sea floor
    d. by observing eruptions of molten materials on the sea floor

4. What does scientist thought about the seafloor before they had data from echo sounders?
    a. The seafloor is steeply sloping.
    b. The seafloor is completely flat.
    c. The seafloor is covered with ridges.
    d. The seafloor is broken up by trenches.

5. What features of seafloor mountain ranges on the ocean floor upwells magma and formed new ocean floor?
    a. abyssal plain
    b. continental slope
    c. mid-ocean ridge
    d. trench

6. What technology did scientist used in the mid-1900s to map the mid-ocean ridge?
    a. deep sea diving
    b. magnetometer
    c. sonar
    d. submarine

7. Which of the following is **not** included in the group?
    a. drilling sample
    b. magnetic strip
    c. mid-ocean ridge
    d. molten materials

8. What feature of seafloor is described as the deepest areas of the ocean where subduction takes place?
    a. abyssal plain
    b. continental slope
    c. mid-ocean ridge
    d. trench

9. What indicators were observed by geologist to conclude that the polarity is reversed?
    a. the north and south are at the center
    b. the north and south are in same direction
    c. the north and south are in opposite direction
    d. the north and south are aligned as they are now

10. Which scientist from the 1960s is credited for proposing the theory of seafloor spreading?
    a. Albert Einstein
    b. Alfred Wegener
    c. Charles Darwin
    d. Harry Hess

11. What earth internal process drives seafloor spreading?
    a. conduction
    b. convection
    c. fusion
    d. radiation

12. Where can we usually found the shrimps, crabs and other organisms cluster near hot water vents in the ocean floor?
    a. mid-ocean ridges
    b. seamount
    c. deep-ocean floor
    d. deep-ocean trench

13. Which is not true about the age pattern on the seafloor?
    a. The pattern is symmetrical on each side of the mid-Atlantic ridge
    b. Seafloor near the mid-Atlantic ridge can be up to 10 million years old
    c. The oldest seafloor can be found towards the edges of the ocean, near the eastern and western continents
    d. The youngest seafloor can be found towards the edges of the ocean, near the eastern and western continents

14. What comprises the Mid-Ocean ridges?
    a. mountains
    b. rivers
    c. rocks
    d. valleys

15. Where do you expect to find the oldest rock on the ocean floor?
    a. near the ridge
    b. at the center of the ridge
    c. opposite side of the ridge
    d. d. further away from the ridge

Lesson 6

Seafloor Spreading

This lesson contains activities and readings about how the seafloor spreads. You will learn basic concepts and information about seafloor through a brief discussion of the process of seafloor spreading, how the convection currents in the earth's interior make the seafloor spread and the evidence that the seafloor is continuously spreading. In the activities, you are expected to use the knowledge and skills that you learned from the previous module and connect it to the new set of information that you will learn from this module

What's In

Read the list of characteristics of the different types of stresses in the earth's crust below. Fill up the table by placing characteristics appropriate in each column. Write your answers in a sheet of paper.

1. Pushes the crust in different direction
2. Causes the rocks to push or collide with each other
3. results in the breaking of the large parts of the crust into smaller sizes
4. it is the opposite of compression
5. this can make the rocks come together or make the plates rise
6. Pulls the rock away from each other
7. these are the forces applied to rock, which can cause the rock to change
8. these forces created continental drifts and mid-ocean ridges
9. it causes the rocks to fracture
10. usually happens when two plates rub against each other as they move in opposite direction

Notes to the Teacher

Have the students be guided on their basic needs. Practically, necessities like materials needed in school, at home or personal protective equipment during such situation.

What's New

Read the situation below and answer the guide questions. Write your answers in a sheet of paper.

You grow, plants grow, and yes-rocks grow too! They just grow very slowly. The earth is made up of different rocky plates, like a big jigsaw puzzle. Together, all of this rocky jigsaw puzzle is called the lithosphere. Plate tectonics is the study of these rocky tectonic plates and how they move and change.

Imagine that you're baking a very delicious chocolate cake. After some time in the oven, the top of the crust begins to crack and parts of the cake's top portion move away from each other. Unfortunately, you've made the batter a little too wet, and the bottom layer of the cake is not yet cooked. As the top portion of the cake cracks and moves away from each other, the gooey underside of the cake moves up into the crack, pushing the pieces of the cake's top crust away from each other.

Guide questions:

1. What do the crust of cake and the cake batter represent?

_____

2. How can you relate the baking of cake in the process of seafloor spreading?

_____

What is It

Before scientists invented **sonar** – a device that bounces sound waves off underwater objects and then record the echoes of these sound waves, many people believed that the ocean floor was a completely a flat surface. But in the data in records up to this day, the seafloor is far from flat. In fact, the tallest mountain and deepest canyons are found on the ocean floor; far taller and deeper than any landforms found on the continents.

During World War II, using the **magnetometers** that were attached to ships scientists discovered a lot about the magnetic properties of the seafloor. Sometimes, no one really knows why the magnetic poles switch positions. North becomes the south and vice versa. Geologists say that polarity is normal when the north and south are aligned while when they are in the opposite position, the polarity is reversed. They found that **magnetic polarity** in the seafloor was normal at mid-ocean ridges but reversed in symmetrical patterns away from the ridge center. This normal and

reversed pattern continues across the seafloor. Scientists were surprised to discover that the normal and reversed magnetic polarity of seafloor basalts creates a pattern of magnetic stripes. The seafloor has different features which includes continental shelf, continental slope, abyssal plain, mid-ocean ridge, seamount and trench.

In 1960, the American geophysicist, **Harry Hess** explained how the convection currents in the Earth's interior make the seafloor spread. Convection current carry heat from the molten materials in the mantle and core towards the lithosphere. These current ensures that the "recycled" materials formed in the lithosphere were back to the mantle. In this recycling process which was later named as **seafloor spreading,** the magma moves up from the mantle and erupts as pillow lava. This forms new **oceanic crust** at the ridge. Then, as new oceanic crust form, it pushes the older crust aside. This means that the nearer the ocean floor to the oceanic ridge, the younger it is compared to the ones farther from the ridge. This crust eventually subducts at the deep ocean **trenches** and melts back into the mantle. Then the seafloor spreading continues as a "recycling" process. Record shows that the oldest seafloor is relatively younger (about 180 million years old) than the oldest rock (about 3 billion years old) found on land.

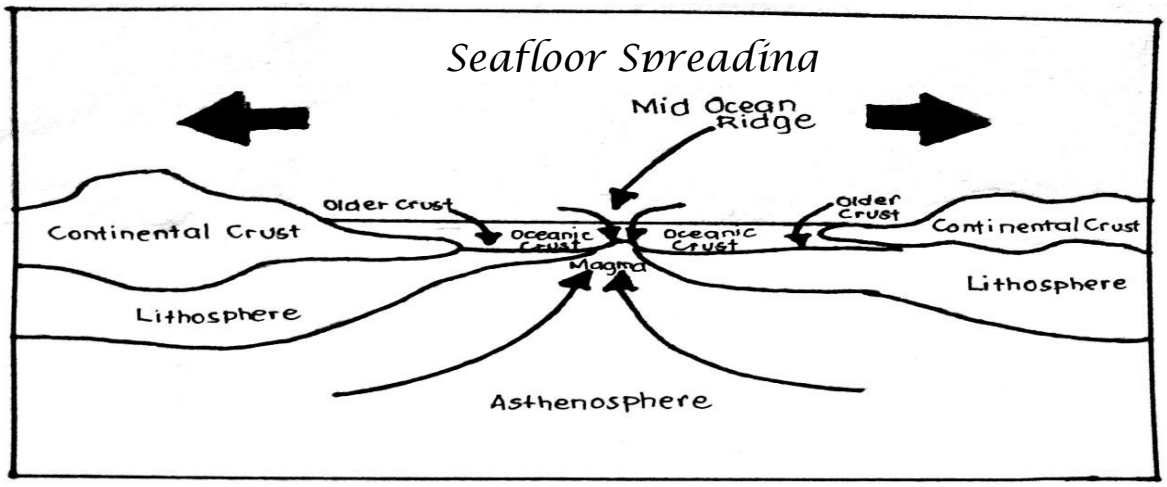


Figure 1. Seafloor Spreading

The following are three evidence that support the idea that seafloor is continuously spreading.

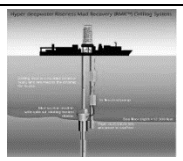
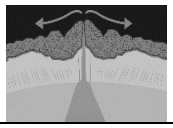
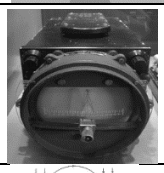
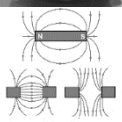
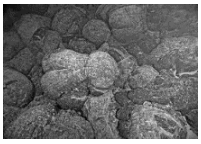
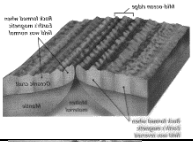
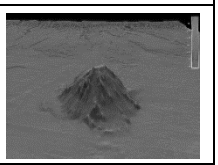
(a.) **Evidence from molten materials**- rocks shaped like pillows (rock pillows) show that molten materials have erupted again and again from cracks along the mid-ocean ridge and cooled quickly.

(b.) **Evidence from magnetic strip**- rocks that make up the ocean floor lie in a pattern of magnetized stripes which hold a record of the reversals in magnetic field; and

(c.) **Evidence from drilling sample** – core samples from the ocean floor show that older rocks are found farther from the ridge; youngest rocks are in the mid-ocean ridge

What's More

A. Match Column A to its description in Column B and to its illustration in Column C. Write your answer in a sheet of paper.

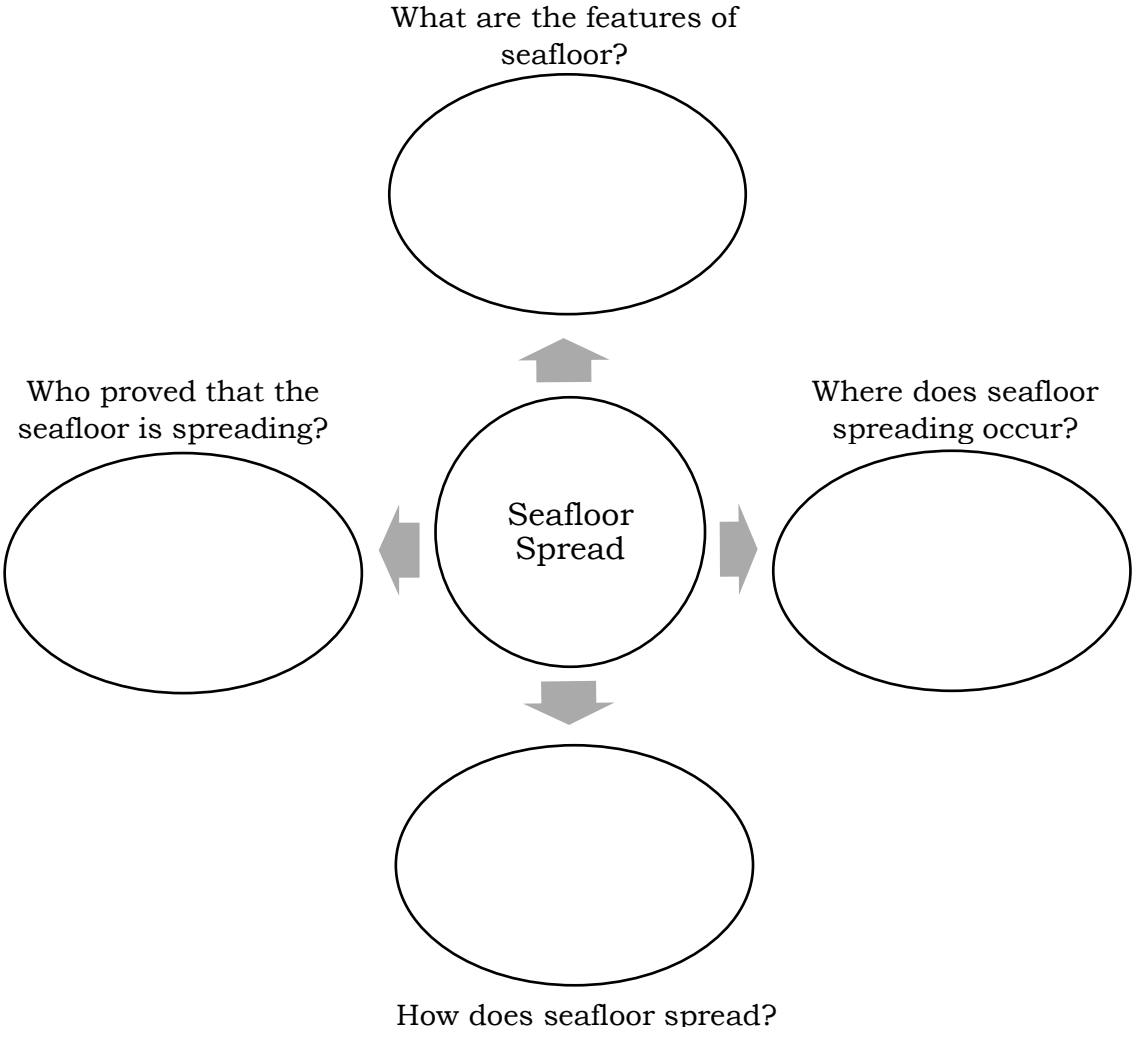
Column A	Column B	Column C
1. sonar	A. a device that bounces sound waves off underwater objects and then record the echoes of these sound waves	k. 
2. Oceanic crust	B. It is the device used to determine the magnetic properties of ocean seafloor.	l. 
3. magnetic polarity	C. It is a normal and reversed magnetic pattern across the seafloor.	m. 
4. evidence from magnetic material	D. It is a type of crust formed in mid-ocean ridges.	n. 
5. magnetometer	E. formation of the rock-shape pillow	o. 
6. mid-ocean ridges	F. core samples from the ocean floor show that older rocks are found farther from the ridge; youngest rocks are in the mid-ocean ridge	p. 
7. evidence from molten material	G. deepest areas of the ocean; found where subduction takes place.	q. 
8. trench	H. A mountain rising from the seafloor that does not reach above the surface of the water. Usually formed from volcanoes	r. 
9. seamount	I. rocks that make up the ocean floor lie in a pattern of magnetized stripes which hold a record of the reversals in magnetic field	s. 
10. evidence from drilling sample	J. mountain ranges on the ocean floor where magma upwells, and new ocean floor is formed.	t. 

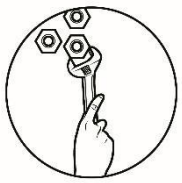
B. Arrange the following according to the correct sequence in the process of seafloor spreading. Use numbers 1-5 in arranging the process. Write your answer in a sheet of paper.

1. The crust eventually subducts at the deep ocean trench and melt back into the mantle.
2. The magma moves up from the mantle and erupts as pillow lava.
3. Then, as new oceanic crust form, it pushes the older crust aside.
4. These forms new oceanic crust at the ridge.
5. Then, the seafloor spreading continues as a recycling process.

What I Have Learned

Using the concept learned, complete the graphic organizer below. Draw the graphic organizer on your answer sheet then answer the questions that follow.





What I Can Do

Analyze the picture below. Answer the question that follows. Write your answers in a separate sheet of paper.

A group of geologists conducted a research on the continues spreading of the seafloor. They found out that the Atlantic Ocean was mysteriously spreading every year.

If the Atlantic Ocean is continuously spreading, after 5 years what can you infer on the following:

a) its size
b) distance between North and South American continent and Europe

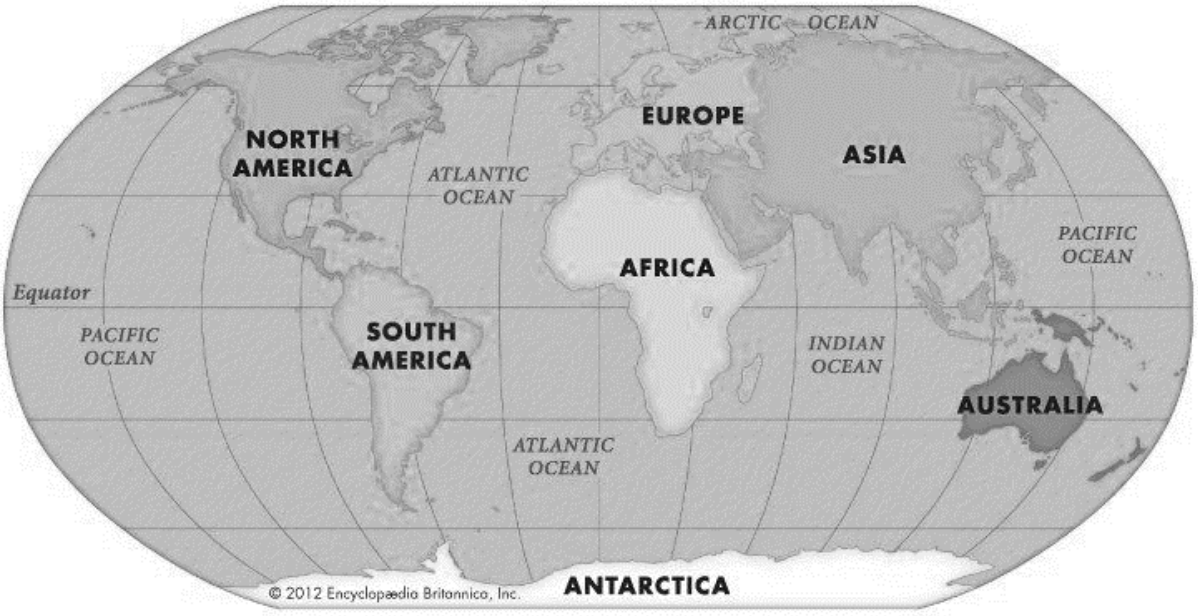


Figure 2. The Map

Assessment

Read and analyze the following questions. Select the correct answer and write it in a sheet of paper.

1. How did drilling samples show that seafloor spreading has really taken place?
    a. The ocean changes in size and shape.
    b. The molten materials cool and form a strip of solid rocks in the center of the ridge.
    c. The Atlantic Ocean only has a few short trenches, the spreading ocean floor has nowhere to go.
    d. The further away from the ridge the samples were taken, the older the rocks were, the younger rocks were always in the center of the ridges.

2. In seafloor spreading, in which of the following parts does molten material rises from the mantle and erupts or flows out?
    a. Along mid-ocean ridges
    b. In the deep ocean trenches
    c. In the north and south poles
    d. Along the edges of all continents

3. Mr. Alvarez wants to make a research about the magnetic property of the sea floor. One day he joined his friend in making a research. He noticed that he used a device that detect magnetic field. What do you call that instrument?
    a. geologist's compass
    b. magnetometer
    c. seismometer
    d. sonar

4. Which is **not** involved in the process of seafloor spreading?
    a. magma
    b. mid-ocean ridges
    c. it tends to happen near the edges of continents
    d. the newest rock is at the center of the mid-ocean ridges

5. How will you compare the age of the rocks in the seafloor?
    a. both younger and older rocks are at the middle at the ridge
    b. the younger rocks are at the left side, the older are at the right side
    c. the younger rocks are in the middle at the ridge, the older are far from the ridge
    d. the older rocks are in the middle at the ridge, the younger are far from the ridge

6. What are the evidences that support the theory of seafloor spreading?
    a. Magma, magnetic strips, drilling sample
    b. Deep ocean trench, mid-ridges, magnetic strips
    c. Molten materials, magnetic polarity, abyssal plain
    d. Molten materials, magnetic strips, drilling sample

7. What feature of seafloor is shallow, gradually sloping seabed around the edge of a continent and has a depth less than 200 meters and can be thought of as the submerged edge of a continent?
    a. Abyssal plain
    b. Continental shelf
    c. Continental slope
    d. Mid- ocean ridge

8. Which is the correct sequence on seafloor spreading?
    I. This forms new oceanic crust at the ridges
    II. Magma moves up from the mantle and erupt as pillow lava.
    III. Then the new oceanic crust forms, it pushes the older crust aside.
    IV. This crust eventually subducts at the deep ocean trenches and melt back into the mantle.

    a. 2-1-3-4 b.1-2-3-4 c.3-1-4-2 d.4-3-2-1

9. What device uses sound waves off underwater objects and then record the echoes of these sound waves.
    a. magnetometer
    b. geologist's compass
    c. sonar
    d. seismometer

10. How was new oceanic crust formed?
    a. when the ocean changes in size and shape.
    b. when a deep valley along the ocean floor slowly sink towards the mantle.
    c. when molten material erupts through the mid ocean ridge called seafloor spreading.
    d. when molten material cool and form strip of solid rocks in the center of the ridge.

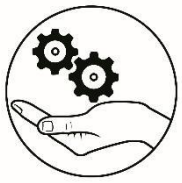
11. Before the invention of sonar device, what was the belief of many people about the ocean floor?
    a. an oblate spheroid.
    b. a perfect circle
    c. empty
    d. a flat surface

12. Who proposed that seafloor is spreading?
    a. Alfred Wegener
    b. Alfred Williams
    c. Harry Hess
    d. Harry Humphrey

13. Which of the following causes seafloor spreading?
    a. Earthquakes and convection
    b. Magma and convection
    c. Magma and subduction
    d. Volcanoes and earthquakes

14. What is the age of the oldest seafloor?
    a. 1.8 million years
    b. 180 million years
    c. 4 billion years
    d. 3 billion years

15. Which of the following provide evidences for seafloor spreading?
    a. Explosive stratovolcanoes and rock drilling
    b. Floating continents and the ages of continental rocks
    c. The pattern of seafloor ages and the pattern of seafloor magnetic stripes
    d. The pattern of seafloor magnetic strip and the age of continental rocks



Additional Activities

Based on the facts learned, write an essay on how seafloor spreading affect the environment. Write your answer on a sheet of paper.

Answer Key

What I Know

1. D
2. B
3. C
4. B
5. C
6. C
7. D
8. D
9. A
10. D
11. B
12. C
13. D
14. A
15. D

What's More

A.

1. A, m
2. D, q
3. C, n
4. I, r
5. B, o
6. J, l
7. E, p
8. G, s
9. H, t
10. F, k

B.

1. 4
2. 1
3. 3
4. 2
5. 5

Assessment

1. D
2. A
3. B
4. C
5. C
6. D
7. D
8. A
9. C
10. D
11. D
12. C
13. B
14. B
15. C

What I Have Learned

Rubric in Essay

Criteria	5 points	3 points	2 points
Ideas	Presents ideas in an original manner	Presents ideas in a consistent manner	Ideas are too general
Organization	Strong and organized in the beg/mid/end	Organized in the beg/mid/end	Some organization: attempt at a beg/mid/end
Word Choice	Sophisticated use of nouns and verbs make the essay very informative	Nouns and verbs make essay informative	Needs more nouns and verbs
Sentence Structure	Sentence structure enhances meaning; flows throughout the piece	Sentence structure is evident; sentences mostly flow	Sentence structure is limited; sentences need to flow

References

Online Resources

Provided by: Wikibooks. The Seafloor Retrieved from:
https://courses.lumenlearning.com/earthscience/chapter/the-seafloor

Courtesy of US Geological Survey Magnetic Evidence for Seafloor Spreading Retrieved from:
https://www.ck12.org/earth-science/Magnetic-Evidence-for-Seafloor-Spreading/lesson/Magnetic-Evidence-for-Seafloor-Spreading-HS-ES

Provided by: Education.com. The Seafloor Spreading Model:
https://www. Education.com/science-fair/article

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