



11 Earth and Life Science



Earth and Life Science

Origin and Structure Of the Earth (Planet Earth)

Earth and Life Science
Origin and Structure of the Earth – Planet Earth
First Edition, 2020

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Introductory Message

For the facilitator:

Welcome to the Earth and Life Science Grade 11 Alternative Delivery Mode (ADM) Module.

This module was collaboratively designed, developed, and reviewed by educators both from public and private institutions to assist you, the teacher or facilitator, in helping the learners meet the standards set by the K to 12 Curriculum while overcoming their personal, social, and economic constraints in schooling.

This learning resource hopes to engage the learners into guided and independent learning activities at their own pace and time. Furthermore, this also aims to help learners acquire the needed 21st century skills while taking into consideration their needs and circumstances.

As a facilitator, you are expected to orient the learners on how to use this module, encourage and assist them as they do the tasks, and track their progress while allowing to manage their learnings.

For the learner:

Welcome to the Earth and Life Science Grade 11 Alternative Delivery Mode (ADM) Module.

The hand is one of the most symbolized parts of the human body. It is often used to depict skill, action, and purpose. Through our hands, we may learn, create, and accomplish many things. Hence, the hand in this learning resource signifies that you, as a learner, are capable and empowered to successfully achieve the relevant competencies and skills at your own pace and time. Your academic success lies in your own hands!

This module was designed to provide you with fun and meaningful opportunities for guided and independent learning. You will be able to process the contents of the learning resource while being an active learner.

This module has the following parts and corresponding icons:

<i>What I Need to Know</i>	This will give you an idea of the skills or competencies you are expected to learn in the module.
<i>What I Know</i>	This part includes an activity that aims to check what you already know about the lesson to take. If you get all the answers correct (100%), you may decide to skip this module.
<i>What's In</i>	This is a brief drill or review to help you link the current lesson with the previous one.
<i>What's New</i>	In this portion, the new lesson will be introduced to you in various ways such as a story, a song, a poem, a problem opener, an activity or a situation.
<i>What is It</i>	This section provides a brief discussion of the lesson. This aims to help you discover and understand new concepts and skills.
<i>What's More</i>	This comprises activities for independent practice to solidify your understanding and skills of the topic. You may check the answers to the exercises using the Answer Key at the end of the module.
<i>What I Have Learned</i>	This includes questions or blank sentence/paragraph to be filled in to process what you learned from the lesson.
<i>What I Can Do</i>	This section provides an activity which will help you transfer your new knowledge or skill into real life situations or concerns.
<i>Assessment</i>	This is a task which aims to evaluate your level of mastery in achieving the learning competency.
<i>Additional Activities</i>	In this portion, another activity will be given to you to enrich your knowledge or skill of the lesson learned. This also tends retention of learned concepts.
<i>Answer Key</i>	This contains answers to all activities in the module.

At the end of this module you will also find:

<i>References</i>	This is the list of all sources in developing this module.
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What I Need to Know

This module was designed and written with you in mind. It is here to help you master the nature of Earth and Life Science. 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 focuses on the lesson:

- Lesson 1 – Planet Earth

After going through this module, you are expected to:

1. identify the characteristics of the Earth that supports life; and
2. expound how the characteristics of the Earth sustain the needs of living organism.

What I Know

Choose the letter of the best answer. Write the chosen letter on a separate sheet of paper.

1. Why is Earth called “the living planet?”
 - A. It sustains life.
 - B. It has atmosphere
 - C. It has water at the surface
 - D. All of the above
2. Which among the set of planets are called terrestrial?
 - A. Jupiter, Neptune, Uranus
 - B. Mercury, Venus, Mars, Earth
 - C. Earth, Venus, Mars, Jupiter
 - D. Jupiter, Saturn, Uranus, Neptune
3. What makes planet Earth uniquely different from other planets?
 - A. It has soil.
 - B. It has tress.
 - C. It has people.
 - D. It has liquid water.
4. What makes planet Earth habitable?
 - A. It has comfortable distance from the sun.
 - B. It has atmosphere that protects from radiation.
 - C. The atmosphere holds carbon dioxide and other gases.
 - D. All of the above
5. Why is Earth called a terrestrial planet?
 - A. It has life
 - B. It is closest to the sun
 - C. It is farther from the sun
 - D. It is placed at almost the middle planets
6. Which of the following best describes the surface of the planet Earth?
 - A. a thick layer of hydrogen gas
 - B. cloudy and hot with lots of volcano
 - C. cold, rocky, and covered with red dust
 - D. mostly water surface with some areas of land

7. What makes Earth different from other planets in the solar system?
 - A. It supports life.
 - B. It is mostly covered in water.
 - C. Its atmosphere is mostly nitrogen and oxygen.
 - D. All of the above
8. Earth is the only planet that can support ____
 - A. life
 - B. a moon
 - C. a rocky core
 - D. an atmosphere
9. How many percent of water comprises the Earth?
 - A. 15%
 - B. 30%
 - C. 50%
 - D. 70%
10. What are the factors that make Earth habitable?
 - A. temperature and nutrient
 - B. atmosphere and energy
 - C. only A
 - D. both A and B
11. What nutrients does the Earth have to maintain an organism's body to survive?
 - A. Earth has a water cycle and atmosphere
 - B. Earth has volcanic activities to circulate nutrients.
 - C. Earth has sub-surface water or molten rock that can circulate and replenish nutrients for organisms.
 - D. All of the above
12. What makes Earth similar to Venus?
 - A. Earth and Venus are the right sizes to hold a sufficient atmosphere.
 - B. Venus' atmosphere is 100 times thicker than Earth.
 - C. Among all the solid planets and moons, only Earth, Venus, and Titan have significant atmospheres.
 - D. Both A and C
13. Why are humans and other living organisms capable to live on earth?
 - A. Earth has no protective equipment like ozone.
 - B. Earth has layer water only for favorable climate.
 - C. Earth has man-made natural cycles
 - D. Earth's temperature is neither the hottest nor the coldest among other planets.
14. What makes Earth different from any other planets in the Solar System?
 - A. It is the only rocky planet.
 - B. It is the only planet that turns around in space.
 - C. It is the only planet that has a large amount of liquid water.
 - D. It is the only planet that changes its structure
15. What does Earth offer to human for survival?
 - A. Earth has abundant plant life.
 - B. Earth has sufficient nutrients from ocean to land.
 - C. Only A
 - D. Both A and B.

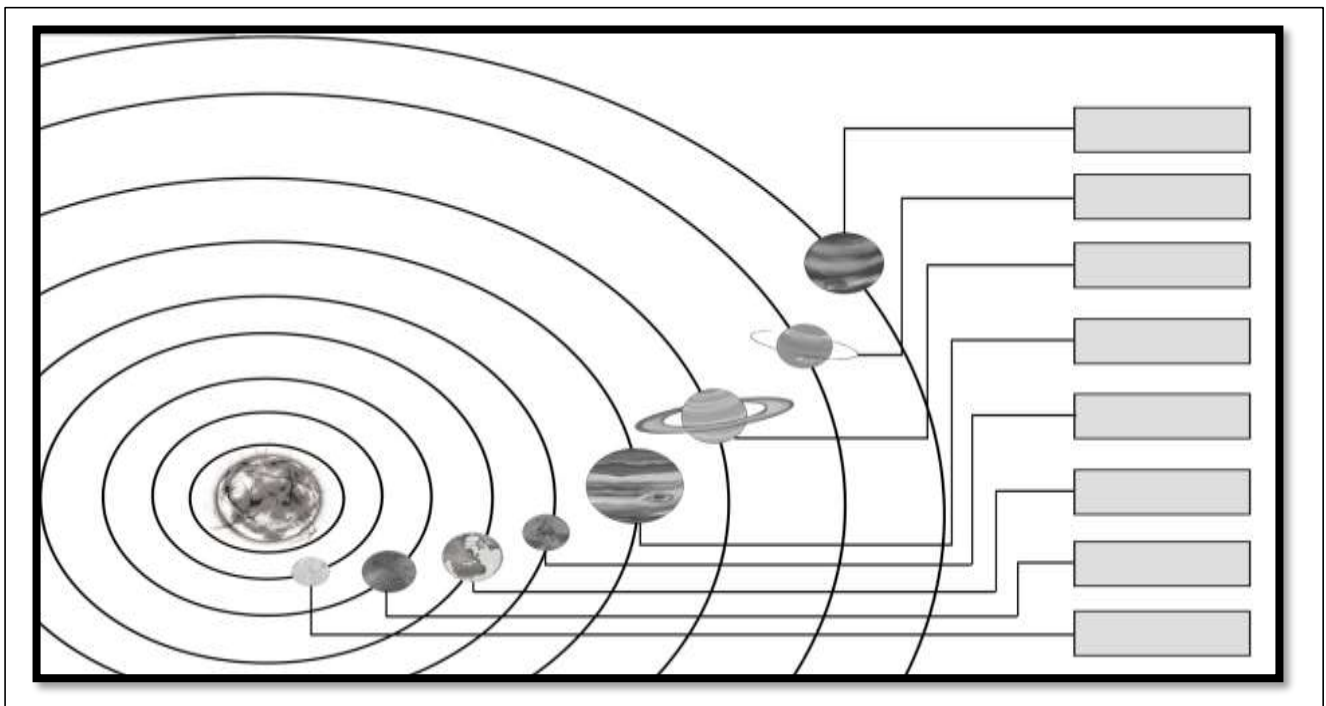
Lesson 1 Origin and Structure of the Earth-Planet Earth

Earth is the only planet in the solar system known to harbour life. Our planet's molten nickel-iron core gives rise to an extensive magnetic field, which, along with the atmosphere, shields us from harmful radiation coming from the Sun. In this module, you will understand why this planet is called the "living planet."

What's In

Just a part of the vast universe is the solar system. From the previous concepts learned, identify the planets in the solar system in the given illustration.

Question: What do you think are the characteristics of the planet Earth that make it different from all the other planets?



What's New

Earth: A Habitable Planet

Read the document carefully and answer the questions that follow

Table 1. Factors that make a planet habitable

Factors that make a Planet Habitable	Not Enough of the Factor	Just Right	Too Much of the Factor	Situation in the Solar System
Temperature influences how quickly atoms and molecules move.	Low temperatures cause chemicals to react slowly, which interferes with the reactions necessary for life. It can also cause the freezing of water, making liquid water unavailable.	Life seems to be limited to a temperature range of -15°C to 115°C. In this range, liquid water can still exist under certain conditions.	At about 125°C, protein and carbohydrate molecules, and the genetic material (e.g., DNA and RNA) start to break apart. Also, high temperatures cause the quick evaporation of water.	Surface: only the Earth's surface is in this temperature range. Sub-surface: the interior of the solid planets and moons may be in this temperature range.
Atmosphere	Small planets and moons have insufficient gravity to hold an atmosphere. The gas molecules escape to space, leaving the planet or moon without an insulating blanket or a protective shield.	Earth and Venus are the right size to hold a sufficient atmosphere. Earth's atmosphere is about 100 miles thick. It keeps the surface warm and protects it from radiation and small- to medium-sized meteorites.	Venus's atmosphere is 100 times thicker than Earth's. It is made almost entirely of greenhouse gasses, making the surface too hot for life. The four giant planets are completely made of gas.	Of the solid planets and moons, only Earth, Venus, and Titan have significant atmospheres. Mars' atmosphere is about 1/100th that of Earth's, too small for significant insulation or shielding.
Energy	When there is too little sunlight or too few of the chemicals that provide energy to cells, such as iron or sulfur, organisms die.	With a steady input of either light or chemical energy, cells can run the chemical reactions necessary for life.	Light energy is a problem if it makes a planet too hot or if there are too many harmful rays, such as ultraviolet. Too many energy-rich chemicals is not a problem	Surface: The inner planets get too much sunlight for life. The outer planets get too little. Sub-surface: Most solid planets and moons have energy-rich chemicals.
Nutrients used to build and maintain an organism's body.	Without chemicals to make proteins and carbohydrates, organisms cannot grow. Planets without systems to deliver nutrients to its organisms (e.g., a water cycle or volcanic activity) cannot support life. Also, when nutrients are spread so thin that they are hard to obtain, such as on a gas planet, life cannot exist.	All solid planets and moons have the same general chemical makeup, so nutrients are present. Those with a water cycle or volcanic activity can transport and replenish the chemicals required by living organisms.	Too many nutrients are not a problem. However, too active a circulation system, such as the constant volcanism on Jupiter's moon, Io, or the churning atmospheres of the gas planets, interferes with an organism's ability to get enough nutrients.	Surface: Earth has a water cycle, an atmosphere, and volcanoes to circulate nutrients. Venus, Titan, Io, and Mars have nutrients and ways to circulate them to organisms. Sub-surface: Any planet or moon with sub-surface water or molten rock can circulate and replenish nutrients for organisms

Factors that make a planet habitable. National Science Foundation, n.d.http://www.lpi.usara.edu/education/explore/our_place/hab_ref_table.pdf

Question:

1. What are the factors that make the planet habitable?
2. What are the characteristics of planet Earth that makes it habitable?

What is It

Earth is the only place in the known universe confirmed to host life and is the only one known for sure to have liquid water in the surface. These are reasons why planet earth is a unique one: (1) It has liquid water; (2) Plate Tectonics; and (3) It has atmosphere that shelters it from the worst of the sun's rays.

Earth is the only planet in the solar system that has a large amount of liquid water. About 70% of the surface of the Earth is covered by liquid or frozen water. Because of this, Earth is sometimes called "blue planet." Planet Earth is habitable because it has the right distance from the sun. It is kept warm by an insulating atmosphere, and it has the right chemical ingredients for life including water and carbon. It can provide water, oxygen, useful biological products for human, and has suitable weather and climate.

Earth, Venus, and Mars may have similarities: (1) They all are terrestrial planets, made of solid rocks and silicates; (2) They all have an atmosphere; (3) They all almost have the same time to rotate on their axes; (4) Earth and Mars both have water; (5) They all have carbon dioxide; and (6) All have landforms. Earth, Venus, and Mars have differences: (1) Venus has no water; (2) Venus and Mars don't have oxygen; and (3) Earth has life forms.

What's More

Activity 1.1 Understanding Planet Earth

Compare and Contrast

How is planet Earth similar and different from Venus and Mars? Provide possible explanations for your observations using the information in the table.

	VENUS	EARTH	MARS
Mass (10 ²⁴ kg)	4.87	5.97	0.642
Diameter (km)	12,104	12,756	6792
Density (kg/m ³)	5243	5514	3933
Gravity (m/s ²)	8.9	9.8	3.7
Escape Velocity (km/s)	10.4	11.2	5
Surface pressure (bars)	92	1	0.01
Composition of atmosphere	96% CO ₂ , 3.5% N	77%N, 21% O ₂ , 1%Ar	95%CO ₂ , 2.7%N, 1.6%Ar
Major Greenhouse Gases(GHG)	CO ₂	CO ₂ H ₂ O	CO ₂
Mean Temperature (0C)	464	15	-65
Temperature if no greenhouse gases are present	-46	-18	-57
Changes in Temperature (0C) due to greenhouse gases	+523	+33	+10
Distance from the Sun (10 ⁶ km)	108.2	149.6	227.9
Orbital Period (days)	224.7	365.2	687
Orbital Velocity (km/s)	35	29.8	24.1
Length of day (hours)	2802	24	24.7
Global Magnetic Field	No	Yes	No

*Comparison of the features of Venus, Earth, and Mars
(National Aeronautics and Space Administration, 2015)*

What I Have Learned

1. Planet Earth is considered habitable because of the following reasons: (1) it has the right distance from the sun; (2) it is protected from harmful solar radiation by its magnetic field; (3) it is kept warm by an insulating atmosphere; and (4) it has the right amount of ingredients for life, including water and carbon.
2. Earth is different from other planet in a way that it is the only planet with liquid water on the surface.
 - a. Earth, Venus, and Mars may have similarities: (1) They all are terrestrial planets, made of solid rocks and silicates; (2) They all have an atmosphere; (3) They all almost have the same time to rotate on their axes; (4) Earth and Mars both have water; (5) They all have carbon dioxide; and (6) All have landforms.
 - a. Earth, Venus, and Mars have differences: (1) Venus has no water; (2) Venus and Mars don't have oxygen; and (3) Earth has life forms.

What I Can Do

Earth Day generally falls in the third week of April. There are a lot of great lessons about how our behavior and activity affect others and our planet.

List down ten (10) activities that you can do to save planet Earth and identify those activities as a form of recycling, reducing, or reusing.

<i>RECYCLE</i>	<i>REDUCE</i>	<i>REUSE</i>

Assessment

Multiple Choice. Choose the letter of the best answer. Write the chosen letter on a separate sheet of paper.

1. What makes planet earth different from the other planets in the solar system?
 - A. It supports life.
 - B. It is mostly covered in water.
 - C. The atmosphere holds gases.
 - D. All of the above
2. Planet Earth is uniquely different from other planets because _____.
 - A. It has people that live in it.
 - B. It has soil where trees grow.
 - C. It has trees that provide oxygen.
 - D. It has liquid water in the surface.

3. What makes planet Earth habitable?
 - A. It has comfortable distance from the sun.
 - B. The atmosphere serves as shields from the sun.
 - C. Only A
 - D. Both A and B
4. Why is Earth called the “living planet?”
 - A. It has life mechanism.
 - B. It has water and atmosphere.
 - C. It has carbon dioxide in the atmosphere.
 - D. It has atmosphere that supports oxygen.
5. Which must be provided for an organism to survive in planet Earth?
 - A. right amount of sunlight and atmosphere
 - B. right amount of water and carbon
 - C. Only A
 - D. Both A and B
6. Planet Earth is considered as “blue planet.” Which of the following best describes the surface of planet Earth?
 - A. Earth has atmosphere.
 - B. Earth has lots of volcano.
 - C. Earth is covered with red dust.
 - D. Earth has mostly water on the surface.
7. What is the reason why Earth is different from other planets in the solar system?
 - A. Earth is mostly covered in water.
 - B. Earth has comfortable distance from the sun.
 - C. Earth has carbon dioxide on its atmosphere.
 - D. It has approximately same size as that of Venus.
8. Which of the following best describes planet Earth?

A. It has gases.	C. It has rocky core.
B. It supports life.	D. It supports other planet.
9. It was found out that Earth’s surface is covered with water. Approximately, how many percent of water comprises the Earth?

A. 45% water	C. 60% water
B. 50% water	D. 70% water
10. Earth can support the survival of organisms. What is/are the factor/s that make/s Earth habitable?

I. atmosphere	III. temperature
II. energy	IV. nutrient
A. I	C. I, II, III
B. I, II	D. I, II, III, IV
11. In order for an organism to survive, nutrients are needed. What are the nutrients that planet Earth can offer for an organism to exist?
 - A. Earth has an atmosphere and ozone layer.
 - B. Earth has both water cycle and nitrogen cycle.
 - C. Earth has natural activities to circulate nutrients.
 - D. All of the above

12. Many studies have shown similarities of Earth and Venus. What makes Earth similar with Venus?
- A. Earth and Venus have the same orbit.
 - B. Earth and Venus have the same diameter.
 - C. Earth and Venus have the same atmosphere.
 - D. Earth and Venus are of the right size to hold a sufficient atmosphere.
13. What makes human and other living organisms capable to live on Earth?
- A. Earth can provide food for the organism.
 - B. Earth can protect the organism from any possible threat.
 - C. Earth's temperature is mostly hot compared to other planets.
 - D. Earth has the right amount of temperature, water, good atmosphere, and favorable climate.
14. Planet Earth is considered uniquely different from any other planets in the Solar system. Which among the given choices correctly answers the statement?
- A. Earth is the only planet that changes structure.
 - B. Earth is the only planet that turns around in space.
 - C. Earth is the only planet that is mostly covered with water.
 - D. Earth is the only planet that is mostly made from rocks.
15. What is the reason why every living thing on Earth has the chance of survival?
- A. Earth is covered with 65% water.
 - B. Earth thick atmosphere consisted mainly of carbon dioxide.
 - C. Earth has active volcanoes similar with those that are found in Venus.
 - D. Earth has ozone layer to protect living organisms from harmful radiation.

Additional Activities

Creating a Planet: Fill up the data needed in your created planet.

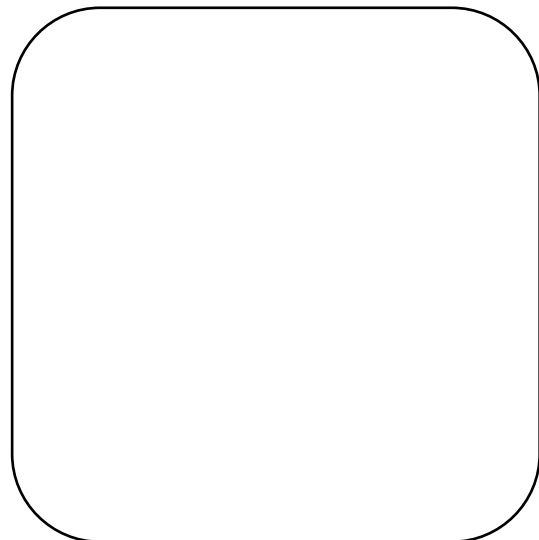
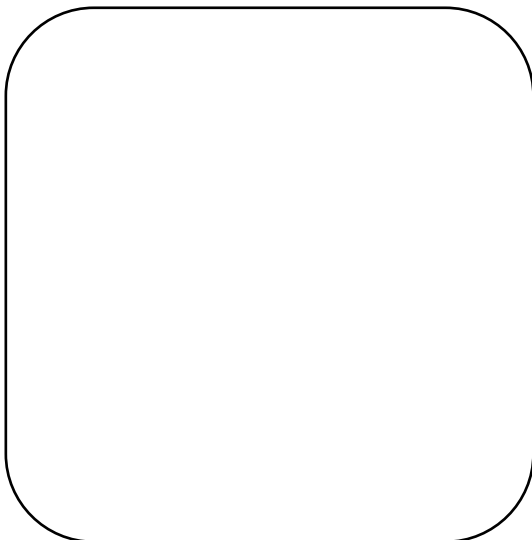
My Planet is called _____. It is located in the _____.

The weather is _____. It would have _____ kinds of organisms.

The individual who live there are called _____.

The individual look like this.

The planet looks like this.



Answer Key

What I Know 1. D 2. B 3. B 4. D 5. B 6. D 7. D 8. A 9. D 10. D 11. D 12. D 13. D 14. A 15. D	What's More Venus has very thick atmosphere which is almost dense as Earth, while Mars has thin atmosphere. Venus is hotter than Earth. Mars is colder than Earth.	Assessment 1. D 2. D 3. D 4. B 5. D 6. D 7. A 8. B 9. D 10. D 11. D 12. D 13. D 14. C 15. D
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Origin and Structure of the Earth (Subsystem)

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Origin and Structure of the Earth – The Subsystem
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What I Need to Know

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The module is composed of:

- Lesson 1 – The Subsystems of the Earth

After going through this module, you are expected to:

1. determine the four subsystems of the Earth;
2. describe the characteristics of each subsystem;
3. trace the flow of matter and energy in the Earth's subsystems; and
4. express one's internalized role as steward of the four subsystems concerning the flow of matter and energy.

What I Know

Choose the letter of the best answer. Write the chosen letter on a separate sheet of paper.

1. Which of the following is NOT one of the four subsystems of the Earth?
A. biosphere
B. hydrosphere
C. water sphere
D. geosphere
2. All of the waters, including subsurface and atmospheric water comprise the Earth. Which geological subsystem best label the statement?
A. the geosphere
B. the hydrosphere
C. the biosphere
D. the atmosphere
3. Earth contains all living organisms including those on the land, in the water and air. Which subsystem best describes the statement?
A. biosphere
B. hydrosphere
C. atmosphere
D. geosphere
4. Which subsystem suits the statement, "All living things, including humans, are part of the immense Earth"?
A. biosphere
B. geosphere
C. hydrosphere
D. atmosphere
5. What subsystem will network with biosphere for photosynthesis to take place?
A. atmosphere
C. hydrosphere

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Lesson 1 Origin and Structure of the Earth – The Subsystem

Earth is sometimes called the “water planet” or the “blue planet” because seas cover more than two-thirds of its surface. Earth is the only planet or moon in the solar system with rain that falls from clouds, runs over the land, and collects in extensive oceans. It is also the only body we know that supports life. This self- learning module will help you understand the subsystem of the planet where you stand right now.

What’s In

Read the statement below and answer the question that follows.

Imagine walking along a rocky coast as a storm blows in from the sea. The wind whips the ocean into whitecaps, and waves crash onto the shore. Before you have time to escape, blowing spray has soaked your clothes. A hard rain begins as you scrambled over the rocks to your car. During the adventure, you have observed the spheres of the Earth.

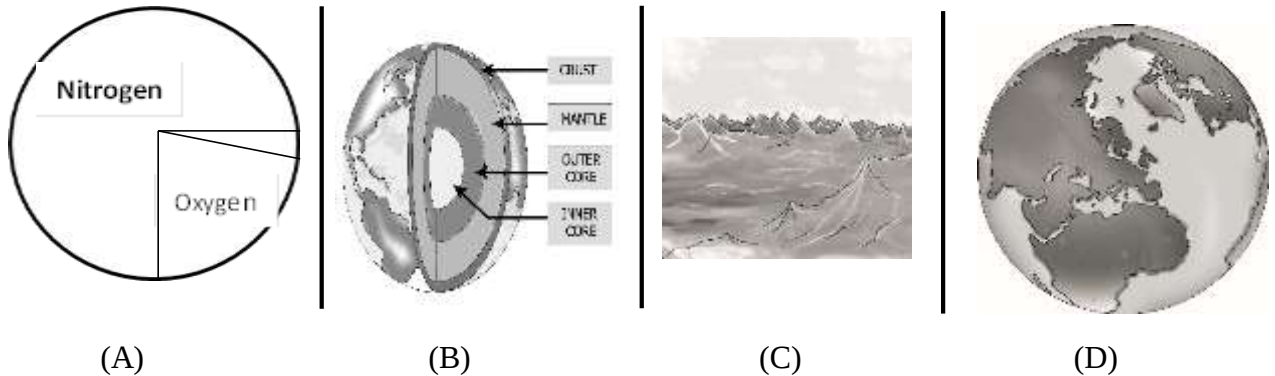
List down the terms that are used in the statement that reflects to what made up the Earth. Categorized them based on the following:

<i>Air</i>	<i>Water</i>	<i>Land</i>	<i>With Life</i>

What's New

Subsystems of the Earth

Analyze and label the given picture. From the picture, create a general concept on each picture and identify the physical characteristics of the subsystem of the Earth. Differentiate one with the other.



What is It

Subsystems of the Earth

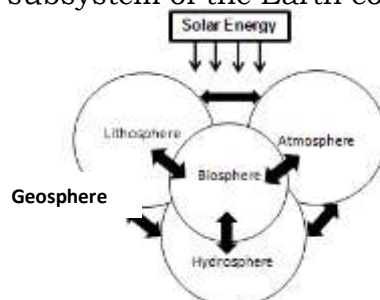
The four subsystems of the Earth are:

1. Atmosphere – the gaseous layer above the Earth's surface primarily composed of different gases such as nitrogen and oxygen.
2. Biosphere – the zone of the Earth where all forms of life exist. This serves as the ecosystem of all living and non- living organisms.
3. Geosphere – the solid part of the Earth that consists the entire planet from the center of the core to the outer crust. It includes core, mantle, and crust of the Earth.
4. Hydrosphere – the water part of the Earth that includes oceans and glaciers.

What's More

Activity 1.1 We are Connected!

According to John Muir, "When one tugs at a single thing in nature, he finds it attached to the rest of the world." How is the given diagram related to the said quote? How does the four subsystem of the Earth connect with each other?



What I Have Learned

Subsystems of the Earth

The four subsystems of the Earth are:

1. **Atmosphere** – it is the gaseous layer above the Earth's surface, primarily composed of 78% nitrogen and 21% oxygen. Other gases like argon, carbon dioxide, carbon monoxide, ozone, and other inert gases made the remaining 1%. The atmosphere supports life because animals and oxygen, and plants need both carbon dioxide and oxygen. In addition, the atmosphere supports life indirectly by regulating climate. Air acts as both a blanket and a filter, retaining heat at night and shielding from direct solar radiation during the day.
2. **Biosphere** – the zone of Earth where all forms of life exist: in the sea, on land, and in water. It is sometimes called as the large ecosystem. This is the zone that life inhabits. Biosphere is a very thin layer of the earth's surface.
3. **Geosphere** – the solid Earth, consisting of the entire planet from the center of the core to the outer crust. It includes the core, mantle, and crust of the Earth.
4. **Hydrosphere** – the water part of the Earth which circulates among oceans, continents, glaciers, and atmosphere. Oceans cover 71% of the Earth and contain 97.5% of its water.

Earth is a complex system made up of many smaller systems through which matter and energy are continuously cycled. Energy and matter flow through Earth's spheres: geosphere, hydrosphere, atmosphere, and biosphere. Energy flows through the atmosphere mostly by convection. How does matter and energy flow across the four subsystems of the Earth? The Earth consists of four subsystems, across whose boundaries matter and energy flows, the atmosphere (air), biosphere (living things), hydrosphere (water), and geosphere (land). The atmosphere provides the geosphere with heat and energy needed for rock breakdown and erosion. The biosphere receives gases, heat, and sunlight (energy) from the atmosphere. It receives water from the hydrosphere and a living medium from the geosphere.

What I Can Do

The human population has increased rapidly since the 1700's. For most of human history, there were fewer than half-billion people on Earth. In mid- 2009, 6.7 billion people inhabited our planet. Because of these, extensive pollution is everywhere. As a student, what can you do to save not only a particular system, but the Earth itself? Write your answer in the table.

MY ENVIRONMENTAL "TO DO" LIST	
1.	

Assessment

2.	
3.	
4.	
5.	

Multiple Choice. Choose the letter of the best answer. Write the chosen letter on a separate sheet of paper.

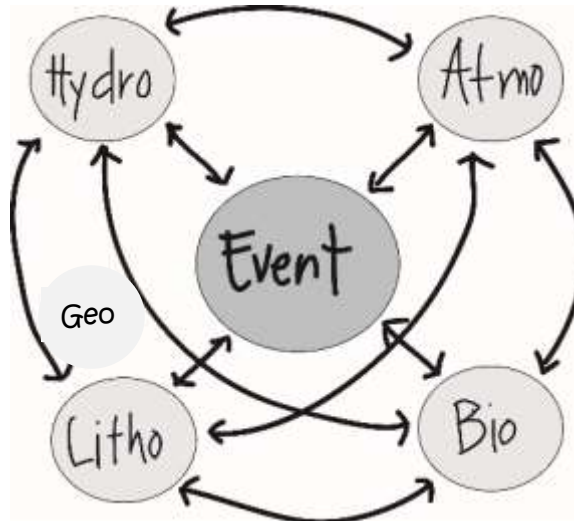
1. Earth includes beach grasses, forms of life in the sea, on land, and even in the air. Which term best describes the statement?
A. atmosphere
B. biosphere
C. geosphere
D. hydrosphere
2. Which system of the Earth is considered as the largest component of the Earth?
A. atmosphere
B. biosphere
C. geosphere
D. hydrosphere
3. Life is supported by oxygen and carbon dioxide. Which subsystem will best describe the statement?
A. atmosphere
B. biosphere
C. geosphere
D. hydrosphere
4. Relationship between the complex communities of individual organism is seen in the different systems of the Earth. What do you call the unit in nature?
A. ecosystem
B. complexity
C. ground
D. system
5. All of earth's cycles and spheres are interconnected. Why is this so?
A. because they are interconnected
B. because Earth is where we live in
C. because Earth is the only living planet
D. because every organism has its own function in the Earth
6. What is an example of a connection between atmosphere and geosphere?
A. water
B. nitrogen
C. mountains
D. volcanic eruption release gas

7. An example of a connection between atmosphere and hydrosphere is _____.
A. lakes
B. rain
C. rivers
D. rocks
8. From the given choices, which is an example of a connection between biosphere connecting to atmosphere?
A. Animals eat plants.
B. Animals drink water.
C. Animals lie in caves.
D. Plants produce oxygen.
9. Which among the choices clearly gives an example of connection between hydrosphere and geosphere?
A. boats transporting goods
B. fish swimming in water
C. water evaporating to make clouds
D. waves eroding rocks on beach
10. All living things, including land and sea made up the Earth. Which term best described the statement?
A. geosphere
B. ozone layer
C. atmosphere
D. biosphere
11. Which interaction will take place if nitrogen is returned to the soil when dead plants decompose?
A. biosphere and atmosphere
B. geosphere and atmosphere
C. biosphere and geosphere
D. atmosphere and geosphere
12. Which interaction best describes carbon dioxide dissolving from the air into the ocean?
A. atmosphere and hydrosphere
B. atmosphere and atmosphere
C. atmosphere and geosphere
D. atmosphere and biosphere
13. The atmosphere of the Earth is composed of ___ oxygen and ____ nitrogen and other gases.
A. 0% and 100%
B. 21% and 78%
C. 78% and 21%
D. 50% and 50%
14. What part of geosphere is a thin layer of solid rock that makes up the outermost part of the Earth?
A. core
B. crust
C. mantle
D. biosphere
15. Ozone plays an important function in every single organism on Earth. To what sphere does ozone layer belong?
A. atmosphere
B. biosphere
C. geosphere
D. hydrosphere

Additional Activities

“Connect Me Spheres”

Procedure: Analyze the interactions of the spheres after the onslaught of Taal Volcano.



1. What sphere caused the event?
2. What are the effects of the event on one or more spheres?
3. What is the global implication of the event?

Answer Key

What's More 1. The Earth consists of four subsystems, across whose boundaries matter and energy flows, the atmosphere (air), biosphere (living things), hydrosphere (water), and geosphere (land). The atmosphere provides the geosphere with heat and energy needed for rock breakdown and erosion. The biosphere receives gases, heat, and sunlight (energy) from the atmosphere. It receives water from the hydrosphere and a living medium from the geosphere.	Assessment 16.B 17.C 18.A 19.A 20.D 21.D 22.B 23.D 24.D 25.D 26.C 27.A 28.B 29.B 30.A	What I Know 16.C 17.B 18.D 19.A 20.A 21.B 22.B 23.B 24.C 25.D 26.D 27.C 28.A 29.C 30.A
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Earth and Life Science

Minerals

Earth and Life Science
Minerals
First Edition, 2020

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What I Need to Know

This module was designed and written with you in mind. It is here to help you master the properties of minerals. 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 divided into two lessons, namely:

- Lesson 1 – Minerals and their Characteristics
 - Different Properties of Minerals

After going through this module, you are expected to:

1. identify the examples of minerals;
2. explain the different characteristics of minerals;
3. differentiate minerals based on their properties; and
4. develop awareness on the importance of minerals around us.

What I Know

Choose the letter of the best answer. Write the chosen letter on a separate sheet of paper.

1. Pyrite is a yellowish mineral that looks like gold and is commonly called fool's gold. What is the property of mineral exhibited by pyrite wherein it reflects light and with metallic look?

A. Color	C. Luster
B. Hardness	D. Streak
2. Quartz can break other than along planes of cleavage. What is the property of mineral that show this characteristic?

A. Cleavage	C. Hardness
B. Fracture	D. Tenacity
3. Some minerals like mica has surfaces with planes of weak bonds in the crystals. Thus, its crystals can be peeled like layers of onion. Which is the property exhibited by mica?

A. Cleavage	C. Hardness
B. Fracture	D. Tenacity
4. Which property refers to the resistance of mineral to scratching?

A. Cleavage	C. Hardness
-------------	-------------

- B. Fracture
D. Luster
3. What are the building blocks of rocks and it is mostly found in the geosphere?
A. minerals
B. soil
C. ore
D. elements
4. In its powdered form, the mineral hematite is reddish. Which mineral property is described?
A. color
B. luster
C. Streak
D. hardness
7. Which is not a property that can be used to identify a mineral?
A. luster
B. streak
C. hardness
D. opaque
8. What is the property of mineral that reflects light on its surface?
A. Crystal structure
B. color
C. streak
D. luster
9. What is a naturally occurring, inorganic solid that has a definite crystalline structure and chemical composition?
A. compound
B. crystal
C. mineral
D. rocks
10. During the 1800's, miners can identify real gold from pyrite through biting the surface of the mineral. If a bite mark is exhibited, then the said mineral is considered real gold. What property is tested in this scenario?
A. cleavage
B. luster
C. hardness
D. streak color
11. What is a carbonate mineral that occurs in a different crystal form and is less common than either calcite or dolomite?
A. aragonite
B. gypsum
C. calcite
D. silica
12. What constitutes the size, shape, and arrangement of mineral grains in a rock?
A. permeable origin
B. porosity
C. cement
D. texture
13. Which of the following is not a characteristic of a mineral?
A. naturally occurring
B. solid
C. Organic
D. crystal structure
14. What do you call to the tendency for a mineral to break along flat surfaces?
A. cleavage
B. hardness
C. ductility
D. tenacity

15. What is the solid form of a mineral produced by a repeating pattern of atoms?
- A. crystal
B. density
C. element
D. fracture

Lesson 1 Minerals

Minerals make up the rocks beneath your feet, the soil that supports plants, and the deep rock of Earth's mantle. Any thorough study of Earth must include an understanding of minerals. But it is not sufficient to study minerals isolated from the rest of the planet. Rather we can learn more by observing the ways that minerals interact with other Earth systems.

What's In

This module contains activities that will enhance the teaching -learning process among learners about the minerals. It deals with the characteristics of minerals and the properties exhibited by the minerals. As the learners answer the questions they will be able to explore and understand the concepts about minerals. Moreover, they will develop awareness on the importance of minerals.

What's New

Name the following pictures below. List down the usage of these object in our daily activities. What do the objects presented below imply?

1. 	
2. 	

3.		
4.		
5.		

We are using these products made from minerals daily. Graphite is the mineral used in wooden pencil. Halite is the mineral found in salt. Your cellphone is made up of different minerals. The cars that we drive, the roads that we travel, the building that we live in, are some examples of products derived from minerals.

Arrange the jumbled letters to find the appropriate criteria to determine whether a material is classified as a mineral or not.

1. N L T L A U R Y N G O I R U C C

_____ - It is a product of Earth's natural processes.

2. C A I I R O G N

_____ - It must be product of Earth's physical processes.

3. S O U E N E G O M O H D I L O S

_____ - have definite shape and volume.

4. E N I L L A T S Y R C E S R T R U C U T

_____ - atoms are arranged in order of increasing pattern.

5. L M C E H A I N O I T O C M O P S I

_____ - represented by chemical formula

What is It

What are Minerals?

Minerals are the building blocks of rocks. Mineralogists use the criteria to determine whether a material is classified as a mineral or not.

Characteristics of Minerals

1. naturally occurring- a product of Earth's natural processes
2. inorganic- it must be product of Earth's physical processes.
3. homogeneous solid- minerals should have definite volume and rigid shape
4. definite chemical composition—represented by a chemical formula
5. orderly crystalline structure- atoms of minerals are arranged in an orderly and repeating pattern

Properties of Minerals

To identify minerals, mineralogists observe the following properties:

- a. Color - mineral's color may change depending on the surface.
- b. Streak - color of mineral in powdered form.
- c. Hardness - minerals resistance to scratching

Mohs Scale of Hardness (Diamond is the Hardest with a scale of 10)

Diamond
Corundum
Topaz
Quartz
Orthoclase
Apatite
Fluorite
Calcite
Gypsum
Talc

- d. Cleavage - mineral's resistance to being broken and fracture
- e. Crystalline structure or habit
- f. Diaphaneity/amount of transparency - ability to allow light to pass through it. This is affected by chemical makeup of the mineral sample.
- g. Luster - how light is reflected off a surface
- h. Tenacity - describes the minerals reaction to stress.
Brittleness- a mineral turns into powder

Malleability a mineral can be flattened by pounding with a hammer.

Ductility- A mineral can be stretched into wire.

Flexible but inelastic- Minerals are bent but they remain in the new position.

Flexible and elastic- Minerals are bent, and they bring back to their original position.

Sectility- ability of minerals to be sliced by a knife.

Prepare a list of minerals based on the Mohs Scale of Hardness and identify some products that make use of these minerals.

Minerals	<i>Products that contain the Mineral.</i>
1. Diamond	
2. Corundum	
3. Topaz	
4. Quartz	
5. Orthoclase	
6 Apatite	
7. Fluorite	
8. Calcite	
9. Gypsum	
10. Talc	

What's More

Understanding Science Words

The pictures below show the common minerals and their properties or uses.

Identify other properties exhibited by the minerals. Choose your answer from the given choices.

BRITTLENESS

MALLEABILITY

DUCTILITY

LUSTER

SECTILITY



1. All true minerals can be drawn into wires _____



2. Overall sheen of mineral _____



3. A mineral can be hammered /flattened _____



4. A mineral can be cut by a knife _____



5. A mineral can be turned into powder_____

What I Have Learned

Fill in the Blanks

Identify the prominent properties exhibited by the following minerals. Fill in the blanks to form the appropriate term that best fits the described mineral property.

1. L ___ T ___ R - a manner by which mineral reflects light.



Pyrite - a. k a. fool's gold

2. S ___ R ___ K - color of mineral in powdered form.



Hematite- both types leave the same powder

3. ___ L ___ V ___ G ___ - tendency of mineral to break along flat surfaces



Mica crystal can be peel like layers of onion

4. R C U - the manner breaks other than along planes of cleavage.



Quartz creates smooth, curved surfaces

5. H R S - resistance of mineral to scratching and it is the most commonly used property for identifying minerals.



Diamond has a scale of 10

HARDNESS	FRACTURE	CLEAVAGE
STREAK	LUSTER	

Matching Type

Match the properties of minerals in column A with the description of mineral properties in column B.

Column A	Column B
____ 1. Mohs hardness scale	A. describes the mineral reaction to stress
____ 2. Sectility	B. true color of mineral
____ 3. Streak	C. a ranking of mineral from softest hardest
____ 4. Crystal	D. ability of mineral to be cut by knife
____ 5. Tenacity	E. repeating pattern in minerals in solid

What I Can Do

List some of the uses of minerals around us.

<i>Minerals</i>	<i>Uses</i>
1.Halite	Mineral found in table salt;as preservatives
2	
3	
4	
5	

Reflect Upon

Upon knowing the value of minerals in our everyday life, as a student how can you help in conserving and preserving the natural sources of these minerals? (For example, graphite is a mineral found in pencil).

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

Assessment

Multiple Choice. Choose the letter of the best answer. Write the chosen letter on a separate sheet of paper.

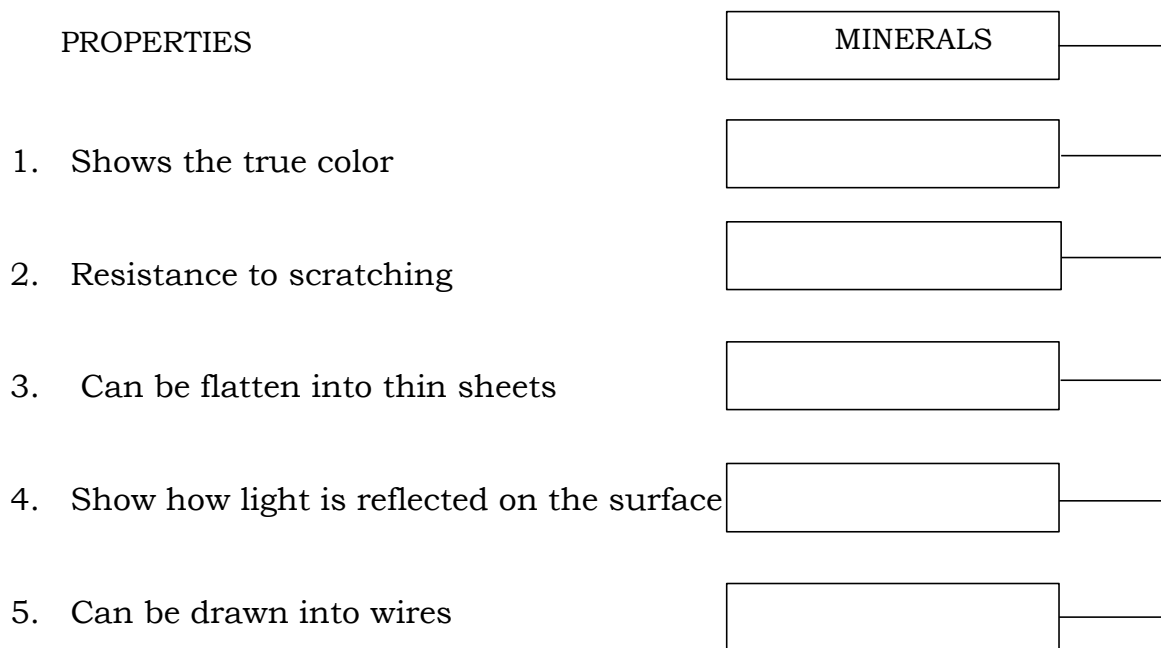
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 - C. Organic
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 - B. hardness
 - C. ductility
 - D. tenacity
15. What is the solid form of a mineral produced by a repeating pattern of atoms?
- A. crystal
 - B. density
 - C. element
 - D. fracture

Additional Activities

Putting together

Directions: Complete the concept map below.

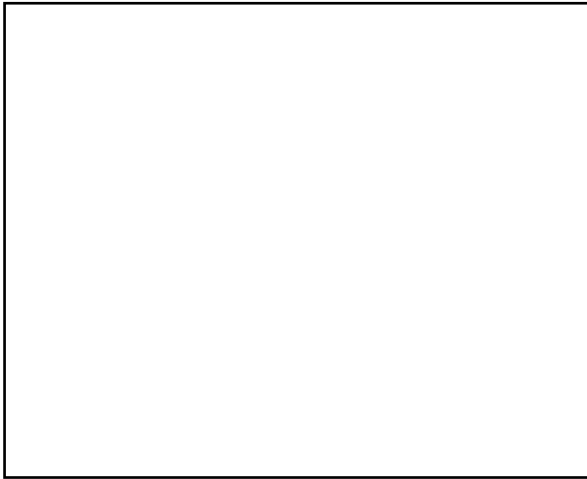


Brainstorming

Assume you are a mineralogist that discovered a new type of mineral. To inform not only the academe but also the common people, you are then tasked to make an infographic that will state its characteristics, properties, and significance (whether economic, health and scientific). Present these important data through a concept map.

Finding the Perfect Match

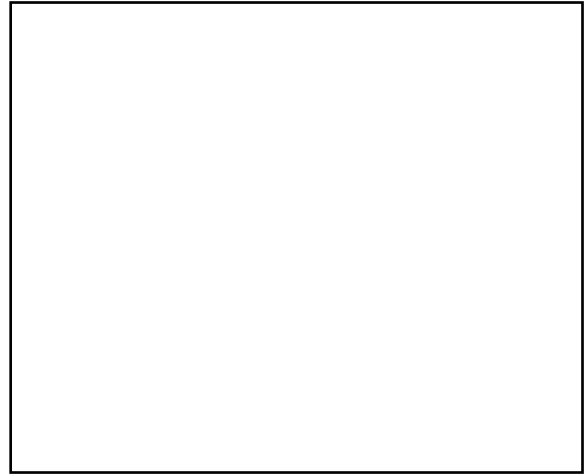
Take at least 5 photos of minerals that are found in our day to day living. Identify the said minerals and state their unique characteristics and significance.



Name: _____

Characteristics: _____

Significance: _____



Name: _____

Characteristics: _____

Significance: _____



Name: _____

Characteristics: _____

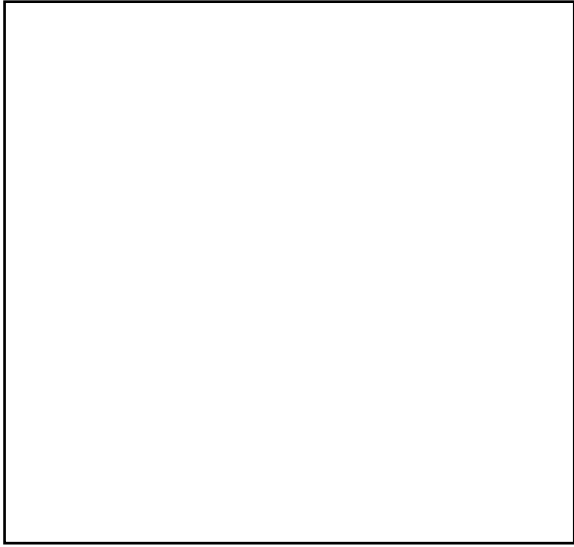
Significance: _____



Name: _____

Characteristics: _____

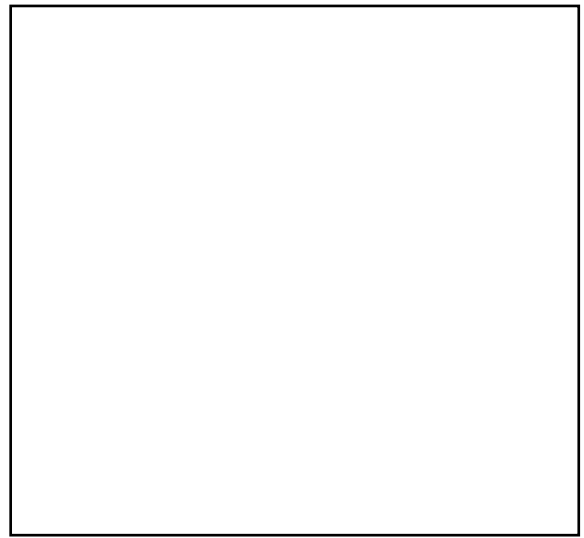
Significance: _____



Name: _____

Characteristics: _____

Significance: _____



Name: _____

Characteristics: _____

Significance: _____

Answer Key

What I Have Learned 1. Luster 2. Streak 3. Cleavage 4. Fracture 5. Hardness Matching Type 1. C 2. D 3. B 4. E 5. A	What's More 1. Ductility 2. Luster 3. Malleability 4. Sectility 5. brittleness	Pre Test/Post test <table> <tr> <td>1. C</td><td>6. C</td><td>11.A</td></tr> <tr> <td>2. B</td><td>7. D</td><td>12. D</td></tr> <tr> <td>3. A</td><td>8. D</td><td>13.C</td></tr> <tr> <td>4. C</td><td>9. C</td><td>14.A</td></tr> <tr> <td>5. A</td><td>10.C</td><td>15 A</td></tr> </table> What's New A. 1. Pencil 2. Table salt 3. Cellphone 4. Car 5. Bridge B 1 Naturally occurring 2. Inorganic 3. Homogeneous - solid 4. crystalline - structure 5, chemical - composition	1. C	6. C	11.A	2. B	7. D	12. D	3. A	8. D	13.C	4. C	9. C	14.A	5. A	10.C	15 A
1. C	6. C	11.A															
2. B	7. D	12. D															
3. A	8. D	13.C															
4. C	9. C	14.A															
5. A	10.C	15 A															

Answer Key

Post Test 1. C 2. B 3. A 4. B 5. A 6. C 7. D 8. D 9. C 10. C 11. A 12. D 13. C 14. A 15. A	Additional activities 1. Streak 2. Hardness 3. Malleability 4. Luster 5. Ductility	What I can do 1. Answer may vary.
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Earth and Life Science

Rocks

Earth and Life Science
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The module covers:

- Lesson 1 – Types of Rocks and their Properties

After going through this module, you are expected to:

1. identify the three types of rocks;
2. classify rocks as to igneous, sedimentary and metamorphic rocks; and
3. appreciate the importance of rocks in our daily life.

What I Know

Choose the letter of the best answer. Write the chosen letter on a separate sheet of paper.

1. Rocks vary in color, size, texture and shape. They are classified based on how they were formed. Which of the following deals with the study of rocks?
A. Biology B. Geology C. Paleontology D. Petrology
2. Halite is made when a body of seawater becomes closed off and evaporates and salt precipitates out and is deposited as crystallized halite. What type of sedimentary rock is formed?
A. Clastic B. Chemical C. Organic D. Pyroclastic
3. Igneous rock is divided into two groups, extrusive and intrusive. Extrusive igneous rocks form when magma makes its way to its surface as lava and the cools forming rocks. Which will be the characteristics of the crystals?
A. Crystals are coarse grained.
B. Crystals are fine grained.
C. Crystals are very large.
D. Crystals are phaneritic
4. Regional metamorphism occurs due to changes in pressure and temperature over a large region of the crust. It may happen when rock is buried deep below the surface or where pieces of the Earth's crust collide. Which is a metamorphic rock?
A. Breccia B. Conglomerate C. Marble D. Sandstone

5. Igneous and metamorphic rock can be buried and undergo tremendous heating and stress. What is the process of transformation of one rock type into another?
 A. Compaction B. Lithification C. Metamorphism D. weathering
6. What type of rocks are formed from sediments over long period of time?
 A. Igneous Rocks C. Metamorphic Rocks
 B. Sedimentary Rocks D. Minerals
7. This refers to type of rock that was heated and compressed over time.
 A. Igneous C. Metamorphic
 B. Sedimentary D. All are correct
8. What is the natural process that causes one kind of rock to change into another kind?
 A. weathering B. rock cycle C. Sediments D. Metamorphism
9. A rock that forms when magma hardens beneath Earth's surface is termed as:
 A. Intrusive metamorphic rock
 B. Extrusive sedimentary rock
 C. Intrusive igneous rock
 D. Extrusive igneous rock
10. Which of the following is an example of an igneous rock?
 A. Limestone B. Coal C. Sandstone D. Granite
11. Which of the following represents the correct order of the processes responsible for the formation of sedimentary rocks?
 A. Erosion, weathering, compaction, cementation, deposition
 B. Compaction, cementation, deposition, weathering, erosion
 C. Deposition, cementation, compaction, erosion, weathering
 D. Weathering, erosion, deposition, compaction, cementation
12. A student obtained a cup of quartz sand from a beach. A saltwater solution is poured into the sand and allowed to evaporate. The mineral residue from salt water solution cements the sand grains together, forming a material that is most likely an:
 A. extrusive igneous rock
 B. intrusive igneous rock
 C. metamorphic rock
 D. sedimentary rock

13. Which of the following is true about rocks?
- A. Rocks are composed of only one mineral.
 - B. Most rocks are a mixture of minerals.
 - C. Rocks do not contain minerals.
 - D. Coal is not considered a rock.
14. What is the type of rock formed from lava that cools quickly that results to finer grain and smaller size of crystals?
- A. Extrusive igneous rock
 - B. Intrusive igneous rock
 - C. Sedimentary rock
 - D. Metamorphic rock
15. Fossils are found on this type of rocks.
- A. Extrusive igneous rock
 - B. Intrusive igneous rock
 - C. Sedimentary rock
 - D. Metamorphic rock

Lesson 2 Rocks

Petrology is the scientific study of rocks. Rocks are combined aggregation of minerals. Petrologist classified rocks based on how they were formed. In general, rocks are classified as igneous, sedimentary, and metamorphic rock.

What's In

This module contains activities that will enhance the teaching-learning process among learners about the minerals. It deals with the characteristics of rocks and the properties exhibited by the rock. As the learner answers the questions, they will be able to classify and understand the concepts about three types of rocks. They will understand the process of their formation. Moreover, they will develop awareness on the importance of rocks to our daily life.

What's New

Word Cryptogram

Directions: To come up with the correct answer for each number, unscramble the letters by placing the correct letter sequence in the shaded box. Use number boxes to complete the answer to the riddle below.

E	M	N	I	S	T	D	A	Y	E	R
							2			

E	M	A	I	H	T	P	C	M	E	R
			4							

G	E	N	O	S	U	C		O	R	I	K
								3			

V	A	C	N	I	O	L
				6		

C	A	S	I	L	T	C
			1	5		

1	2	3	4	5	6

Riddle: the layers of sediments that accumulated and carry the records of the Earth's history.

What is It

Earth is a solid rock to a depth of 2,900 kilometers, where mantle meets the liquid outer core. A **rock** is a naturally occurring solid aggregate of one or more minerals. The aggregate minerals forming the rocks are held together by chemical bonds. Grains can be different in color, texture, and sizes. Geologists then group rocks into three categories based on how the rocks form: igneous sedimentary and metamorphic rock. **Petrology** is the scientific study of rocks. Petrologists classify rocks based on how they were formed.

Three types of Rocks

Igneous- formed from hardening and **crystallization of magma** or molten material that originates deep within the earth.

Two types of igneous rock:

A. Extrusive/Volcanic rock - forms when magma makes its way to Earth's surface as lava and then cools. The crystals are very small (fine grained) since the cooling process is fast.

B. Intrusive/Plutonic - It cools slowly beneath the Earth surface and are created by magma. The intrusive igneous rocks have very large crystals (coarse grained).

Igneous rocks are classified based on

1. Composition

FELSIC - light in color; feldspar and silicates

MAFIC - dark in color; made up of magnesium and iron

INTERMEDIATE - between mafic and felsic

ULTRAMAFIC - very dark color

2. Texture- overall appearance of rock

Aphanistic - fine grained

Phaneritic- coarse grained

Porphyritic- large crystals with small crystals

Glassy- non-ordered solid from rapid quenching

Pyroclastic- composite of ejected fragments

Examples:

Obsidian, pumice, basalt, granite, diorite, gabbro



Metamorphic - forms from pre-existing rocks: either metamorphic, igneous, sedimentary

Examples: Quartzite, marble, slate, phyllite

Metamorphism - transformation of one rock type into another.

2 types of metamorphism

1. Regional-due to changes in pressure and temperature over large region of the crust
2. Contact-mainly by heat due to contact with magma

Classification:

- a. Texture - refers to the size arrangement and grains within the rock.
- b. Foliation - any planar arrangement of mineral grains or structural features within the rock.

*foliated - appeared banded or layered, contains crystals Example: mica

Non-foliated - made up of only few minerals

EXAMPLES OF METAMORPHIC ROCKS



Sedimentary rocks provide information about surface conditions that existed in the Earth's past.

- Particles of sand, shells, pebbles, and other fragments of materials called sediments, accumulate in layers and over long period of time harden into rocks.
- Compaction-due to increase of pressure of layered sediments it bind together to form the sedimentary rocks.

Three types of sedimentary rocks

- a. Clastic Sedimentary rock - formed from accumulation of clasts: little pieces of broken rocks and shells. Examples: conglomerate, breccia, sandstone, shale
- b. Chemical - formed when dissolved minerals precipitate from a solution.

Example: Halite - formed when a body of seawater becomes closed off and evaporates.

c. Organic - rocks formed from the accumulation of animal debris

Example: Coal - composed of organic matter in the form of plants fragments.

SEDIMENTARY ROCKS



CHALK



LIMESTONE



SANDSTONE

Identify and classify the types of rocks below as to igneous, sedimentary, and metamorphic rock.



1. _____



2. _____



3. _____



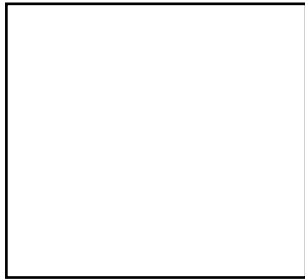
4. _____



5. _____

Collect at least five rock samples in your place and take a photo of the samples.
Describe the characteristics of each rock depending on their appearance, texture,

color, and layers (or bands). Then classify them as to igneous, sedimentary, or metamorphic rock.



Type of Rock: _____

Description: _____

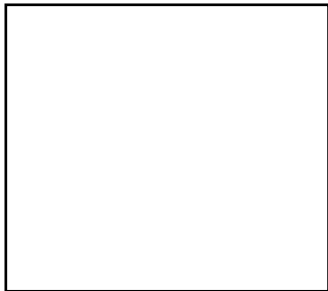
Importance: _____



Type of Rock: _____

Description: _____

Importance: _____



Type of Rock: _____

Description: _____

Importance: _____



Type of Rock: _____

Description: _____

Importance: _____



Type of Rock: _____

Description: _____

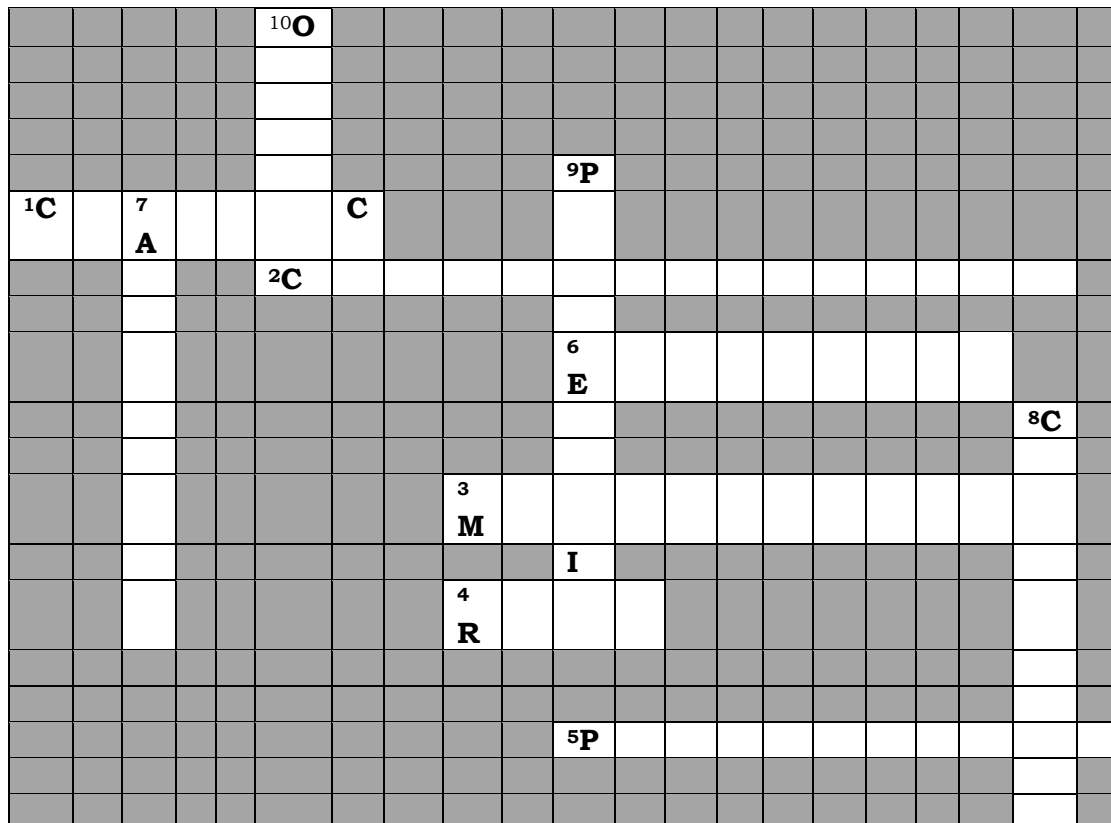
Importance: _____

What's More

Understanding Science Words

Crossword Puzzle

Answer the questions below that refer to the terms about the characteristics and different types of rocks.



ACROSS

1. rocks formed from accumulation of clasts little pieces
2. formation of igneous rocks due to hardening of magma
3. transformation of one rock type into another
4. combined aggregation of minerals
5. composed of ejected fragments
6. a.k.a. volcanic rock
7. fine grained rock

DOWNWARD

8. sediments bind together due to increase in pressure
9. coarse grained
10. sedimentary rocks formed from plants and animals.

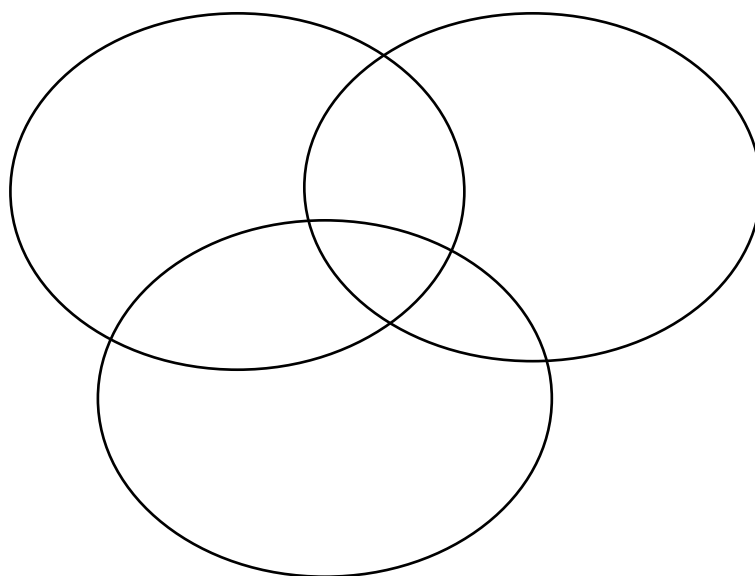
What I Have Learned

Fill in the table below by providing basic information about the types of rocks. You may refer to the words in the box below.

	<i>Igneous</i>	<i>Sedimentary</i>	<i>Metamorphic</i>
Types			
Examples			
Process of formation			

WORD LISTS		
Lithification	pumice	clastic
Metamorphism	sandstone	intrusive
Cooling	andesite	extrusive
Cementation	slate	non- clastic
Deposition metamorphism	marble	contact

Fill in the Venn Diagram to determine the similarities and differences of the three types of rocks.



What I Can Do

Reflect upon:

Rocks are all around us. It is used for building materials, cars, roads, and appliances. As a senior high school student, how can you promote the sustainable development in utilizing these resources? Give some suggestions.

[illegible]

Using the Internet, research three rocks of different types (igneous, sedimentary, and metamorphic) and state their respective economic and medical significance in our present society.

[illegible]

Assessment

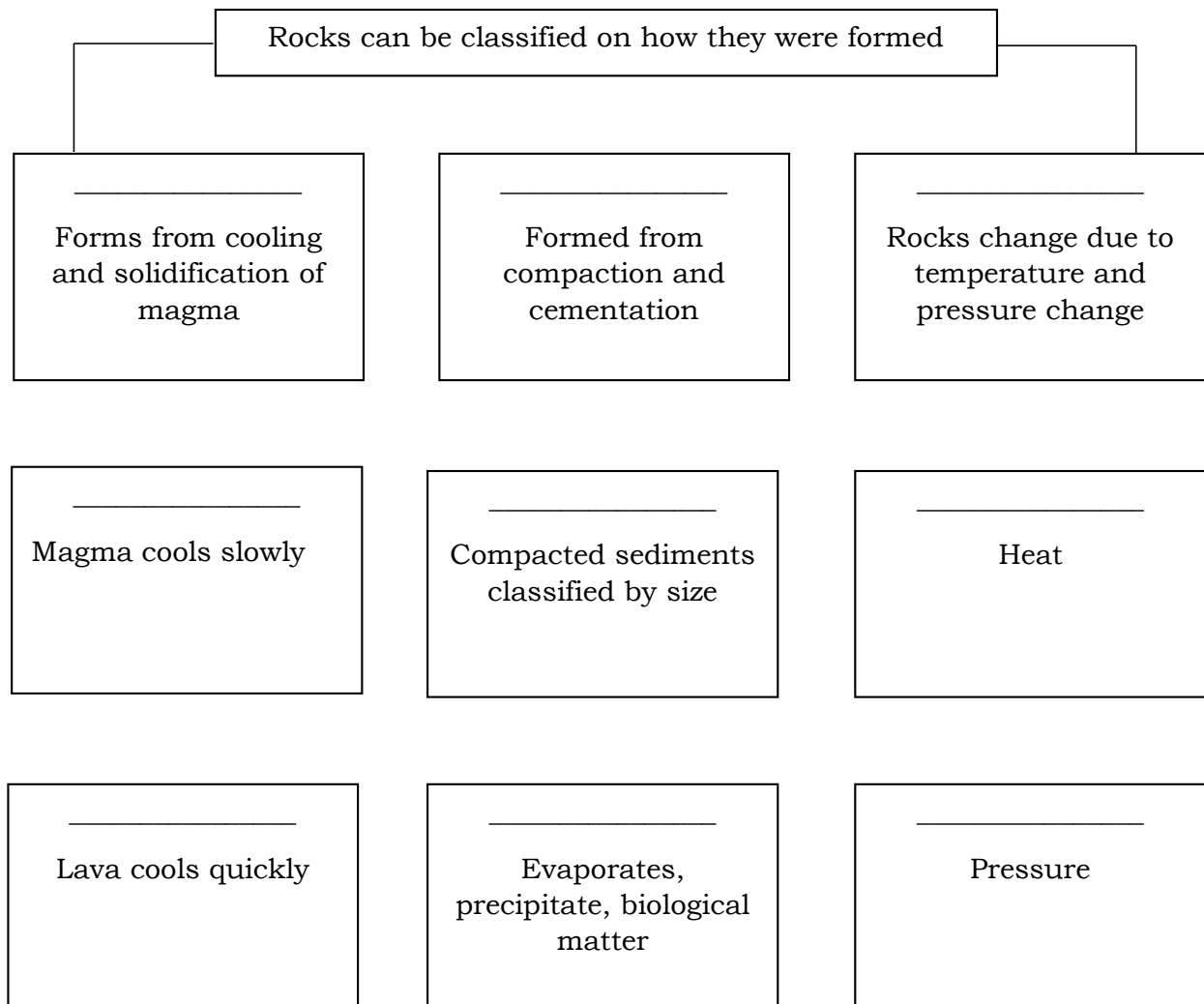
Multiple Choice. Choose the letter of the best answer. Write the chosen letter on a separate sheet of paper.

1. Petrologist classifies rocks based on how they were formed. What is the branch that deals with the study of rocks?
A. Biology B. Geology C. Paleontology D. Petrology
2. Halite is made when a body of seawater becomes closed off and evaporates and salt precipitates out and is deposited as crystallized halite. What type of sedimentary rock is formed?
A. Clastic B. Chemical C. Organic D. Pyroclastic
3. Igneous rock is divided into two groups, extrusive and intrusive. Extrusive igneous rocks form when magma makes its way to its surface as lava and the cools forming rocks. Which of the following will be the characteristics of the crystals?
A. Crystals are coarse grained.
B. Crystals are fine grained.
C. Crystals are very large.
D. Crystals are phaneritic
4. Regional metamorphism occurs due to changes in pressure and temperature over a large region of the crust. It may happen when rock is buried deep below the surface or where pieces of the Earth's crust collide. Which is a metamorphic rock?
A. Breccia B. Conglomerate C. Marble D. Sandstone
5. Igneous and metamorphic rock can be buried and undergo tremendous heating and stress. What is the process of transformation of one rock type into another?
A. Compaction B. Lithification C. Metamorphism D. weathering
6. What type of rocks are formed from sediments over long period of time?
A. Igneous Rocks C. Metamorphic Rocks
B. Sedimentary Rocks D. Minerals
7. This refers to a type of rock that was heated and compressed over time. Which best fits the description?
A. Igneous B. Metamorphic C. Sedimentary D. All are correct
8. What is the natural process that causes one kind of rock to change into another kind?
A. weathering B. rock cycle C. Sediments D. Metamorphism

9. A rock that forms when magma hardens beneath Earth's surface is called an:
- A. Intrusive metamorphic rock
 - B. Extrusive sedimentary rock
 - C. Intrusive igneous rock
 - D. Extrusive igneous rock
10. Which of the following is an example of an igneous rock?
- A. Limestone
 - B. Coal
 - C. Sandstone
 - D. Granite
11. Which of the following represents the correct order of the processes responsible for the formation of sedimentary rocks?
- A. Erosion, weathering, compaction, cementation, deposition
 - B. Compaction, cementation, deposition, weathering, erosion
 - C. Deposition, cementation, compaction, erosion, weathering
 - D. Weathering, erosion, deposition, compaction, cementation
12. A student obtain a cup of quartz sand from a beach. A saltwater solution is poured into the sand and allowed to evaporate. The mineral residue from salt water solution cements the sand grains together, forming a material that is most likely an:
- A. Extrusive igneous rock
 - B. intrusive igneous rock
 - C. sedimentary rock
 - D. metamorphic rock
13. Which of the following is true about rocks?
- A. Rocks are composed of only one mineral.
 - B. Most rocks are a mixture of minerals.
 - C. Rocks do not contain minerals.
 - D. Coal is not considered a rock.
14. What is the type of rock formed from lava that cools quickly that results to finer grain and smaller size of crystals?
- A. Extrusive igneous rock
 - B Intrusive igneous rock
 - C. Sedimentary rock
 - D. Metamorphic rock
15. Fossils are found on this type of rocks.
- A. Extrusive igneous rock
 - B. Intrusive igneous rock
 - C. Metamorphic rock
 - D. Sedimentary rock

Additional Activities

A. Complete the concept map using the words below.

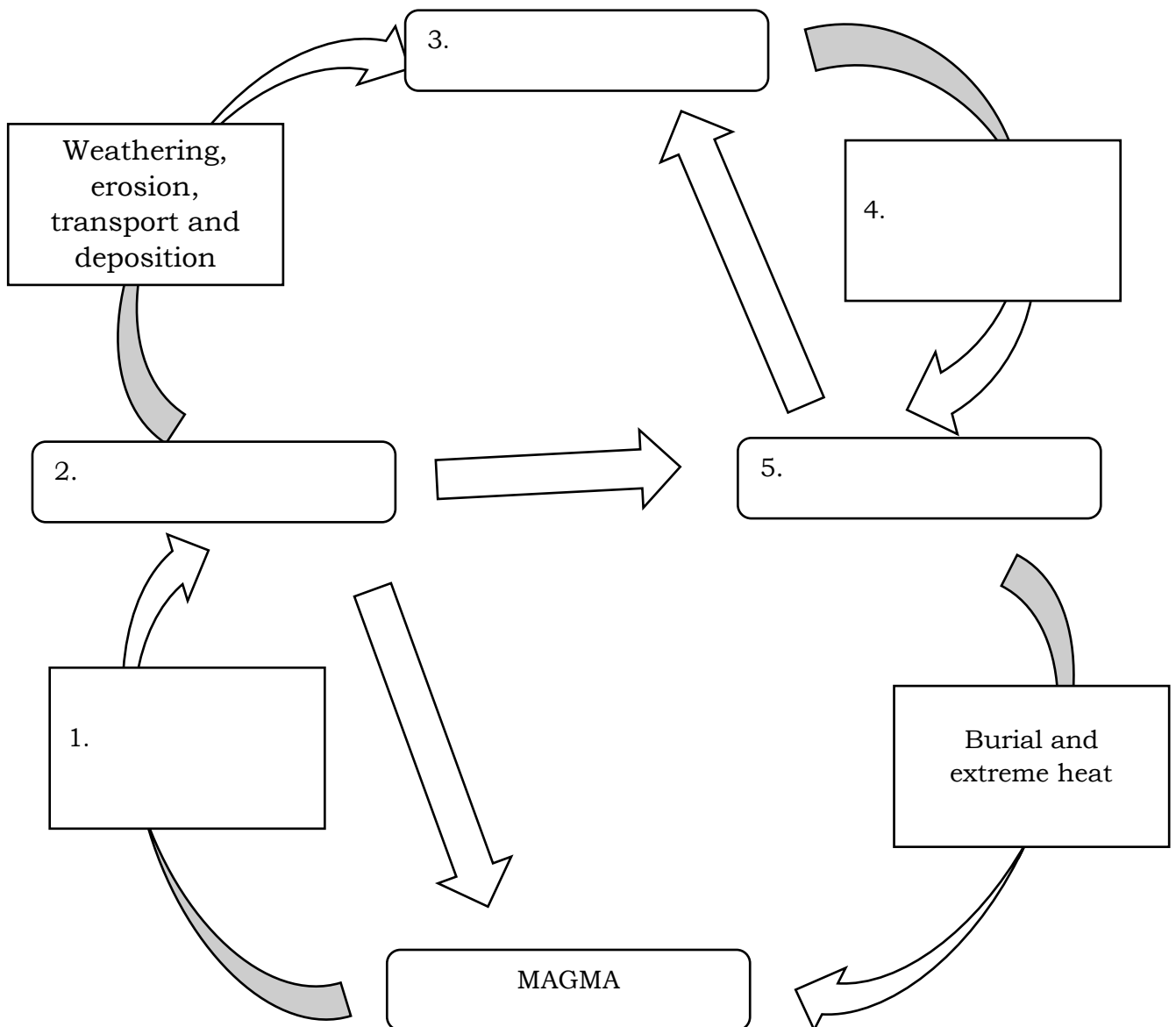


Metamorphic	Clastic	Contact metamorphism
Sedimentary	Extrusive	Regional Metamorphism
Non- Clastic	Igneous	Intrusive

Additional Activities

B. Fill in the missing word/term to complete the rock cycle. You may refer to the box below.

ROCK CYCLE



Igneous

Metamorphic

Sedimentary

Heat and/or pressure

Minerals

Metamorphism

Thermal Expansion

Intrusion/eruption

Answer Key

What's New

Word Cryptogram 1,2

E	M	N	I	S	T									
S	E	D	I	M	E									
E	A	Y	E	R										

2

N	T	A	R	Y										
D	A	Y	E	R										

3

R	O	C	K											
O	R	I	K											

4

E	M	A	I	H	T	P	C	M	E	R				
M	E	T	A	M	O	R	P	H	I	C				

5

I	G	N	E	O	U	S								
G	E	N	O	S	U	C								

6

V	A	C	N	I	O	L								
V	A	C	N	I	O	L								

7

C	L	A	S	I	L	T								
C	L	A	S	I	L	T								

8

C	L	A	S	I	L	T								
C	L	A	S	I	L	T								

9

C	L	A	S	I	L	T								
C	L	A	S	I	L	T								

10

C	L	A	S	I	L	T								
C	L	A	S	I	L	T								

11

C	L	A	S	I	L	T								
C	L	A	S	I	L	T								

12

C	L	A	S	I	L	T								
C	L	A	S	I	L	T								

13

C	L	A	S	I	L	T								
C	L	A	S	I	L	T								

14

C	L	A	S	I	L	T								
C	L	A	S	I	L	T								

15

C	L	A	S	I	L	T								
C	L	A	S	I	L	T								

Pre Test

1. D

2. B

3. B

4. C

5. C

6. B

7. C

8. B

9. C

10. D

11. D

12. D

13. B

14. A

15. C

[illegible]

What I can do?				
1. Chalk/Sedimentary	2. Sandstone, Sedimentary	3. Schist, Metamorphic	4. Limestone, Sedimentary	5. Gabbro, Sedimentary
Examples	Types	Processes	Involved	
Igneous	Intrusive	Obsidian, Granite, Basalt, Pumice	Crystallization, cooling	Compaction, Lithification, cementation
Sedimentary	Clastic	Non-Clastic	Breccia, conglomerate	Limestone, sandstone
Metamorphic	Contact	Regional	Metamorphism	metamorphism
What I have Learned?				

Additional Activities				
A.	Igneous	Sedimentary	Metamorphic	
B.	Intrusive	Clastic	Contact	Regional
	Extrusive	Non-Clastic		
1. Intrusion/eruption				
2. Igneous				
3. Sedimentary				
4. Heat and/or Pressure				
5. Metamorphic				
Assessment / Post Test				
1. D	2. B	3. B	4. C	5. C
6. B	7. C	8. B	9. C	10. D
11. D	12. C	13. B	14. A	15. C

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Earth and Life Science

Exogenic Processes

Earth and Life Science
Exogenic Processes
First Edition, 2020

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What I Need to Know

This module was designed and written with you in mind. It is here to help you master interaction and interdependence in the ecosystem. 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 covers:

- Lesson 5 – Exogenic Processes

After going through this module, you are expected to:

1. describe how rocks undergo weathering;
2. identify the agents of erosion; and
3. explain how the products of weathering are carried away by erosion and deposited elsewhere.

What I Know

Choose the letter of the best answer. Write the chosen letter on a separate sheet of paper.

1. A plant is growing into the base of a stone monument and creating a crack on it? This is an example of _____.
 - A. thawing
 - B. freezing
 - C. chemical weathering
 - D. mechanical weathering
2. Some minerals dissolve rapidly in water while others do not. If you put crystals of halite or rock salt in water, the crystals rapidly dissolve to form a solution. What is the type of chemical weathering exhibited by the mineral halite?
 - A. abrasion
 - B. oxidation
 - C. dissolution
 - D. hydrolysis
3. Stalactites and stalagmites on caves are a popular attraction. These were formed through deposition of calcium carbonate and other minerals. What type of weathering occurred during the process?
 - A. freezing and thawing
 - B. chemical weathering
 - C. mechanical weathering
 - D. thermal and pressure change

4. Water reacts with one mineral to form a new mineral that has water part of crystal structure. A mineral feldspar, the most abundant on the Earth's crust weathers by the process of chemical weathering. What is the process that is exhibited by the feldspar?
- A. oxidation
 - B. hydrolysis
 - C. dissolution
 - D. pressure-release fracturing
5. Rusting is an example of chemical weathering. What is the process involved?
- A. pressure-release fracturing
 - B. dissolution
 - C. hydrolysis
 - D. oxidation
6. Rocks and sand collide with one another when currents or waves carry them along a stream or beach. During these collisions, their sharp edges and corners wear away and the particles become rounded. What is the mechanical weathering of rocks by friction and impact?
- A. abrasion
 - B. oxidation
 - C. hydrolysis
 - D. dissolution
7. Which of the following human activities result in moving the sediments from one place to another?
- A. cultivating soil and gardening
 - B. developing new athletic field
 - C. building a highway
 - D. all of the above
8. Which of the following is NOT an agent of erosion?
- A. glacier
 - B. gravity
 - C. wind
 - D. rocks
9. All of the following are the advantages of wind barrier such as row of trees along the edge of field EXCEPT:
- A. conserve moisture
 - B. trap the blowing wind
 - C. protect crops from the effects of wind
 - D. increase the effects of wind erosion.
10. The process by which rocks on the earth's surface breaks down or changes its composition is called _____.
- A. erosion
 - B. deposition
 - C. weathering
 - D. mass wasting

11. Which of the following processes does NOT cause physical weathering?
- A. oxidation
 - B. freezing and thawing
 - C. burrowing of animals
 - D. temperature and pressure
12. Which of the following processes does NOT cause chemical weathering?
- A. oxidation
 - B. hydrolysis
 - C. dissolution
 - D. temperature
13. Which of the following processes of chemical weathering occur in the formation of stalactites and stalagmites?
- A. oxidation
 - B. hydrolysis
 - C. dissolution
 - D. all of the above
14. What statement is NOT correct about dissolution?
- A. It happens when elements react with atmospheric oxygen.
 - B. Rocks and minerals dissolve rapidly when water is either acidic or basic.
 - C. Limestone composed of calcite is weathered and develops caves through time.
 - D. The crystal of halite dissolves rapidly and completely in water to form a solution.
15. Soil is an essential component of the earth's crust. What is the composition of the soil?
- A. a mixture of clay, dust, and sand
 - B. a mixture of silt, dust, sand, and water
 - C. a mixture of rock, dust, sand, water, and gas
 - D. a mixture of grains, organic matter, H₂O, and gas

Lesson 5 Exogenic Process

The earth's surface is composed of water and landmasses. The solid portion is made out of rocks and minerals that could experience changes either physically or chemically. The weathered materials are transported by different agents from one place to another and will settle down in a particular area. These progressions that happen is achieved by forms called exogenic processes. It includes weathering, erosion, and deposition.

What's In

Activity 1

Organize the disordered letters. Describe each term briefly.

S	K	O	R	C
---	---	---	---	---

E	I	G	N	O	S	U
---	---	---	---	---	---	---

E	I	M	N	D	S	E	T	S
---	---	---	---	---	---	---	---	---

N	A	I	O	T	G	D	I	S	I	N	T	E	R
---	---	---	---	---	---	---	---	---	---	---	---	---	---

P	O	I	C	M	O	N	I	O	T	S	D	E
---	---	---	---	---	---	---	---	---	---	---	---	---

What's New

Activity 2

Weathering is the process of disintegration (physical) and decomposition (chemical) of rocks. Weathering is a process of breaking down rocks into small particles such as sand, clay, gravel and other fragments. There are two types of weathering: mechanical weathering and chemical weathering. This activity will allow learners to differentiate physical changes from chemical changes.

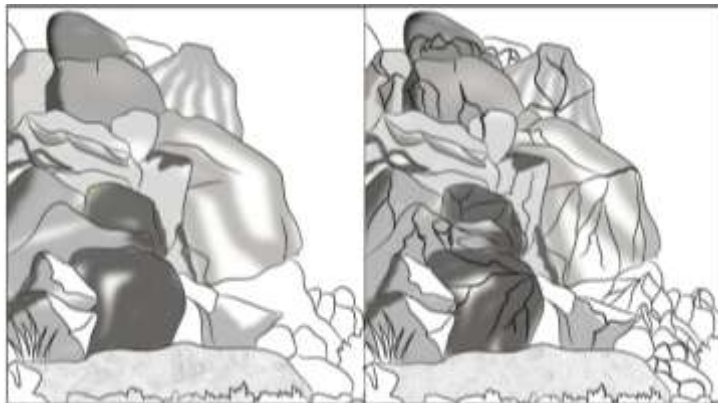
Learners will follow the following instructions:

1. Prepare the needed materials: two pieces of paper and match.
2. Tear one paper, observe, and record your answer.
3. Burn the other paper (with teacher supervision), observe, and record your answer.
4. Based on your observation, differentiate the changes after tearing and burning.

<i>Tearing of paper</i>	<i>Burning of paper</i>
Before	Before
After	After

Activity 3

Spot the difference/s.



What can you say about the image? Do you see any difference?

What is It

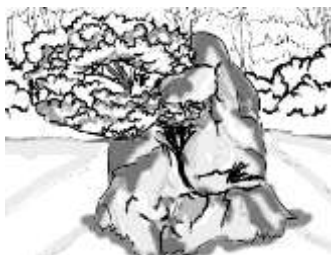
Mechanical weathering or physical weathering is the breakdown of rocks into pieces without any change in its composition. In this process, the size and shape of rocks changes and this occurs because of the following factors shown in the table below.

<i>Factors</i>	<i>Description</i>
Pressure	Due to tectonic forces, granite may rise to form mountain range. After the granite ascends and cools, the overlying rocks and sediments may erode. At the point when the pressure diminishes, the rock expands, cools, and became brittle and fractured.
Temperature	Rocks expand and are fractured when expose to high temperature. However, if the temperature drops to 0°C (freezing point of water), it also expands and causes fracture.

Frost Wedging	Generally, rocks have fracture in its surface and when water accumulates in the crack and at that point freezes, the ice expands and breaks the rock apart.
Abrasion	The breakdown of rocks is caused by impact and friction. This primarily occurs during collision of rocks, sand, and silt due to current or waves along a stream or seashore causing sharp edges and corners to wear off and become rounded.
Organic Activity	The roots grow causing penetration into the crack, expand, and in the long run, break the rock.
Human Activities	Activities such as digging, quarrying, denuding forests and cultivating land contribute to physical weathering.
Burrowing Animals	Animals like rats, rabbits and squirrels excavate into the ground to create a space for habitation.

Activity 4

I. Identify the factors of physical weathering shown in each picture.



1. _____



2. _____



3. _____

In chemical weathering, there are changes in the composition of rocks due to the chemical reactions presented below.

Chemical Reactions	Description
Dissolution	It occurs in specific minerals which are dissolved in water. Examples of these minerals are Halite (NaCl) and Calcite (CaCO ₃). The formation of stalactites and stalagmites in caves are brought about by this chemical reaction.
Hydrolysis	Rock-forming minerals like amphibole, pyroxene, and feldspar react with water and form different kinds of clay minerals.
Oxidation	It is the response of oxygen with minerals. If the iron oxidizes, the mineral in rocks decomposes. Rusting is an example of this chemical reaction.

II. Analyze each picture. Identify the chemical reaction that causes chemical weathering.



4. _____



5. _____

What's More

Weathering is an important process in the formation of soil. Soil is a mixture of grains, organic matter, H₂O, and gas.

Plants, animals, and humans play an important role in the erosional process. Erosion is the separation and removal of weathered rocks due to different agents like water, wind, and glacier that causes transportation of the material to where they are deposited.

Activity 5

Answer the following questions:

1. How do animals cause erosion?

2. How do human activities affect the rate of erosion?

Activity 6

Illustrate the agents of erosion and explain how each of them causes erosion.

C. _____ _____ _____ _____ _____ _____	B. _____ _____ _____ _____ _____ _____	A. _____ _____ _____ _____ _____ _____

The movement of sediments downslope under the influence of gravity is called mass wasting. The example of this are fall, slide, avalanche, and flow. On the other hand, deposition is the process in which the weathered materials carried out by erosion settle down in a particular location.

Activity 7

Define the type of mass movement.

1. Fall

2. Slide

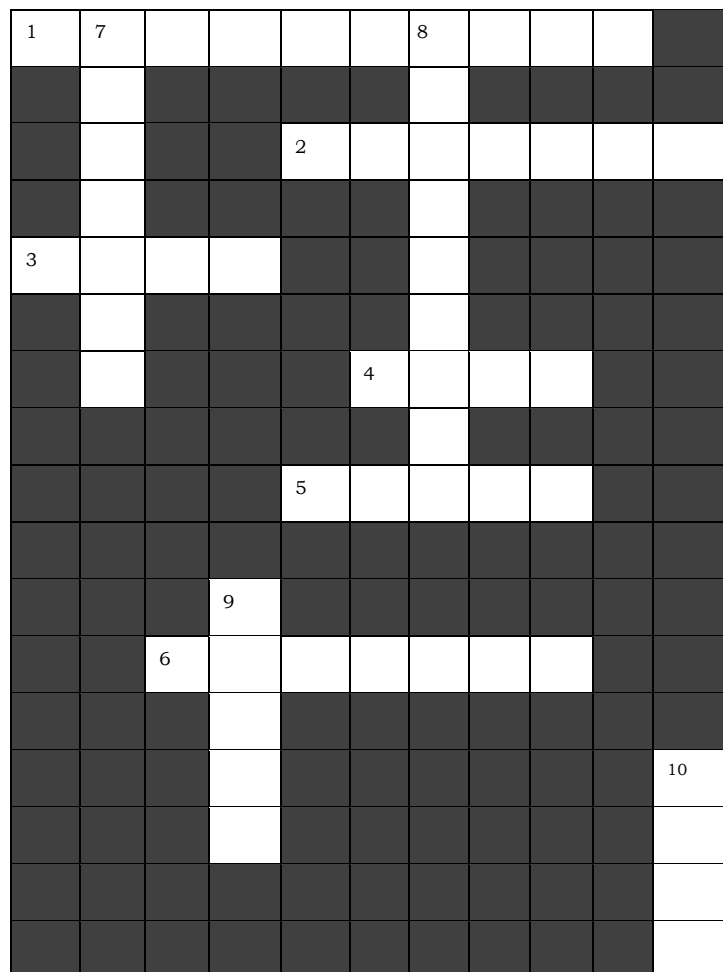
3. Flow

4. Spread

5. Topple

Activity 8

Crossword puzzle: Identify the terms being described across and down that refer to the agents of exogenic processes.



ACROSS

1. It refers to the aggregation or accumulation of weathered sediments to create different landforms.
2. It is associated with many agents because it pulls the materials downslope.

3. It is a major erosional agent on areas on Earth's surface that experience both limited precipitation and high temperature.
4. It is one of the components of lithosphere.
5. It has the power to move large particles of weathered material than wind does.
6. It has the capacity to carry huge rocks and piles of debris over great distances.

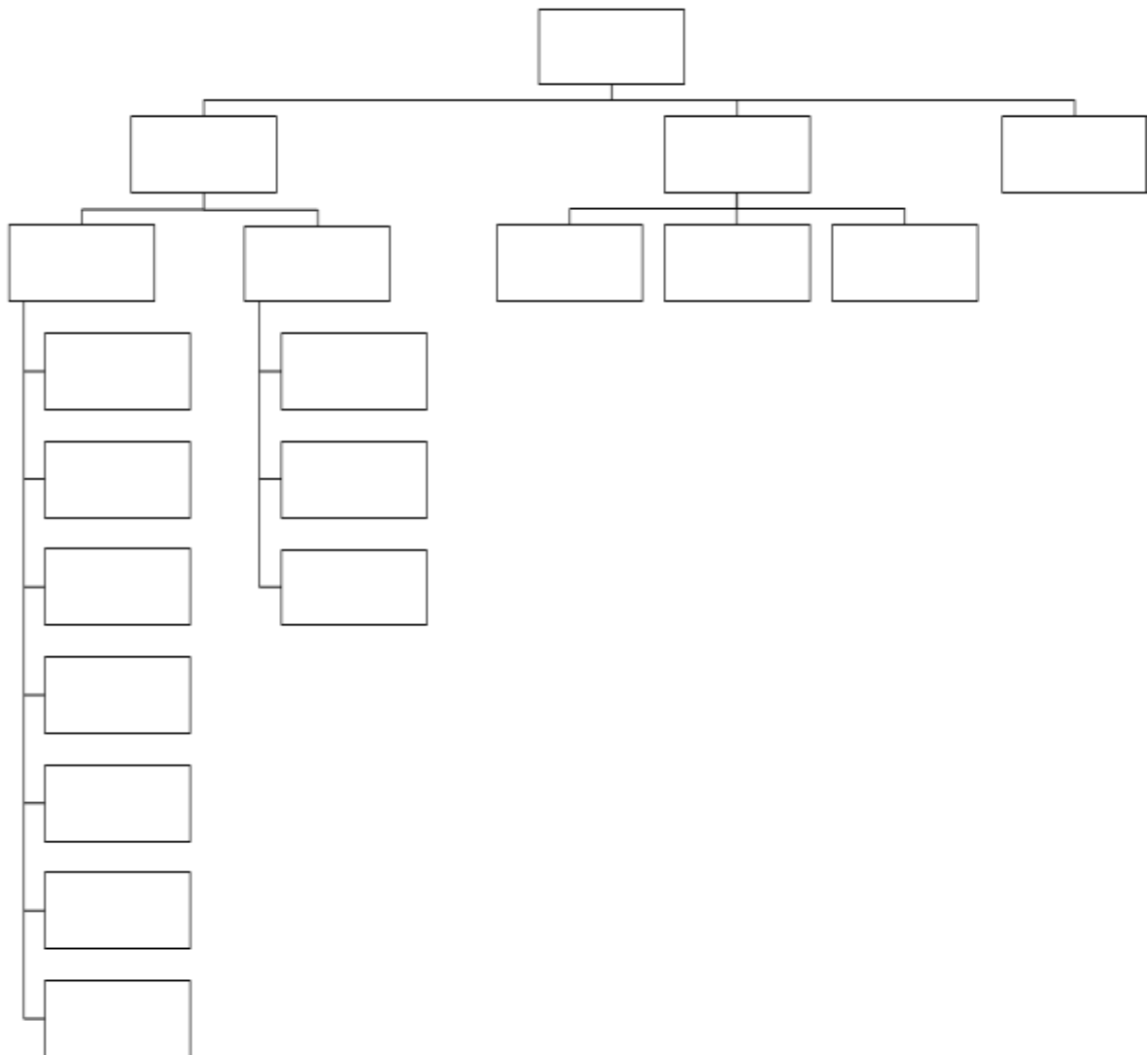
DOWNWARD

7. It is the process that transports Earth's materials from one place to another.
8. It is the process wherein materials are carried away.
9. It refers to the downslope movement of weathered materials along a well-defined surface.
10. It refers to the movement of saturated materials downslope like liquid.

What I Have Learned

Activity 9

Complete the concept map using the words below.



Water Hydrolysis	Organic Activity Deposition	Chemical Wind	Frost wedging Exogenic Process
Burrowing Physical Glacier	Dissolution Weathering Human Activities	Abrasion Erosion Temperature	Pressure Oxidation

Activity 10

Fill in the blanks with the correct answer.

1. The process of breaking down rocks either physically or chemically is called _____.
2. _____ is the breakdown of rocks into pieces without any change in its composition.
3. _____ is the response of oxygen with minerals.
4. _____ is a mixture of grains, organic matter, H₂O, and gas.
5. _____ is the breakdown of rocks that is caused by impact and friction.
6. The change in the composition of rocks is called _____.
7. The separation and removal of weathered rocks due to different agents like water, wind, and glacier is called _____.
8. The movement of sediments downslope under the influence of gravity is _____.
9. The process in which the weathered materials carried out by erosion and gravity settle down in a particular location is called _____.
10. _____ is a chemical reaction wherein rock forming minerals react with water and form different kinds of clay minerals.

What I Can Do

Activity 11

Soil is an essential component of the earth's crust. It enabled life to exist and provides the services necessary for human survival. What is the effect of soil erosion? What will you do to protect the community?

[illegible]

Assessment

Multiple Choice. Choose the letter of the best answer. Write the chosen letter on a separate sheet of paper.

1. It is a process that does NOT alter the composition of material.
 - A. abrasion
 - B. organic activity
 - C. chemical weathering
 - D. mechanical weathering
2. The rocks are fractured, cracked, and broken down into small pieces. What is the type of weathering?
 - A. oxidation
 - B. pressure change
 - C. physical weathering
 - D. chemical weathering
3. Which of the following is an example of oxidation?
 - A. rusting
 - B. halite dissolves in water
 - C. feldspar decomposes to form clay
 - D. stalactites and stalagmites formation
4. Which activity does NOT facilitate erosion?
 - A. Kaingin
 - B. planting
 - C. loss of plant cover
 - D. steepening of slope
5. Which of the following diagram is TRUE about exogenic processes?
 - A. weathering – erosion – transport-deposition
 - B. sediments – erosion – weathering – transport
 - C. sediments – transport – erosion – weathering
 - D. erosion – sediments – weathering – transport- deposition
6. The removal and transport of weathered material from one place to another is called _____.
 - A. erosion
 - B. deposition
 - C. weathering
 - D. sublimation

7. Which of the following is not an agent of erosion?
- A. wind
 - B. water
 - C. rocks
 - D. glacier
8. Which of the following is NOT a role of gravity in erosion?
- A. It moves glaciers down slope.
 - B. It loosens the land materials.
 - C. In mountains, it moves down large slabs of rocks.
 - D. It acts as agents of mass wasting like landslides, fall, mudflows, and avalanches.
9. What is the term that refers to the process wherein rocks break down into pieces?
- A. erosion
 - B. deposition
 - C. weathering
 - D. mass wasting
10. Water reacts with one mineral to form a new mineral. Feldspar when weathered forms clay. What process of chemical weathering is involved?
- A. oxidation
 - B. hydrolysis
 - C. dissolution
 - D. all of the above
11. The repeated thawing and freezing of water in the cracks of rocks is known as
- A. solution
 - B. abrasion
 - C. oxidation
 - D. frost wedging
12. Which of the following does NOT cause chemical changes in the composition of rocks?
- A. abrasion
 - B. oxidation
 - C. dissolution
 - D. hydrolysis
13. When rusting of iron takes place, weathering is manifested by_____.
- A. abrasion
 - B. oxidation
 - C. hydrolysis
 - D. dissolution

14. The following are exogenic processes occurring on the earth surface EXCEPT:

- A. erosion
- B. eruption
- C. deposition
- D. weathering

15. Which of the following is the process by which sediments settle down in a particular area?

- A. transport
- B. deposition
- C. weathering
- D. deformation

Additional Activities

Draw and explain how the products of weathering are carried away by erosion and deposited elsewhere.



Explanation:

Answer Key

What I Have Learned

1. Weathering
2. Mechanical weathering
3. Oxidation
4. Soil
5. Abrasion
6. Chemical weathering
7. Erosion
8. Mass wasting
9. Deposition
10. hydrolysis

What I Can Do

Activity 11

Answer may vary among students' perceptions.

Assessment

16. D
17. C
18. A
19. B
20. A
21. A
22. C
23. B
24. C
25. B
26. D
27. A
28. B
29. B
30. B

What's More

Activity 5

Answer may vary among students' perceptions.

Activity 6

Answer may vary among students.

Activity 7

Answer may vary among students.

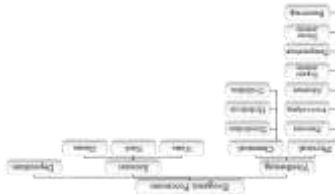
What's More

Activity 8



What I Have Learned

Activity 9



What I Know

6. D
7. C
8. B
9. B
10. D
11. A
12. D
13. D
14. D
15. C
16. A
17. D
18. C
19. A
20. D

What's in

Activity 1

ROCKS	Answer may vary among students' perceptions.
IGNEOUS	Answer may vary among students' perceptions.
SEDIMENTS	Answer may vary among students' perceptions.
DISINTEGRATION	Answer may vary among students' perceptions.
DECOMPOSITION	Answer may vary among students' perceptions.

What's New

Activity 2

Answer may vary among students' perceptions.

Activity 3

Answer may vary among students' perceptions.

What is It

Activity 4

1. Physical weathering
2. organic activity
3. human activity
4. burrowing of animals
5. Chemical weathering
6. dissolution
7. hydrolysis

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Earth and Life Science

The Earth's Internal Heat

Earth and Life Science – Senior High School
The Earth's Internal Heat
First Edition, 2020

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What I Need to Know

This module was designed and written with you in mind. It is here to help you master the nature of Earth and Life Science. 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 covers:

- Lesson 1 – The Earth’s Internal Heat

After going through this module, you are expected to:

1. Describe where the Earth’s internal heat comes from.
2. Identify the sources of Earth’s internal heat; namely, radiogenic heat and primordial heat.
3. Describe the parts and function of Earth’s interior.
4. Describe the processes of heat transfer in Earth’s mantle.

What I Know

Directions. Read each question and choose the correct answer. Write your answer on a separate sheet of paper.

1. Why does radioactive decay play a very important role in earth’s internal heat?
 - a. Radioactive element can be found anywhere in the planet.
 - b. When radioactive element decays, it produces heat.
 - c. Spontaneous nuclear disintegration of radioactive elements produced thermal energy.
 - d. All of the above
2. How does the conduction in the surface of the earth affect the temperature of our atmosphere?
 - a. Air molecules come in contact with the warmer surface of the land and ocean resulting to the increase of its thermal energy.
 - b. Air molecules come in contact with the cooler surface of the land and ocean resulting to the decrease of its thermal energy.
 - c. Air molecules does not come in contact with the warmer surface of the land and ocean resulting to the increase of its thermal energy.
 - d. Air molecules do not come in contact with the cooler surface of the land and ocean resulting to the increase of its thermal energy.

3. How does convection in Earth's mantle affects the formation of landmass like volcano and mountain?
 - a. Heat tries to escape in the interior of the earth.
 - b. Collision and separation of tectonic plates happens due to the slow motion of convection cells.
 - c. When warm material in the mantle rises up to the surface (ground), it will cool and sinks, these cooled materials will eventually be turned into landmass.
 - d. All of the above
4. What is produced by the radioactive decay of isotopes in the mantle and crust?
 - a. radiogenic heat
 - b. primordial heat
 - c. superheating
 - d. heat from the sun
5. This refers to the heat left over from the formation of the Earth?
 - a. radiogenic heat
 - b. primordial heat
 - c. superheating
 - d. heat from the sun
6. How much is the approximate terawatts in the flow of heat in Earth's interior to its surface?
 - a. 41 terawatts
 - b. 43 terawatts
 - c. 47 terawatts
 - d. 49 terawatts
7. Which of the following is the outermost layer of the Earth?
 - a. crust
 - b. core
 - c. discontinuity
 - d. mantle
8. Which of the following stores magma and located in a region just beneath the crust all the way to the core?
 - a. crust
 - b. outer core
 - c. inner core
 - d. mantle
9. What heat transfer of fluid in the Earth's interior results to the movement of rocky mantle up to the surface?
 - a. convection current
 - b. conduction
 - c. insolation
 - d. radiation

10. Which of the following are boundaries between the three major layers of the Earth?
 - a. arches
 - b. discontinuities
 - c. poles
 - d. plates
11. What refers to the shaking of the surface of the Earth resulting from a sudden release of energy caused by a convection current?
 - a. earthquake
 - b. volcanic eruption
 - c. storm surge
 - d. hurricane
12. How does the mantle behave as a viscous fluid on a geological time scale?
 - a. presence of high radiation
 - b. absence of high pressure
 - c. existence of high temperature
 - d. decrease in altitude
13. What kind of heat transfer occurs mostly on the Earth's surface?
 - a. conduction
 - b. convection
 - c. insolation
 - d. radiation
14. What kind of process by which heat energy is transmitted through collisions between neighboring atoms or molecules?
 - a. conduction
 - b. convection
 - c. insolation
 - d. radiation
15. What are the two factors that affect conduction on the Earth's surface?
 - a. Radioactive decay and nuclear disintegration of elements.
 - b. Heat from the Earth's core and radiation from the Sun.
 - c. Movement of plates and radiation from the Earth's core.
 - d. Stored magma and volcanic eruption.

Lesson 1 **The Earth's Internal Heat**

Heat energy plays a vital role in our planet. It is one of the extreme factors in what makes the world livable. If you think of a volcano, you know Earth must be hot inside. The heat inside of our planet moves continents, build mountains and causes earthquakes, but where does all this heat inside the earth come from?

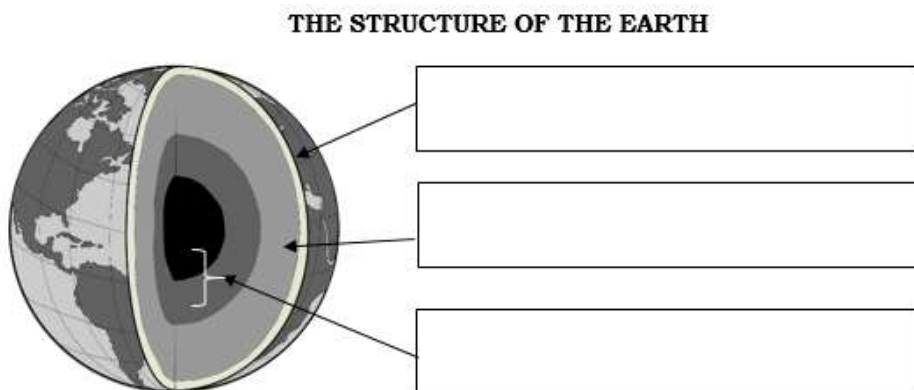
Sources of heat in our planet can be identified as Primordial and Radiogenic heat. During the early formation of the Earth, the internal heat energy that gradually gathered together by means of dispersion in the planet during its few million years of evolution is called **Primordial heat**. The major contribution of this internal heat is the accretional energy – the energy deposited during the early formation of a planet. The core is a storage of primordial heat that originates from times of accretion when kinetic energy of colliding particles was transformed into thermal energy. This heat is constantly lost to the outer silicate layers of the mantle and crust of the earth through convection and conduction. In addition, the heat of the core takes tens of thousands of years to reach the surface of the earth. Today, the surface of the earth is made of a cold rigid rock since 4.5 billion years ago, the earth's surface cools from the outside but the core is still made of extremely hot material.

On the other hand, the thermal energy released as a result of spontaneous nuclear disintegration is called **Radiogenic Heat**. It involves the disintegration of natural radioactive elements inside the earth – like Uranium, Thorium and Potassium. Uranium is a special kind of element because when it decays, heat (radiogenic) is produced. Estimated at 47 terawatts (TW), the flow of heat from Earth's interior to the surface and it comes from two main sources in equal amounts: the radiogenic heat produced by the radioactive decay of isotopes in the mantle and crust, and the primordial heat left over from the formation of the Earth. Radioactive elements exist everywhere on the earth in a fairly significant concentration. Without the process of radioactive decay, there would be fewer volcanoes and earthquakes – and less formation of earth's vast mountain ranges.

What's In

Activity 1: Earth's Layers

Directions. Label the diagram below with the names of each layers. Include a brief description of each of the Earth's layers.



Activity 2: Which of which?

Directions. Identify the sources of internal heat by writing **RH** for radiogenic heat and **PH** for primordial heat. Write your answer on a separate sheet of paper.

- ___ 1. Presence of different isotopes of heat producing element in the mantle and crust.
- ___ 2. Internal heat accumulated by dissipation of planet.
- ___ 3. Release of accretional energy.
- ___ 4. Processes involved in mantle convection.
- ___ 5. Release of thermal energy as a result of spontaneous nuclear disintegration.

What's New

Activity 3: Find Me

Directions. Encircle the 10 words listed below. Words may appear straight across, back-word straight across, up, and down.

**MANTLE
CURRENT
EARTH
TECTONIC
RADIATION**

**CONVECTION
PRIMODIAL
RADIOGENIC
HEAT
CONDUCTION**

S	M	V	X	R	S	B	J	E	R	X	C	H	K	N
O	Y	U	D	H	W	L	T	L	Y	Q	S	L	S	Z
Q	N	Z	E	C	I	N	E	G	O	I	D	A	R	N
Y	B	A	D	W	O	P	Q	B	Q	X	V	Q	C	V
C	T	M	H	B	R	Y	D	J	K	R	U	S	D	E
D	O	U	F	C	O	N	V	E	C	T	I	O	N	A
T	F	N	L	A	I	D	O	M	I	R	P	U	B	R
L	N	K	D	E	C	Z	K	I	X	U	J	F	D	T
S	X	E	Z	U	L	I	H	C	T	E	S	I	S	H
P	D	K	R	E	C	T	N	E	K	A	K	G	Y	D
O	I	S	H	R	A	T	N	O	V	W	I	A	V	Z
M	N	D	C	D	U	H	I	A	T	O	T	D	I	K
Q	V	Y	Z	W	S	C	L	O	M	C	G	O	A	P
R	S	N	E	P	X	O	M	Q	N	F	E	B	J	R
N	A	K	Z	F	A	Q	U	J	C	X	S	T	K	Q

Sources of Heat and Heat Transfer

Both sources of heat whether primordial or radiogenic undergo heat transfer and it plays an important role to the continuous changes and development of our planet. In connection, another part of this module describes the heat transfer in the Earth. Three processes can transfer heat: **conduction**, **convection**, and **radiation**.

Conduction governs the thermal conditions in almost entire solid portions of the Earth and plays a very important role in the lithosphere. Its processes happen in the earth's surface. Conduction is one of the three main ways that heat energy moves from place to place. Technically, it can be defined as the process by which heat energy is transmitted through collisions between neighboring atoms or molecules. Heat from the Earth's core and radiation from the Sun is transferred to the surface of the Earth by conduction. Contact of the atmosphere with these warm surfaces transfers thermal energy, which then heats up the rest of the air through convection.

Convection involves transfer of heat by the movement of mass, which is a more efficient means of heat transport in the Earth compared to pure conduction. Convection dominates the thermal conditions in the zones where large quantities of fluids (molten rocks) exist, and thus governs the heat transport in the fluid outer core and the mantle. In geological time scale, the mantle behaves as a viscous fluid due to the existence of high temperatures. In convection current, the mantle of the earth moves slowly because of transfer of heat from the interior of the earth up to the surface. This result to the movement of tectonic plates. Hot materials are added at the edges of a plate and then it cools. At those edges, it becomes dense by its exposure from the heat and sinks into the earth at an ocean trench. This start the formation of volcanoes.

Radiation is the least important mode of heat transport in the Earth. The process of heat exchange between the Sun and the Earth, through radiation, controls the temperatures at the Earth's surface. Inside the Earth, radiation is significant only in the hottest parts of the core and the lower mantle. When the land and water become warm in summer, they emit long – wavelength infrared radiation that is readily absorbed by the atmosphere. This continues during night time too. Convection in the air then spreads out the thermal energy throughout the atmosphere.

Activity 4: My Notepad

Directions. In your own words, how do the three (3) major processes of heat transfer affect the temperature of the Earth? Write your answer on the space provided.

[illegible]

What is It

Activity 5: Fill me up!

Directions. Use the word bank to fill in the gaps in the passage below. Write your answers on a separate sheet of paper.

Convection	Earth's plates	Plates
Convection current	Earthquakes	Volcanoes
Crust	Plate tectonics	

The surface layer of the earth is called the _____. This layer is broken up into pieces called _____. These _____ “float” on the mantle. Heat rising and falling inside the mantle creates current called _____. The _____ current move the _____. This movement is known as _____. The movement of the earth’s plate causes earthquakes and _____.

What's More

What's inside the Earth's Mantle?

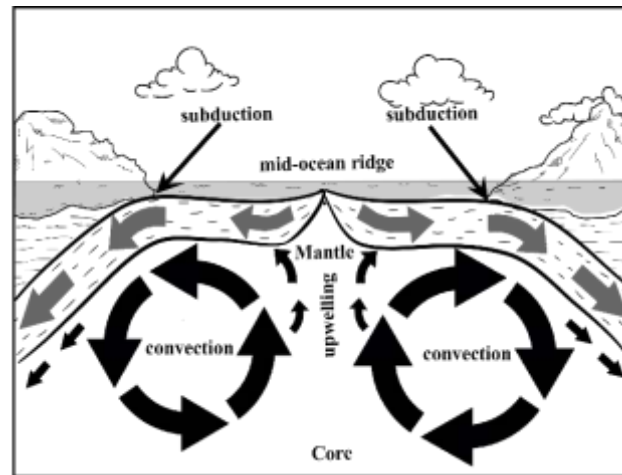


Figure A. Convection



Figure B. Conduction

Figure A shows a convection cell, warm material rises (up to the surface of the earth) and cool material sinks. These cooled materials will eventually turn to land formation. In mantle convection, the heat source is the core. The core of the earth is very hot. It is nearly as hot as the surface of the sun – about 6000°C. Convection current is relevant to the movement of tectonic plate because the heat builds up pressure underneath the crust (tectonic plates). As they become unstable, they push against each other (subduction) and rise upwards or one goes under the other.

Figure B shows the process of conduction on how air molecules come in contact with the warmer surface of the land or ocean, resulting to the increase of its thermal energy through conduction. The thermal energy of the core is transferred to the surface of the earth and the lower levels of ocean by conduction.

Activity 6: Picture Analysis

Directions. Read and analyze figures A and B. Answer the questions stated below.

- a. Figure A shows the process of **convection** in the earth's mantle. How does it affect the formation of mountains and the temperature in the surface (ground)?

- b. How the **convection current** affects the movement of tectonic plates?

- c. How convection in earth's interior and conduction in the surface affect the temperature in our atmosphere?

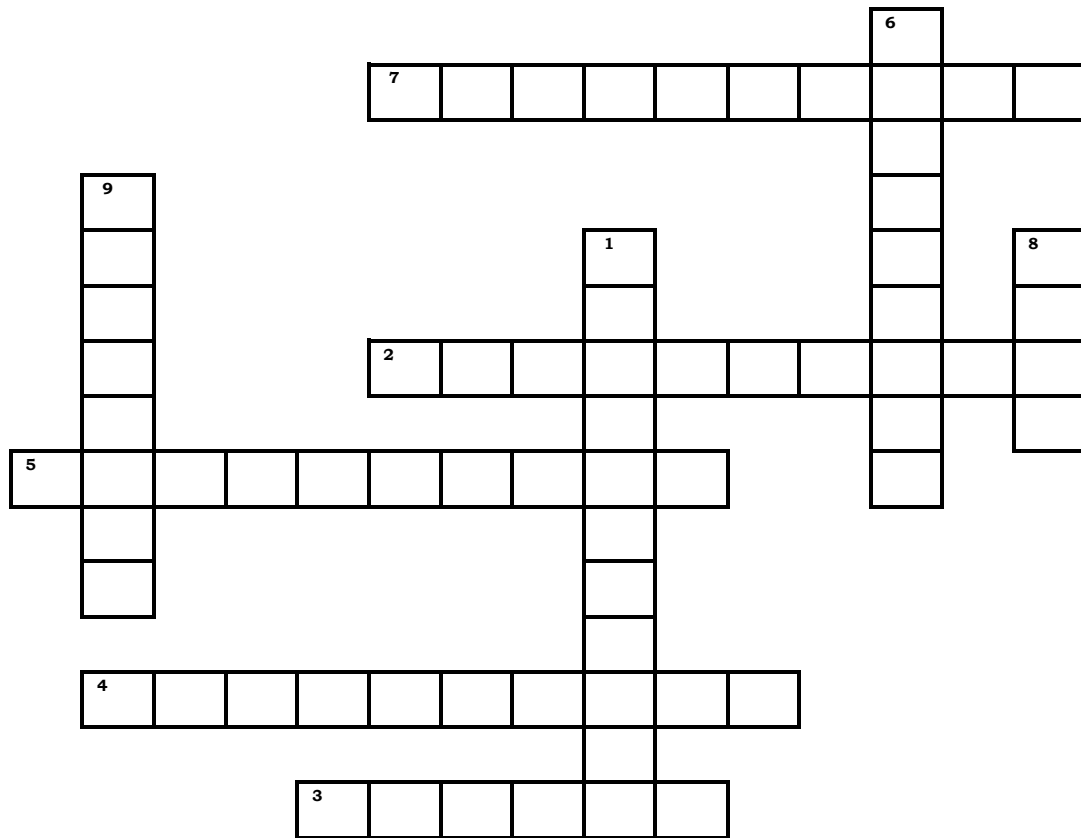
- d. How subduction cause the formation of land mass like mountains and volcano?

- e. Why does earthquake occur in subduction zone? (*The area where subduction occur*)

Synthesis: Based from figure A and B, how convection and conduction is inter-related?

Activity 7: Crossword Puzzle

Directions. Complete the crossword by filling in the word that describes each clue.



Across:

2. air molecules come in contact with warmer molecules
3. crust are made up of puzzle – like landmass called ____.
4. rising and falling movement of material in the mantle
5. when tectonic plates push with each other
7. it is the result of movement of earth's plate

Down:

1. elements that play a vital role in Earth's internal heat
6. least important mode of heat transport
8. warm material rise; cool material ____.
9. heats build up underneath the crust

What I Have Learned

Directions. Read each question and fill in the blanks with the correct term to complete the statement. Write your answer on a separate sheet of paper.

1. _____ in the interior of the earth can be classified as primordial and radiogenic heat.
2. The thermal energy released as a result of spontaneous _____ is called **Radiogenic Heat** while the internal heat energy accumulated by _____ in a planet during its few million years of evolution is called **Primordial heat**.
3. There are three processes can transfer heat: _____, _____, and **radiation**.
4. _____ governs the thermal conditions in almost entire solid portions of the Earth and plays a very important role in the lithosphere.
5. _____ involves transfer of heat by the movement of mass, which is a more efficient means of heat transport in the Earth compared to pure conduction.
6. _____ is the least important mode of heat transport in the Earth.
7. Convection current is relevant to the movement of _____ because the heat builds up pressure underneath the crust.
8. The _____ of the core is transferred to the surface of the earth and the lower levels of ocean by conduction.
9. Air molecules come in contact with the warmer surface of the land or ocean, resulting to the increase of its _____.
10. The area where subduction occur is called _____.

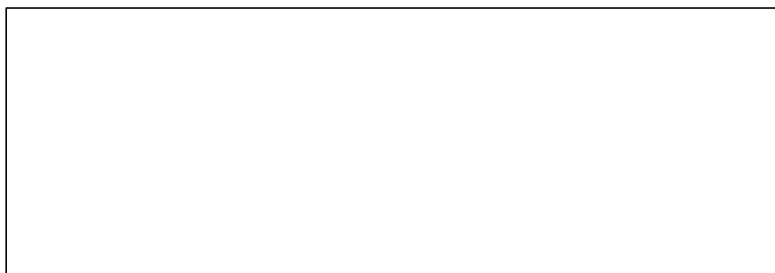
What I Can Do

Activity 6: Illustrate and Explain

Directions. Illustrate the example indicated in the given scenario in the box where conduction and convection are applied. Then, relate it to the processes occurring in the Earth's internal heat.

CONDUCTION

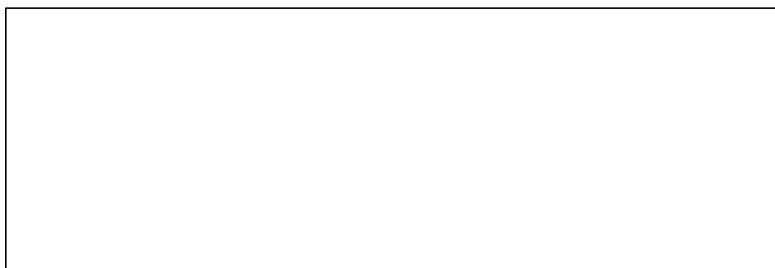
Chocolate candy in your hand will eventually melt as the heat from your body is released and makes it melted.



Explanation:

CONVECTION

A heater in the hot air balloon heats the air. The air inside is trapped causing the balloon to rise.



Explanation:

Assessment

Directions. Read each question and choose the correct answer. Write your answers on separate sheet of paper

1. What process by which heat is directly transmitted through a substance when there is a difference of temperature or between adjoining regions, without movement of the material?
 - A. conduction
 - B. convection
 - C. insolation
 - D. radiation

2. Why radioactive decay plays a significant role in Earth's internal heat?
 - A. Radioactive element can be found anywhere in the planet.
 - B. When radioactive element decays, it produces heat.
 - C. Spontaneous nuclear disintegration of radioactive elements produced thermal energy.
 - D. All of the above
3. Which of the following is described as the process of heat exchange between the Sun and the Earth that controls the temperatures of the latter?
 - A. conduction
 - B. convection
 - C. insolation
 - D. radiation
4. What is produced by the radioactive decay of isotopes in the mantle and crust?
 - A. radiogenic heat
 - B. primordial heat
 - C. superheating
 - D. heat from the sun
5. How the conduction in the surface of the earth affect the temperature of our atmosphere?
 - A. Air molecules come in contact with the warmer surface of the land and ocean resulting to the increase of its thermal energy.
 - B. Air molecules come in contact with the cooler surface of the land and ocean resulting to the decrease of its thermal energy.
 - C. Air molecules do not come in contact with the warmer surface of the land and ocean resulting to the increase of its thermal energy.
 - D. Air molecules do not come in contact with the cooler surface of the land and ocean resulting to the increase of its thermal energy.
6. What are the two factors that affects conduction on the Earth's surface?
 - A. radioactive decay and nuclear disintegration of elements
 - B. heat from the Earth's core and radiation from the Sun
 - C. movement of plates and radiation from the Earth's core
 - D. stored magma and volcanic eruption
7. What kind of process by which heat energy is transmitted through collisions between neighboring atoms or molecules?
 - A. conduction
 - B. convection
 - C. insolation
 - D. radiation

8. What kind of heat transfer occurs mostly on the Earth's surface?
- A. conduction
 - B. convection
 - C. insolation
 - D. radiation
9. How does the mantle behave as a viscous fluid on a geological time scale?
- A. radiation
 - B. pressure
 - C. temperature
 - D. altitude
10. What refers to the shaking of the surface of the Earth resulting from a sudden release of energy caused by a convection current?
- A. earthquake
 - B. volcanic eruption
 - C. storm surge
 - D. hurricane
11. Which of the following are boundaries between the three major layers of the earth?
- A. arches
 - B. discontinuity
 - C. poles
 - D. plates
12. What heat transfer of fluid in the earth's interior results to the movement of rocky mantle up to the surface of the earth?
- A. convection current
 - B. conduction
 - C. insolation
 - D. radiation
13. Which of the following stores magma and located in a region just beneath the crust all the way to the core?
- A. crust
 - B. outer core
 - C. inner core
 - D. mantle
14. Which of the following is the outermost layer of the Earth?
- A. crust
 - B. core
 - C. discontinuity
 - D. mantle

15. How much is the approximate terawatts in the flow of heat in Earth's interior to its surface?
- A. 41 terawatts
 - B. 43 terawatts
 - C. 47 terawatts
 - D. 49 terawatts

Additional Activities

Directions. Using your smartphones, take a picture of five (5) common activities/scenarios on which heat transfer is applied. It may be material, event or situation. Classify each whether it is conduction, convection or radiation. Provide brief explanation to support your answer. Post the picture and your answer on a separate sheet of paper.

PICTURE	KIND OF HEAT TRANSFER	BRIEF EXPLANATION

Answer Key

What's More Activity 5 Answer may vary according to student's perception Assessment 1. D 2. D 3. D 4. A 5. A 6. B 7. A 8. D 9. C 10. A 11. B 12. A 13. D 14. A 15. C	What's New Activity 3 Answer may vary according to student's perception What's It Activity 4 1. Crust 2. Earth's Plates 3. Plates 4. Convection current 5. Convection 6. Plate tectonics 7. Earthquakes 8. Volcanoes	What I Know 1. D 2. A 3. D 4. A 5. B 6. C 7. A 8. D 9. A 10. B 11. A 12. C 13. A 14. A 15. B What's in Activity 1 a. Crust – Oceanic and Continental crust b. Mantle – Upper and Lower mantle c. Core – Outer and Inner core Activity 2 1. RH 2. PH 3. PH 4. RH 5. RH
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Earth and Life Science

Magmatism

Earth and Life Science
Magmatism
First Edition, 2020

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What I Need to Know

This module was designed and written with you in mind. It is here to help you master the nature of Earth and Life Science. 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 covers:

- Lesson 1 – Magmatism

After going through this module, you are expected to:

1. describe the characteristics of magma;
2. identify the substances/elements present in magma; and
3. explain the processes involved in the formation of magma.

What I Know

Directions. Choose the letter of the best answer. Write the chosen letter on a separate sheet of paper.

1. What term should be used to describe a semi-liquid hot molten rock located beneath the Earth?
 - A. lava
 - B. sand
 - C. rocks
 - D. magma
2. What do you call the semi-liquid hot molten rocks found on the surface of earth once the volcano erupts?
 - A. magma
 - B. rocks
 - C. sand
 - D. lava
3. What process occurs if there are formation and movement of magma under the earth's crust?
 - A. decompression melting
 - B. partial melting
 - C. heat transfer
 - D. flux melting
4. In what part of the earth does magmatism happen?
 - A. Asthenosphere
 - B. Earth's crust

- C. Earth's core
 - D. Lithosphere
5. What are the two most abundant elements in magma?
- A. oxygen and magnesium
 - B. silicon and aluminum
 - C. silicon and oxygen
 - D. oxygen and iron
6. What will happen to the temperature of rocks during partial melting?
- A. decreases
 - B. increases
 - C. remains the same
 - D. all of the above
7. Which of the following is NOT a factor of partial melting?
- A. addition of volatiles
 - B. decrease in pressure
 - C. an increase in pressure
 - D. an increase in temperature
8. During partial melting, which of the following minerals melt last?
- A. biotite
 - B. quartz
 - C. feldspar
 - D. none of the above
9. During partial melting, which of the following minerals melt first?
- A. biotite
 - B. quartz
 - C. feldspar
 - D. both b and c
10. Conduction in mantle happens when heat is transferred from hotter molten rocks to the Earth's cold crust. What process is being described?
- A. flux melting
 - B. heat transfer
 - C. partial melting
 - D. decompression melting
11. Mantle rocks remain solid when exposed to high pressure. However, during convection, these rocks tend to go upward (shallower level) and the pressure is reduced. What process is being described?
- A. flux melting
 - B. heat transfer
 - C. partial melting
 - D. decompression melting

12. When water or carbon dioxide is added to hot rocks, the melting points of minerals within the rocks decrease. What process is being described?
- A. flux melting
 - B. heat transfer
 - C. partial melting
 - D. decompression melting
13. During partial melting of magma, where does heat transfer take place?
- A. convergent boundary
 - B. mid-ocean ridge
 - C. subduction zone
 - D. all of the above
14. During partial melting of magma, where does decompression melting take place?
- A. convergent boundary
 - B. mid-ocean ridge
 - C. subduction zone
 - D. all of the above
15. During partial melting of magma, where does flux melting take place?
- A. convergent boundary
 - B. mid-ocean ridge
 - C. subduction zone
 - D. all of the above

Lesson 1 Magmatism

Do you still remember what happened to Taal Volcano last January 12, 2020? Yes, you are right. This volcano, which is located at the province of Batangas, spewed ash plumes up to nine miles (14 kilometers) into the air due to a “steam-driven” or phreatic eruption. According to the Philippine Institute of Volcanology and Seismology (PHIVOLCS), for the past two days, over 600 volcanic tremors have been recorded which was an indication of continuous movement of magma or molten rocks beneath the volcano. You might be wondering how magma got inside the volcano.

For this module, we will be discussing all about magma; its formation and composition.

What's In

Activity 1. Decoding Time

In the previous lesson, you have learned that Earth's interior is the site of great amount of heat. Let us review first about this before proceeding to the next topic.

Your task is to reveal the magic words by decoding the given numbers to their corresponding letters of the alphabet. Then, complete the statement below using those words.

18	1	4	9	1	10	9	15	14
1. Word: _____								

18	1	4	9	15	7	5	14	9	3		8	5	1	20
2. Word: _____														

3	15	14	4	21	3	20	9	15	14
3. Word: _____									

16	18	9	13	15	18	4	9	1	12		8	5	1	20
4. Word: _____														

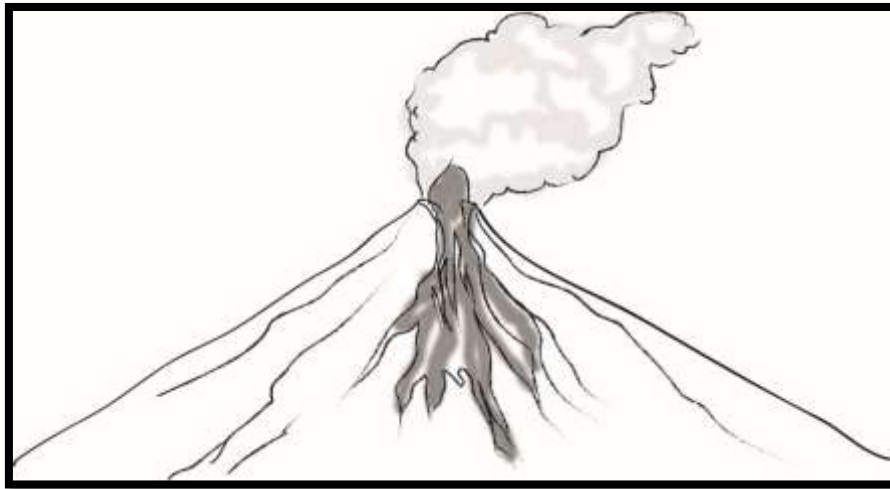
3	15	14	22	5	3	20	9	15	14
5. Word: _____									

9	14	20	5	18	14	1	12		8	5	1	20
6. Word: _____												

The Earth's internal heat comes from two main sources: the radiogenic heat produced by the radioactive decay of isotopes in the mantle and crust, and the (7) _____ left over from the formation of the Earth. The heat can be transferred by three processes, namely, (8) _____, (9) _____, and (10) _____.

What's New

Activity 2. Picture Analysis



Mount Mayon is one of the most active volcanoes in the Philippines. It erupted for eight minutes last January 23, 2018, spewing a 3-mile-tall column of debris and volcanic gas. It exploded at least five more times for two days.

According to Philippine Institute of Volcanology and Seismology (PHIVOLCS), two "explosion-type earthquakes" had occurred, as well as 18 tremor events — some of which sent forth fountains of lava. One of the lava flows advanced nearly 2 miles from the summit's crater.

Observe the picture of Mount Mayon and answer the following.

A. Give three (3) descriptions about the picture.

1. _____
2. _____
3. _____

B. What is the material being extruded by Mount Mayon? Where do you think did this material come from?

What is It

What is Magma?

Magma is composed of semi-liquid hot molten rocks located beneath the Earth, specifically in the melted mantle rock and oceanic plate. This molten state, when solidified, creates **igneous rocks** found on the surface of the Earth.

Do you know the difference between magma and lava? **Magma** and lava are both molten rocks. However, they differ in location. Magma is found in the magma chamber of the volcano while **lava** is found on the surface of earth once the volcano erupts.

Magmatism is a process under the earth's crust where formation and movement of magma occur. So where does these formation and movement take place? These happen in the lower part of the Earth's crust and in the upper portion of the mantle, known as **asthenosphere**.

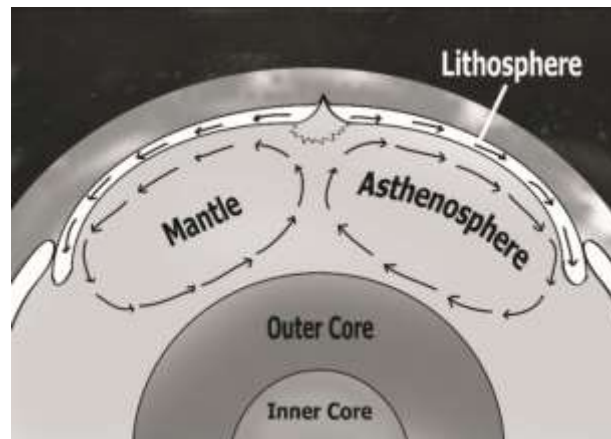


Figure 1. Convection Process in Asthenosphere

On the given figure, identify the substances/elements present in magma.

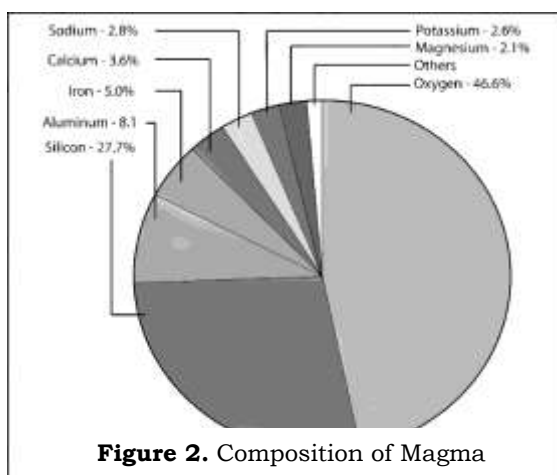


Figure 2. Composition of Magma

Guide Questions:

1. Which of the following elements has the highest amount in the magma? _____
2. Which of the following elements has the lowest amount in the magma? _____
3. What are the top two compositions of magma?

How is magma formed?

The magma present in the lower crust and upper mantle of the Earth is formed or generated through the process of **partial melting**. In this process, different minerals in rock melt at different temperature and pressure. Another factor being considered in this process is the addition of volatile materials such as water and carbon dioxide.

This is a diagram showing how minerals in rocks undergo partial melting.

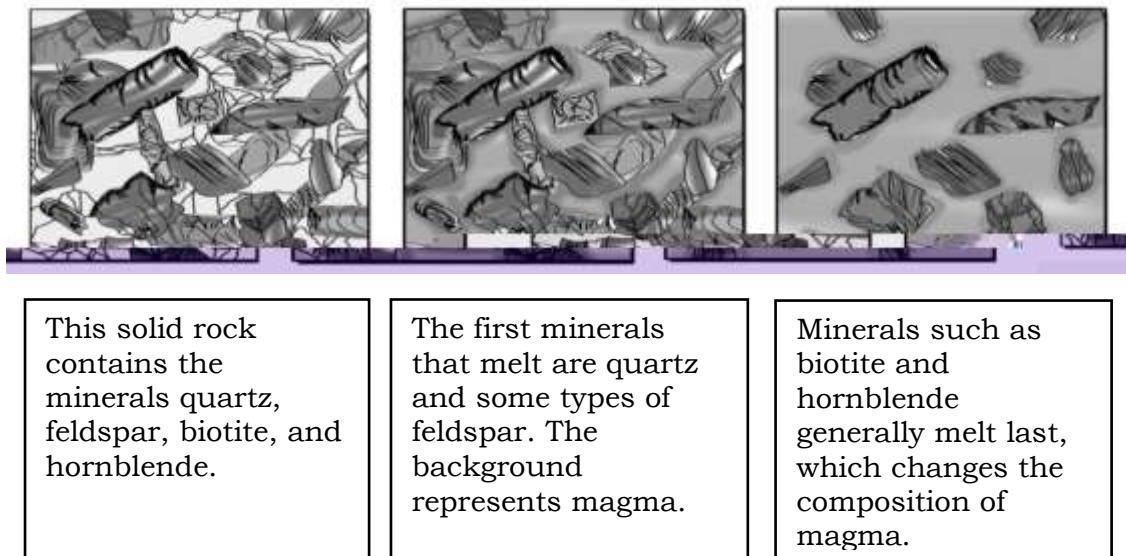


Figure 3. The Process of Partial Melting

Melting in the mantle requires one of three possible events to occur:

1. **AN INCREASE IN TEMPERATURE:** Conduction in mantle happens when heat is transferred from hotter molten rocks to the Earth's cold crust. This process is known as **heat transfer**. As magma rises, it is often hot enough to melt the rock it touches. It happens at **convergent boundaries**, where tectonic plates are crashing together.

Rocks are composed of minerals. These rocks start to melt once the temperature in the lower crust and upper mantle increases or exceeds the melting point of minerals. The temperature of mantle is around 1200 degrees Celsius. Rock minerals such as quartz and feldspar begin to partially melt at around 650-850 degrees Celsius.

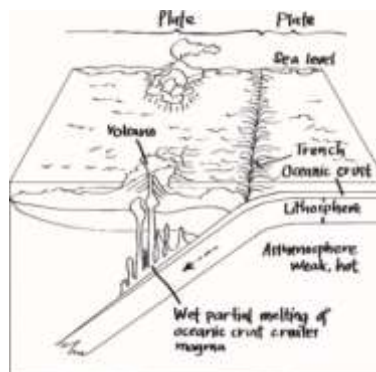


Figure 4. Heat Transfer in Convergent Boundary

2. **A DECREASE OF PRESSURE:** Mantle rocks remain solid when exposed to high pressure. However, during convection, these rocks tend to go upward (shallower level) and the pressure is reduced. This triggers the melting of magma. This is known

as **decompression melting**. This process occurs at the **Mid-Ocean Ridge**, an underwater mountain system.

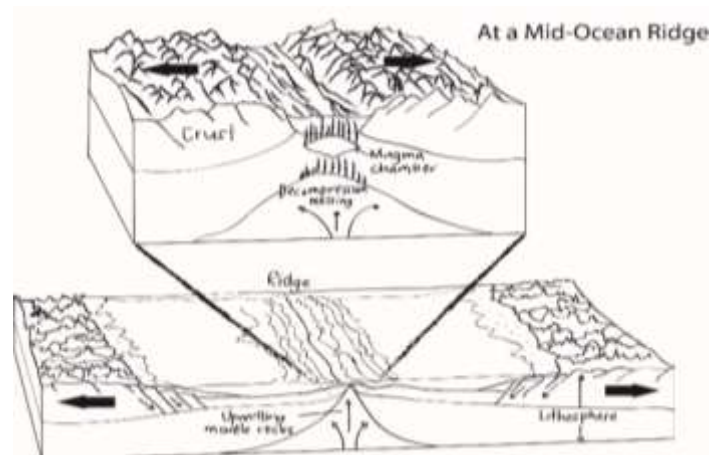


Figure 5. Decompression Melting in Mid-Ocean Ridge

3. **ADDITION OF VOLATILES:** When water or carbon dioxide is added to hot rocks, **flux melting** occurs. The melting points of minerals within the rocks decrease. If a rock is already close to its melting point, the effect of adding these volatiles can be enough to trigger partial melting. It occurs around **subduction zones**.

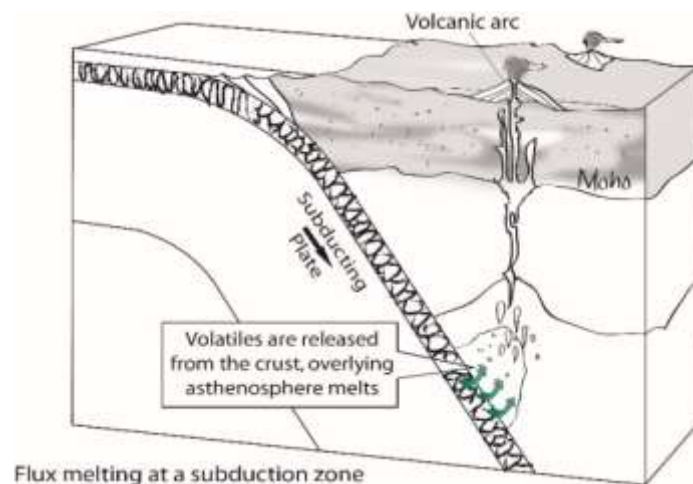
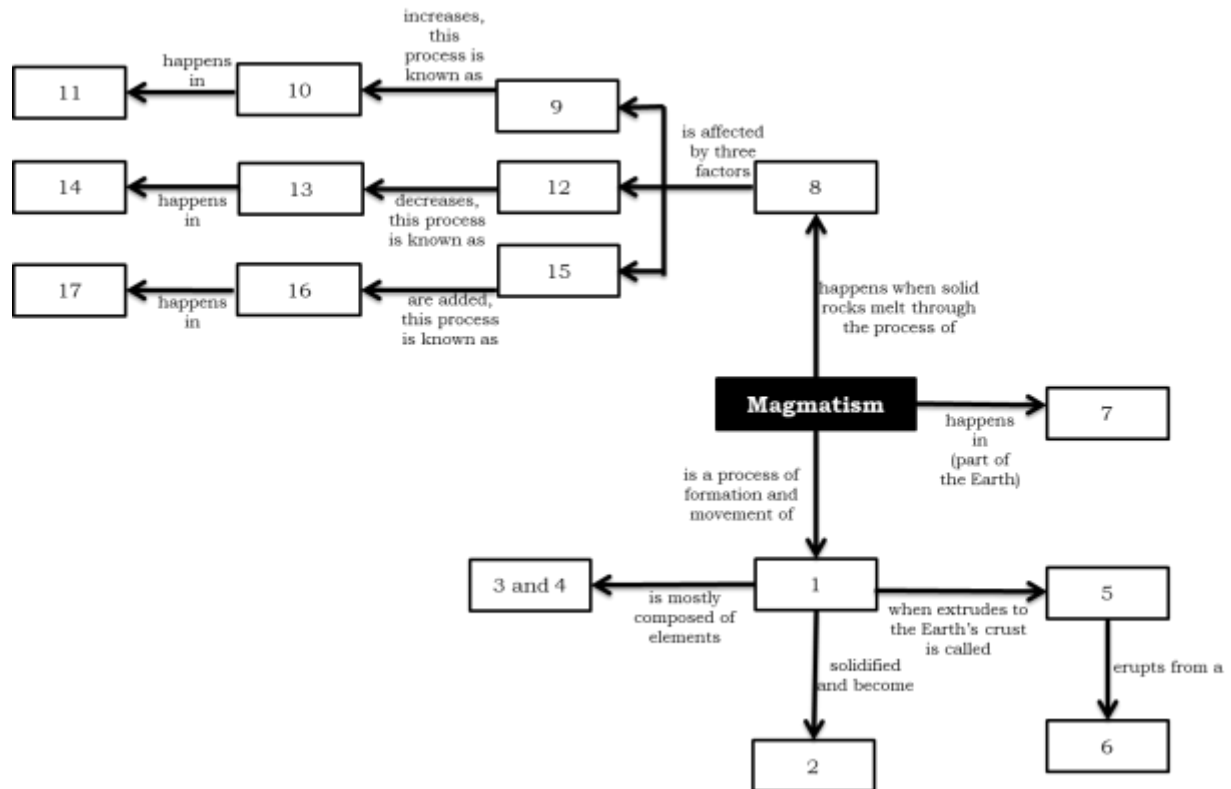


Figure 6. Flux Melting in Subduction Zone

What's More

Activity 3. Concept Map

Directions. Complete the concept map about Magmatism. Choose your answers on the box below.



asthenosphere

convergent boundary

decompression

melting

flux melting

heat transfer

igneous rocks

lava

magma

mid-ocean ridge

oxygen

partial melting

pressure

silicon

subduction zone

temperature

volatiles

volcano

Activity 4. What Do You Think?

Directions. Based on the discussion, justify your answer to the following questions.

- a. Do you think partial melting will occur if the pressure is high in the asthenosphere?

- b. Do you think partial melting will occur if there is too much amount of water in the subduction zone?

- c. Do you think partial melting will occur if there is direct contact of hot molten rock in the Earth's crust?

What I Have Learned

Activity 5. Complete Me!

Directions. Read the following statements and fill in the blanks.

1. _____ is composed of _____ hot molten rocks located beneath the Earth, specifically in the melted mantle rock and oceanic plate.
2. When magma solidifies, it creates _____ found on surface of the Earth.
3. Magma is found in the _____ of the volcano while _____ is found on the surface of earth once the _____ erupts.
4. _____ is a process under the earth's crust where formation and movement of magma occur.
5. Magma is mostly composed of elements _____ and _____.
6. Magma present in the lower crust and upper mantle of the Earth is formed or generated through the process of _____.
7. Melting in the mantle requires one of three possible events to occur: _____, _____, and _____.
8. Conduction in mantle happens when heat is transferred from hotter molten rocks to the Earth's cold crust. This process is known as _____. It happens at _____, where tectonic plates are crashing together.
9. During convection, rocks tend to go upward (shallower level) and the pressure is reduced. This is known as _____. This process occurs at the _____, an underwater mountain system.
10. When water or carbon dioxide is added to hot rocks, _____ occurs. It occurs around _____.

What I Can Do

Activity 6. Apply It!

Directions. Observe the illustrations below and relate these to the lesson.

A.



What is in the picture?

How will you relate it to magmatism?

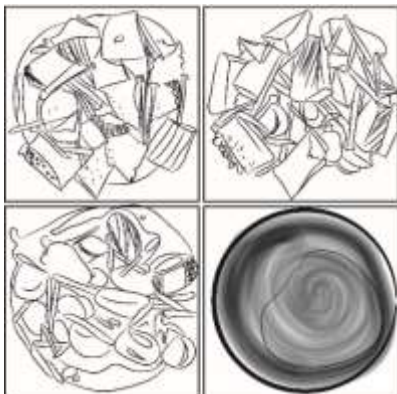
B.



What is in the picture?

How will you relate it to magmatism?

C.



What is in the picture?

How will you relate it to magmatism?

Activity 7. ACRONYM!

Directions. Use the word MAGMATISM as an acronym. Use each letter to represent word/s that is related to the lesson.

M
A
G
M
A
T
I
S
M

Assessment

Directions. Choose the letter of the best answer. Write the chosen letter on a separate sheet of paper.

1. What process occurs if there are formation and movement of magma under the earth's crust?
 - A. flux melting
 - B. heat transfer
 - C. partial melting
 - D. decompression melting
2. What term should be used to describe a semi-liquid hot molten rocks located beneath the Earth?
 - A. lava
 - B. sand
 - C. rocks
 - D. magma
3. In what part of the earth does magmatism happen?
 - A. Asthenosphere
 - B. Earth's crust
 - C. Earth's core
 - D. Lithosphere
4. What do you call the semi-liquid hot molten rocks found on the surface of earth once the volcano erupts?
 - A. lava
 - B. sand
 - C. rocks
 - D. magma

5. During partial melting of magma, where does decompression melting take place?
 - A. convergent boundary
 - B. mid-ocean ridge
 - C. subduction zone
 - D. all of the above
6. Which of the following is NOT a factor of partial melting?
 - A. addition of volatiles
 - B. decrease in pressure
 - C. an increase in pressure
 - D. an increase in temperature
7. When water or carbon dioxide is added to hot rocks, the melting points of minerals within the rocks decrease. What process is being described?
 - A. flux melting
 - B. heat transfer
 - C. partial melting
 - D. decompression melting
8. During partial melting, which of the following minerals melt last?
 - A. biotite
 - B. quartz
 - C. feldspar
 - D. none of the above
9. What are the two most abundant elements in magma?
 - A. oxygen and magnesium
 - B. silicon and aluminum
 - C. silicon and oxygen
 - D. oxygen and iron
10. What will happen to the temperature of rocks during partial melting?
 - A. decreases
 - B. increases
 - C. remains the same
 - D. all of the above
11. During partial melting of magma, where does heat transfer take place?
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12. Mantle rocks remain solid when exposed to high pressure. However, during convection, these rocks tend to go upward (shallower level) and the pressure is reduced. What process is being described?
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 - B. heat transfer
 - C. partial melting
 - D. decompression melting

13. During partial melting, which of the following minerals melt first?
- A. biotite
 - B. quartz
 - C. feldspar
 - D. both b and c
14. During partial melting of magma, where does flux melting take place?
- A. convergent boundary
 - B. mid-ocean ridge
 - C. subduction zone
 - D. all of the above
15. Conduction in mantle happens when heat is transferred from hotter molten rocks to the Earth's cold crust. What process is being described?
- A. flux melting
 - B. heat transfer
 - C. partial melting
 - D. decompression melting

Additional Activities

Directions. Read the poem below and answer the question that follows.

Magma

by Jemie Ann A. Quiroba

(Mataasnakahoy Senior High School)

HUMSS 12 SY 2019-20

I kept myself

I hid to deep

Burned myself, with my own heat

I must go out, must go with the flow

My red tears shouted pain, as it glows

So as I am, later on it would be tough

I freed my burning self and I'll go reach the top

What is the message of the poem?

Answer Key

What I Know 1. D 2. D 3. B 4. A 5. C 6. B 7. C 8. A 9. D 10. B 11. D 12. A 13. A 14. B 15. C What's in Activity 1 1. RADIATION 2. RADIOGENIC HEAT 3. CONDUCTION 4. PRIMORDIAL HEAT 5. CONVECTION 6. INTERNAL HEAT 7. primordial heat 8. conduction 9. convection 10. radiation Assessment 1. C 2. D 3. A 4. A 5. B 6. C 7. A 8. A 9. C 10. B 11. A 12. D 13. D 14. C 15. B	What's More Activity 3 1. magma 2. igneous rocks 3. silicon 4. oxygen 5. lava 6. volcano 7. asthenosphere 8. partial melting 9. temperature 10. heat transfer 11. convergent boundary 12. pressure 13. decompression melting 14. mid-ocean ridge 15. volatiles 16. flux melting 17. subduction zone What's More Activity 4 a. No. There is NO partial melting because there should be a decrease of pressure in the asthenosphere. b. No. There is NO partial melting because too much water will decrease the melting of the rocks. c. Yes. There is partial melting because heat is transferred from the molten rocks to the Earth's cold crust.	What I Have Learned 1. magma, semi-liquid 2. igneous rocks 3. magma chamber, lava, volcano 4. magmatism 5. silicon, oxygen 6. partial melting 7. an increase in temperature, decrease of pressure, volatiles 8. heat transfer, convergent boundaries 9. decompression melting, mid-ocean ridge 10. flux melting, subduction zones What I Can Do Activity 6 a. The ice cream is melting due to sunlight. This is related to heat transfer. b. Compressing clothes in the luggage. This is related to the decompression melting. c. Melting of different materials. This is the same as the minerals in the rocks melt to form magma. Activity 7 Answers may vary.
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Earth and Life Science

Changes in Mineral Components and Texture of Rocks (Metamorphism)

Earth and Life Science – Senior High School
Changes in Mineral Components and Texture of Rocks (Metamorphism)
First Edition, 2020

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What I Need to Know

This module was designed and written with you in mind. It is here to help you master the Nature of Earth and Life Science. 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 included lesson about the Changes in Mineral Components and Texture of Rocks (Metamorphism).

After going through this module, you are expected to:

1. Describe the changes in mineral components and texture of rocks due to changes in pressure and temperature (metamorphism).
2. Identify rock samples based on the effects of changes on temperature and pressure.
3. Analyze through a diagram on how temperature and pressure affect the mineral components and texture of rocks.

What I Know

Directions: Read and analyze each statement and choose the letter of the correct answer. Write your answer in a separate paper.

1. Which of the following statements describe metamorphosis?
 - A. process of rock formation
 - B. change in rock formation
 - C. process which involves changes
 - D. change that takes place within body of rock once expose to different conditions
2. Which of the following metamorphism is affected by heat and reactive fluid?
 - A. contact only
 - B. regional only
 - C. both contact and regional
 - D. neither contact nor regional
3. Which of the following is an example of rock produced by a contact metamorphism?
 - A. slate
 - B. gneiss
 - C. marble
 - D. hornfels

4. Which of the following led to the formation of deformed rocks with foliation?
- E. volume of air entering the rocks
 - F. temperature and rising of magma
 - G. temperature and volume of minerals
 - H. pressure and recrystallization of minerals
5. What is the effect of heat and pressure in rocks as there is an increase in depth?
- E. foliation surfaces shine
 - F. low-grade metamorphism
 - G. grain size becomes coarse
 - H. increase in mineral alignment
6. Which of the following is the main factor in the process of regional metamorphism?
- A. air
 - B. water
 - C. pressure
 - D. temperature
7. Which of the following rock samples is less influenced by the heat?
- A. slate
 - B. schist
 - C. gneiss
 - D. phyllite
8. How do you describe the grain size texture of hornfels?
- A. fine
 - B. coarse
 - C. coarse to fine
 - D. medium coarse
9. All of the following samples are included in non-foliated classification of metamorphic rock EXCEPT
- A. marble
 - B. phyllite
 - C. hornfels
 - D. metaconglomerate
10. What happened to the temperature and pressure if the rocks are buried down deep?
- A. increases
 - B. decreases
 - C. remain constant
 - D. intermittently degrading

11. Which of the following is NOT true about metamorphism?
- A. Slate and Gneiss are examples of foliated rock.
 - B. Contact Metamorphism creates non-foliated rocks.
 - C. Pressure is the main factor of contact metamorphism.
 - D. Magma will bake the surrounding rocks due to different in temperature.
12. Complete the analogy: Foliated is to slate as non-foliated is to
- A. schist
 - B. gneiss
 - C. marble
 - D. phyllite
13. Complete the analogy: contact: heat as regional: _____
- A. air
 - B. fire
 - C. pressure
 - D. temperature
14. Which type of metamorphism is caused by high temperature and high pressure enacted over a large volume of crust?
- A. burial
 - B. contact
 - C. regional
 - D. pyroclastic
15. Which of the following is a distinct projecting textural feature of regional metamorphic rocks?
- A. ripples
 - B. bedding
 - C. foliation
 - D. non-foliation

This part of the module contains topics about metamorphism. Students must describe changes in mineral component and texture of rocks due to changes in pressure and temperature by doing the different activities included in this part of the module. Likewise, concept about the metamorphism is available for the students reference in doing each activity incorporated in the procedure.

What's In

Metamorphism is the change that takes place within a body of rock as a result of it being subjected to conditions that are different from those in which it is formed. It is from the Greek word “meta” *means* change and “*morphe*” means form.

Major Task: Take note of the number of correct responses you will be making in every activity (What I know, What's new, What is it, What's more A and B, What I have learned, and What I can do). Then, look for the corresponding letter of each number of responses and think of the words which are associated in metamorphism. Accomplish it in the "Additional Activity" part.

Example:

- A. What I know: 6-F=Fluid
- B. What's new : 4-D= Deep Rock
- C. What is it: 7- G=Gneis
- D. What's more A&B: 9-I= Intrusive
- E. What I have learned: 8-H=Heat
- F. What I can do: 5=E= Energy.

What's New

Directions. The box in the left side contains important words which may or may not be associated to metamorphic process. Identify words which are related to the said process by choosing it from that box and write it on the opposite box.

HEAT	→		Score: _____
VOLCANIC ROCK			
PRESSURE			
FLUID			
MANTLE			
TEMPERATURE			
WEATHERING			
CEMENTATION			

What is It

Activity: Heat, Pressure and Metamorphism

METAMORPHIC ROCK is formed at the surface of the Earth through the process of metamorphism with recrystallization of minerals in rocks due to changes in pressure and temperature conditions.

A. Contact Metamorphism

B. Regional Metamorphism

MAIN FACTORS

Heat and Reactive Fluids

Pressure

The table below shows the scheme of metamorphic rock identification. It includes key points on how to classify rocks depending on its type, texture and grain size. Specific rock samples are also presented with their map symbol. Likewise, compositions of metamorphic rock are also situated parallel to the type of metamorphism.

SCHEME OF METAMORPHIC ROCK IDENTIFICATION																		
TEXTURE		GRAIN SIZE	COMPOSITION					TYPE OF METAMORPHISM	COMMENTS	ROCK NAME	MAP SYMBOL							
FOLIATED	MINERAL ALIGNMENT	FINE	MICA	QUARTZ	FELDSPAR	AMPHIBOLE	GARNET	PYROXENE	Regional	Low-grade metamorphism of shale	Slate							
		FINE TO MEDIUM							(Heat and Pressure increase with depth)	Foliation surfaces shiny from microscopic mica crystals	Phyllite							
	Platy mica crystals visible from metamorphism of clay or feldspars									Schist								
	High-grade metamorphism; some mica changed to feldspar, segregated by mineral type into bands									Gneiss								
BANDING	MEDIUM TO COARSE																	
NONFOLIATED	FINE	Variable													Contac Heat	Various rocks changed by heat from nearby magma/lava	Hornfels	
	FINE TO COARSE	Quartz													Regional or Contact	Metamorphism of rocks sandstone	Quartzite	
		Calcite and/or dolomite														Metamorphism of limestone or dolostone	Marble	
	COARE	Various Minerals in particles and matrix							Pebbles may be distorted or stretched	Metaconglomerate								

Let's do it!

Directions. Answer the question below by putting a check in the box which will response to the question.

Question: How do temperature and pressure affect the metamorphic rock formation?
(5 points)

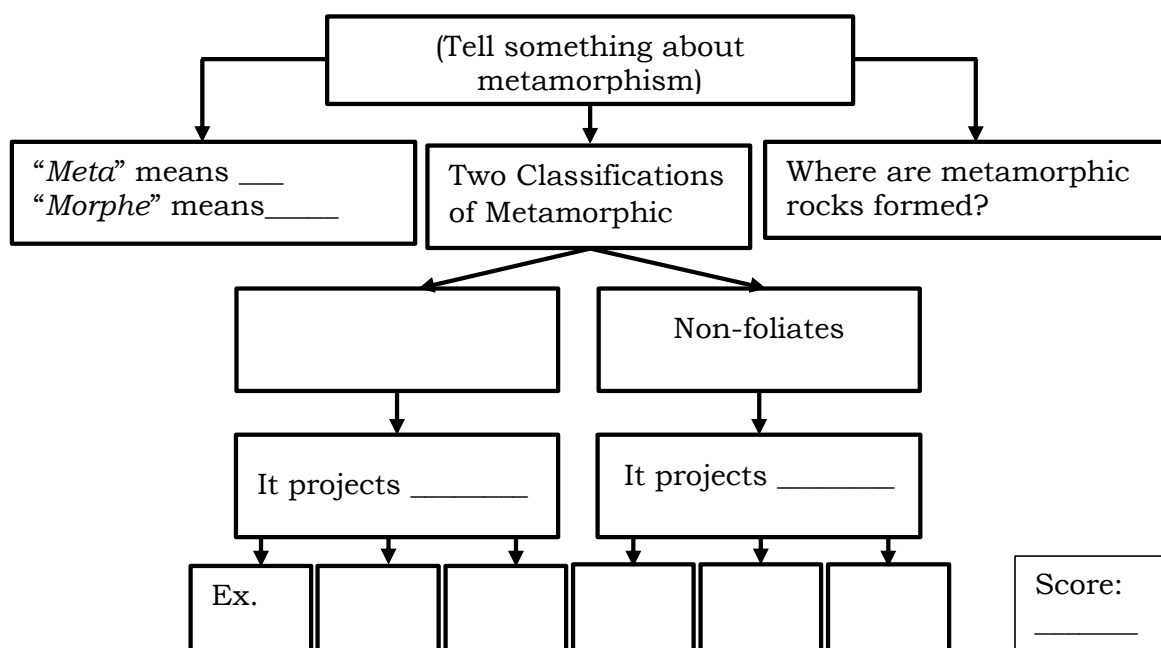
- ☐ If the rocks are buried deep, temperature and pressure will get increased.
- ☐ Contact metamorphism creates no-foliated metamorphic rocks.
- ☐ Magma will bake the surrounding rocks due to difference in temperature.
- ☐ Deformed rocks with foliation/lineation is brought by pressure and recrystallization of minerals.
- ☐ Pressure is the main factor of contact metamorphism
- ☐ Slate and gneiss are examples of foliated rocks.

Score:

What's More

Activity A: Metamorphism Map

Directions. Complete the concept map about metamorphism by supplying the missing words and phrases which can be chosen from the box below.



Score:

Key Terms

form volcano

lineation/foliation

schist

gneiss

non-Foliated

fine grain

hornfels

magma

pressure

marble

heat

slate

quartzite

Activity B: Word Cryptogram

Directions. Arrange the scrambled letters by putting the correct sequence on the shaded boxes to form a word (rock sample) based on the given description. Use the numbered boxes to discover the hidden word.

1. It has low-grade metamorphism of shale.

T	E	L	A	S
	2			

2. Plays mica crystals visible from metamorphism of clay or feldspar.

T	S	S	I	C	H
4					

3. Metamorphism of bituminous coal.

A	N	I	T	H	R	A	C	T	E
3									

4. High -grade metamorphism.

S	S	I	N	E	G

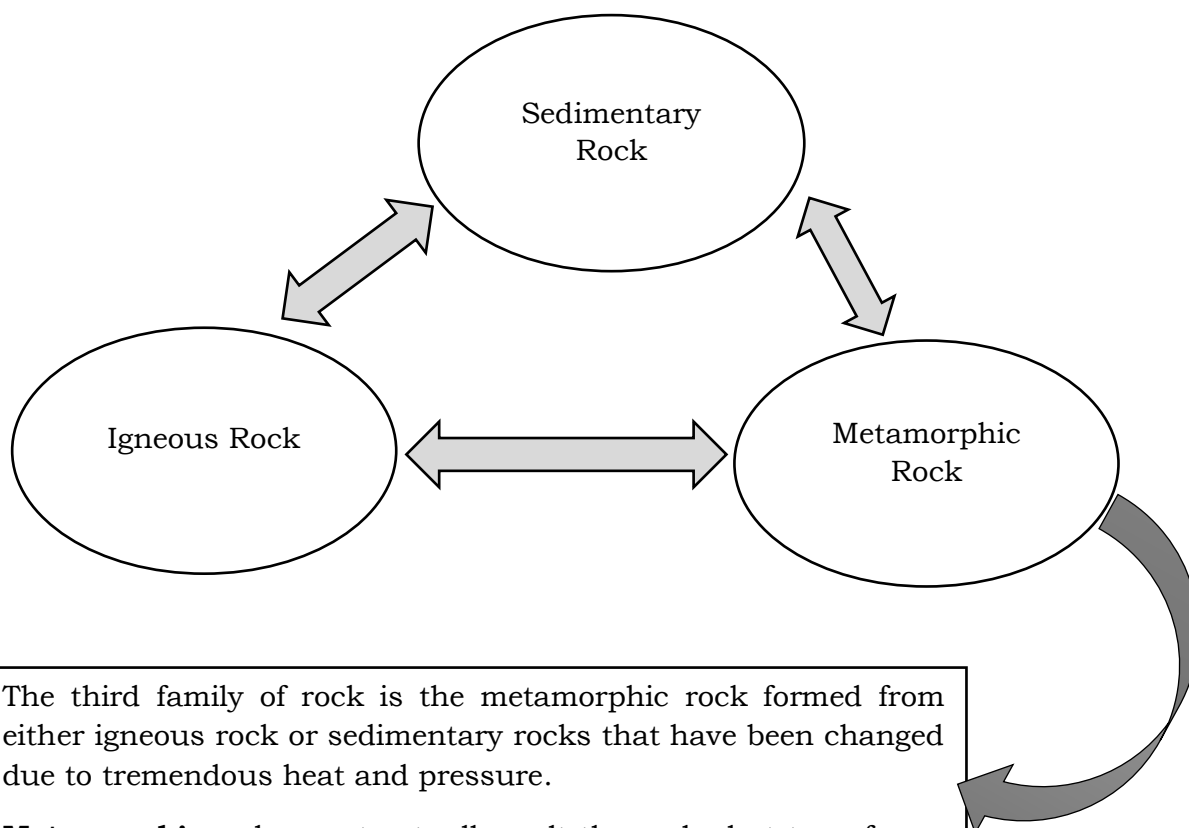
5. Foliation surface is shiny from microscopic mica crystals.

E	T	P	Y	H	L	L	I
				1			

The hidden word is _____.

Activity C: Rock You

Directions. Read and analyze the diagram below. It will provide you better understanding about the lesson.



The third family of rock is the metamorphic rock formed from either igneous rock or sedimentary rocks that have been changed due to tremendous heat and pressure.

Metamorphism does not actually melt the rocks but transforms them into denser, more compact rocks. Mineral may also be rearranged due to chemical reactions involving fluids that enter rocks

Metamorphic Rocks are used for variety of purposes.

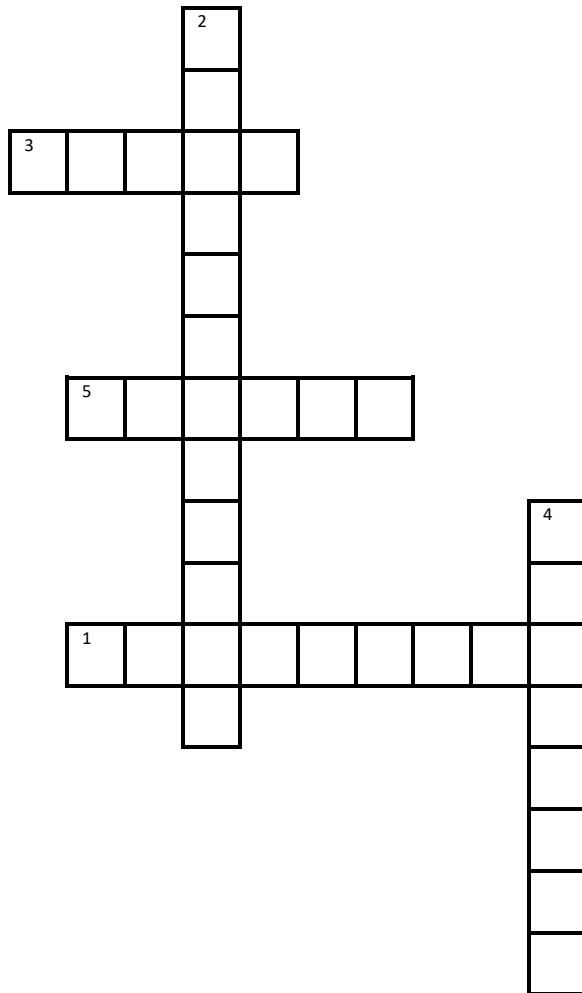
Slate is used commercially for your classroom blackboards and for pool table tops.

Marble is used in the construction of building floors and bathroom walls and counter parts (Pavico and Faraon, 2007, 224-225).

Extreme heat and pressure change the original state of an existing rock. They also change chemical composition and physical structure of existing rocks. Combinations of minerals in rocks are stable only over specific ranges of pressure and temperature. At pressure and temperature not within the ranges, the minerals form a different combinations call mineral assemblages (Kasten 2012, 290-291).

Activity D: My Metamorphic Puzzle

Directions. Identify the words being described on the right part and write it on the specific area.



Across

1. Different combination of a mineral formation

3. Used commercially classroom blackboards

- ## 5. Used construction of building floors

Down

2. It transforms rock into denser and more compact rock

4. Occurs from the increasing in both heat and pressure

What I Have Learned

Directions. Match the statements in column A with the indicated terms in column B. Write the letter of the correct answer on the blank before each number.

A.

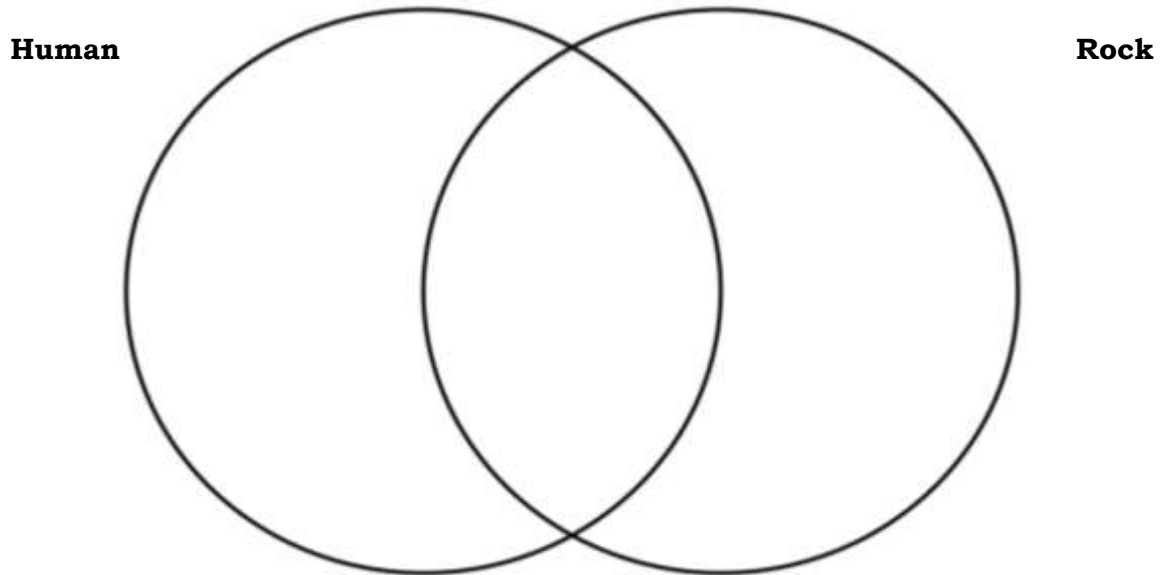
B.

- | | |
|--|--------------------------|
| _____ 1. It is a Greek word which means “change”. | a. quartzite |
| _____ 2. It is one of the factors affecting metamorphic rock which creates lineation. | b. metamorphism |
| _____ 3. Hornfels, marble and _____. | c. <i>meta</i> |
| _____ 4. It is the main factor of contact metamorphism. | d. regional metamorphism |
| _____ 5. It is a process of changing rock formation. | e. heat |
| _____ 6. It has a foliation surface shiny from microscopic mica crystal. | f. pressure |
| _____ 7. A rock sample which maybe distorted or stretched | g. phyllite |
| _____ 8. A rock sample with carbon composition. | h. metaconglomerate |
| _____ 9. It is formed by great heat and pressure deep within the earth. | i. anthracite |
| _____ 10. It takes place when magma introduces great amount of heat into an existing rock resulting in the recrystallization and mineral reaction in the rock. | j. metamorphic rock |
| | k. contact metamorphism |

Score:

BONUS TASK: For your own reflection and understanding, answer the posted question below. You may use the available diagram in answering the question.

Based from the quotation above, how do you see the similarities and differences of human and rocks?



What I Can Do

- A. **Directions.** Give the uses of the following metamorphic rock samples. Write your answer in the box provided under each rock samples.

SLATE	MARBLE	SCHIST
↓	↓	↓
↓	↓	↓
↓	↓	↓

B. **Directions.** Read the following tips on how you can make rock useful at home. Look for rocks with different textures as the highlight of your task. Choose one from the three suggestions and once you do it, take a picture of it and attach it in the space below. In case, you do not have ways to print it, just illustrate your project on the space provided.

1. Rock can be displayed in crystal or transparent vase/jar.
2. Make a good arrangement of rocks in a jar. You can make it with same color, same textures or sizes.
3. Aside from the rock in jar. You can also use them in a garden by putting it together with plants. Arrange it according to your taste.



Assessment

Directions. Read and analyze each statement and choose the letter which corresponds to the correct answer by shading the circle before the number.

1. Which of the following words is NOT associated with metamorphism?
 - A. heat
 - B. mantle
 - C. pressure
 - D. weathering
2. What is the effect of heat and pressure in rocks as there is an increase in depth?
 - A. foliation surfaces shine
 - B. low-grade metamorphism
 - C. grain size becomes coarse
 - D. increase in mineral alignment

3. What is the main factor that affects regional metamorphism?
 - A. heat
 - B. fluid
 - C. water
 - D. pressure
4. Which of the following rock sample contains fine texture?
 - A. gneiss
 - B. hornfels
 - C. quartzite
 - D. metaconglomerate
5. What rock is the result of the metamorphism of limestone?
 - A. slate
 - B. schist
 - C. marble
 - D. phyllite
6. What are the main factors for contact metamorphism to occur?
 - A. air and water
 - B. heat and reactive fluid
 - C. temperature and water
 - D. pressure and temperature
7. How do you describe the grain size texture of Hornfels?
 - A. fine
 - B. coarse
 - C. coarse to fine
 - D. medium coarse
8. Which of the following rock samples is less influenced by the heat?
 - A. phyllite
 - B. gneiss
 - C. schist
 - D. slate
9. Which of the following is NOT true about metamorphism?
 - A. Slate and gneiss are examples of foliated rock.
 - B. Contact metamorphism creates non-foliated rocks.
 - C. Pressure is the main factor of contact metamorphism.
 - D. Magma will bake the surrounding rocks due to different in temperature.

10. What happens to the grain size of the minerals in rocks when the heat is increased? Its size
- A. increases
 - B. decreases
 - C. remains constant
 - D. degrades intermittently
11. Which of the following DOESN'T belong to the group?
- A. mica
 - B. quartz
 - C. dolomite
 - D. feldspar
12. Foliation or lineation happens among deformed rocks due to
- A. eruption of magma from the mantle to the crust
 - B. pressure and recrystallization of rocks
 - C. increase in temperature in the surrounding area
 - D. increase in volume of water as the rocks' depth increases
13. Which of the following relationships is INCORRECT?
- A. fine grain: slate
 - B. banding: gneiss
 - C. non-foliated: phyllite
 - D. contact heat: hornfels
14. How do temperature and pressure affect metamorphism?
- A. Pressure and temperature increase as you go up to the crust.
 - B. The deeper the rock depth, the higher the pressure and temperature.
 - C. Foliation happens as there is an increase in the pressure and temperature.
 - D. Magma cannot bake the surrounding rocks due to the difference in temperature.
15. Samer is walking down the river when she see an unknown metamorphic rock. Which of the following characteristic can BEST help her to immediately identify the type of metamorphism that the rock underwent using a magnifying glass?
- A. foliation
 - B. grain size
 - C. name of the rock
 - D. kind of mineral present in the rock

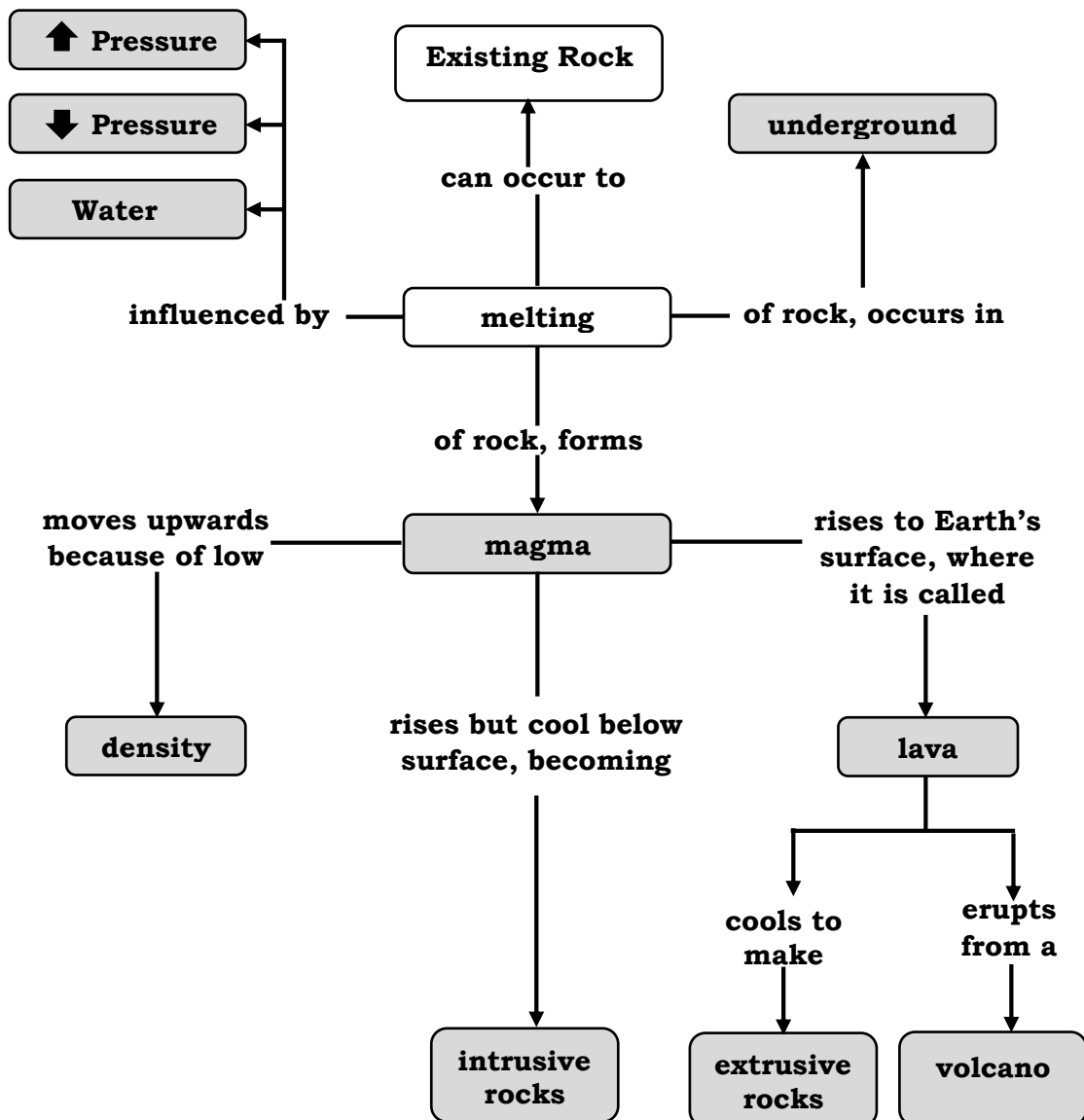
Score:

Additional Activities

- A. **Directions.** Indicate the scores you obtained from the previous activities. Please refer to the major task in case you forget the directions. Write your answer on the space provided in the box below.

ACTIVITY	SCORE	FORMED WORDS
What I Know		
What's New		
What is it		
What's More (A+B)		
What I have Learned		
What I can Do		
Assessment		

B. **Directions.** For additional information, take time to read and observe the concept map.



The concept map above presents the processes between igneous and metamorphic rocks. It shows how metamorphism takes place from any existing rocks such as igneous rock.

Answer Key

Assessment - D - C - D - B - C - B - C - A - D - A - C - B - C - B - A - B - C - B - A - B What I Have Learned? - C - F - A - E - B Bonus Task Example - Human shows characteristics and attitudes which are unique to humans as a rational being. - Rocks display characteristic, beauty, appearance which are different from other types of rocks - However, in spite of differences both are the same when it comes to the ability of showing how unique and wonderful they are.	What I can Do Slate: - good roofing material - decorative gardening stones - base for snooker tables and it was used as a writing board (or writing slate) Marble: - use for building or sculpture material - can be ground down and use as cleaning and soap material Schist: - use for building, sculpture. Paving and grade decoration What is It - If the rocks buried deep, temperature and pressure in get increase. - Contact metamorphism creates no-foliated metamorphic rocks. - Magma will bake the surrounding rocks due to difference in temperature. - Deformed rocks with foliation/lineation is brought by pressure and recrystallization of minerals. - Slate and gneiss are examples of foliated rocks	What's More A. B. - Slate - Schist - Anthracite - Gneiss - Phyllite D. - Assemblages - Slate - Marble - Metamorphosis - Regional What I Know - D - A - D - A - C - C - A - A - B - A - C - C - C - C - A - B - A - C - C What's New Heat Pressure Fluid Mantle Temperature Volcanic Rock
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Earth and Life Science

Igneous Rocks: How Are They Formed?

Earth and Life Science – Senior High School
Igneous Rocks: How Are They Formed?
First Edition, 2020

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What I Need to Know

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The module covers:

- Lesson 1 – Igneous Rocks: How Are They Formed?

After going through this module, you are expected to:

1. compare and contrast the formation of different types of igneous rocks;
2. distinguish intrusive from extrusive igneous rocks;
3. differentiate igneous rocks based on silica content; and
4. differentiate the different textures of igneous rocks.

What I Know

Directions. Read the following questions and choose the letter of the best answer. Write the chosen letter on a separate sheet of paper.

1. What classification of rocks is formed from solidification and crystallization of molten rocks?
 - A. igneous rocks
 - B. metamorphic rocks
 - C. sedimentary rocks
 - D. all of the above
2. What Latin word was the term “igneous” derived from?
 - A. *ignus*
 - B. *lithos*
 - C. *meta*
 - D. *sedere*
3. Which of the following is/are the process/es to igneous rocks?
 - A. sedimentation
 - B. recrystallization
 - C. solidification and crystallization
 - D. solidification and recrystallization

4. Which type of igneous rocks based on composition has the highest amount of silica content?
- A. felsic
 - B. intermediate
 - C. mafic
 - D. ultramafic
5. What happens to the molten rocks when they reach the Earth's surface?
- A. They flow continuously.
 - B. They cool down and solidify.
 - C. Their temperature remains the same.
 - D. They remain semi-liquid molten rocks.
6. Which of the following is NOT an extrusive igneous rock?
- A. basalt
 - B. granite
 - C. obsidian
 - D. rhyolite
7. Which type of igneous rock forms from lava on Earth's surface?
- A. clastic
 - B. extrusive
 - C. intrusive
 - D. non-clastic
8. Which type of igneous rock forms when magma hardens beneath Earth's surface?
- A. clastic
 - B. extrusive
 - C. intrusive
 - D. non-clastic
9. What is the size of the crystals if the rock cools slowly and forms below the Earth's surface?
- A. large
 - B. no crystal
 - C. small
 - D. none of the above
10. Which of the following is NOT an intrusive igneous rock?
- A. diorite
 - B. gabbro
 - C. granite
 - D. obsidian

11. Which of the following is NOT true about extrusive rocks?
- A. They cool down quickly.
 - B. They have small crystals.
 - C. These are formed beneath the Earth.
 - D. Basalt and scoria are example of these rocks.
12. Which of the following is TRUE about intrusive rocks?
- A. They have fine grains.
 - B. They are usually dark.
 - C. They are formed from lava.
 - D. They have usually low density.
13. What type of igneous rock texture has large minerals?
- A. aphanitic
 - B. glassy
 - C. phaneritic
 - D. vesicular
14. How are igneous rocks classified based on their origin?
- A. large or small crystals
 - B. plutonic and volcanic
 - C. coarse or fine grains
 - D. from magma or lava
15. How does the amount silica affect the color of igneous rock?
- A. It has no effect at all.
 - B. It doesn't matter what the color is.
 - C. The lesser the silica has, the lighter the color is.
 - D. The more the silica it has, the lighter the color is.

Lesson 1 Igneous Rocks: How Are They Formed?

Have you tried mountain climbing? Did you notice different rocks in the mountain trail? Do they look the same? Do they have different colors? Do they have crystals? Do they undergo same process of formation? Some of you might think that all rocks are just the same, however if we study it thoroughly, you will be surprised that they are different in terms of their formation, physical and chemical characteristics.

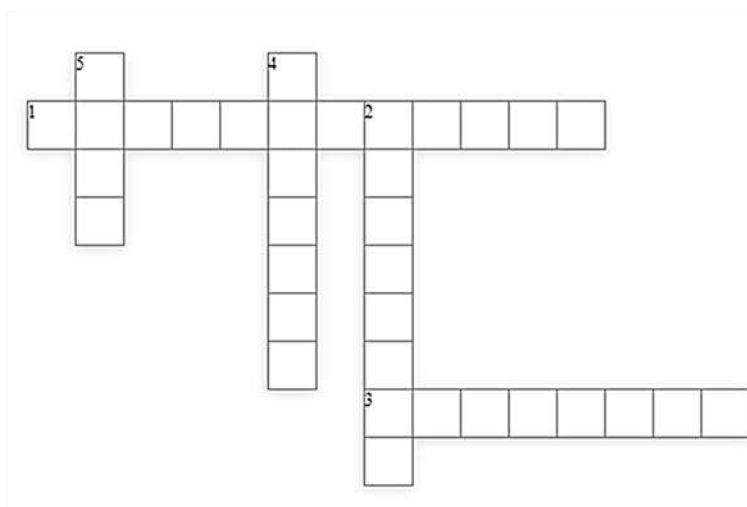
In your previous lesson, you already learned that rocks can be classified as igneous, sedimentary, and metamorphic. For this module, we will be focusing on igneous rocks and how they are formed.

What's In

Activity 1. Crossword Puzzle

In the previous lesson, you have learned about metamorphism of rocks. Let us review first about this before proceeding to the next topic.

Directions. Fill-in the crossword puzzle with the words being described. Match the number of the sentences to the boxes of placed across or down the grid.



ACROSS

1. It is the change that takes place within a body of rock as a result of being subjected to conditions.

3. It is a type of metamorphic rock which is formed due to pressure.

DOWN

2. It is the main factor of regional metamorphism.

4. It is a type of metamorphic rock which is formed due to heat.

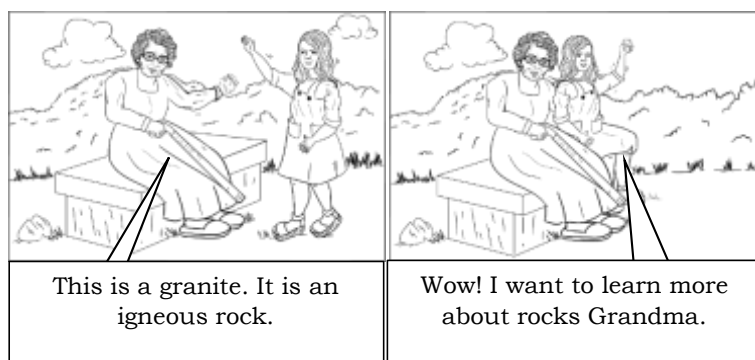
5. It is the main factor of contact metamorphism.

What's New

Activity 2. Comic Strip Analysis

Directions. This comic presented below is about a short conversation of a grandmother and her granddaughter. Read the comics and answer the given questions.





Guide Questions:

1. Who are the characters in the comic?
2. Where do you think is the location of the characters?
3. What is the topic of their conversation?
4. According to the grandmother, Taal volcano is composed of what kind of rock?
5. What specific rock is mentioned in the conversation?

What is It

What are Igneous rocks?

Igneous rocks are one of the three major categories of rocks. The word igneous is derived from the Latin word for fire, *ignis* or *ignus*.

These rocks are commonly found in the surface and beneath the Earth, specifically in divergent boundaries, convergent boundaries, subduction zones and hotspots. Not all igneous rocks have the same physical and chemical characteristics. They differ in the origin, process of formation, color, density, size of grains, crystals and many more.

How are igneous rocks formed?

Igneous rocks are formed through the process of **solidification** and **crystallization** of molten rocks; magma and lava. When hot, molten rocks reach the surface of the earth, they undergo changes in temperature and pressure causing them to cool, solidify and crystallize. Moreover, there are also solidification and crystallization magma beneath the earth.

What are the types of igneous rocks based on their formation?

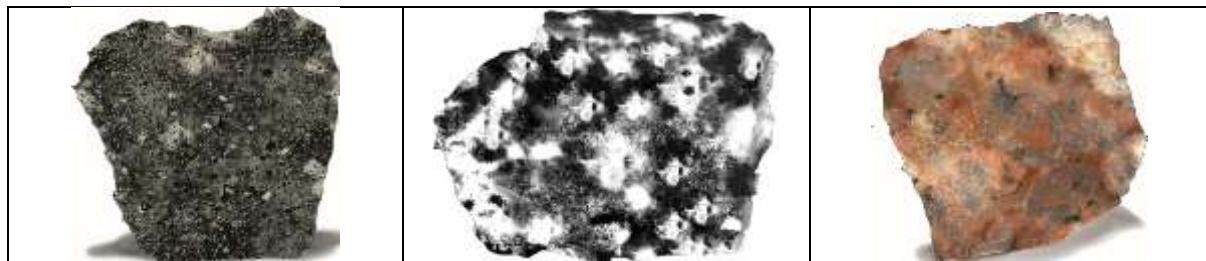
In terms of formation, igneous rocks can be classified into two: intrusive and extrusive rocks. Below is the comparison of these two types.

Table 1. Differences Between Intrusive and Extrusive Rocks

Point of Comparison	Intrusive Rocks	Extrusive Rocks
Other terminology	plutonic rocks	volcanic rocks
Location	beneath the Earth	surface of the Earth
Process of Formation	plutonic	volcanic
Origin	formed from magma	formed from lava

Color	usually dark	usually light colored
Density	usually dense	usually low density (light)
Composition	mafic: magnesium and iron	felsic: feldspar (aluminum)
Rate of Cooling	cools slowly	cools quickly (with voids/holes)
Size of Grains	large/coarse grains	fine/small or no grains (fine/glassy)
Size of Crystals	large crystals	small or no crystals

These are some examples of intrusive and extrusive rocks.



Gabbro

Diorite

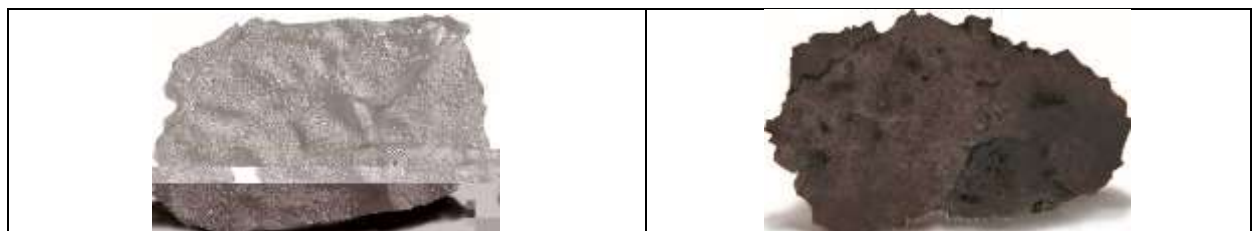
Granite

Figure 1. Examples of Intrusive Rocks



Basalt

Obsidian



Rhyolite

Scoria

Figure 2. Examples of Extrusive Rocks

What are the types of igneous rocks based on composition?

Igneous rocks can also be classified according to their composition. They are composed of **SiO₂** or **silica**. Not all igneous rocks have the same silica content. If there is **oversaturation** of silica in the magma, its minerals will precipitate. On the other hand, if there is **undersaturation** of silica in the magma, its minerals will not

precipitate and will not be present in the igneous rocks. The viscosity of magma is also affected because of silica content.

There are four classifications of igneous rocks based on silica content: ultramafic, mafic, intermediate and felsic.

1. Ultramafic Igneous Rocks

- They have a **very low silica content; less than 45% of SiO_2** .
- Before forming into igneous rocks, its magma has very low viscosity.
- Its color is ranged too black (peridotite) to olive green (dunite).
- Their density is very high.
- They are rich in pyroxene and olivine minerals.
- Examples of these rocks are peridotite and dunite.

2. Mafic Igneous Rocks

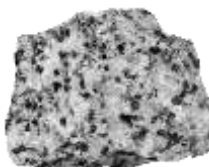
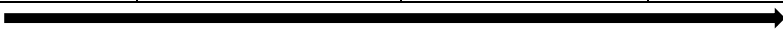
- They have a **low silica content; 45-52% of SiO_2** .
- Before forming into igneous rocks, its magma has low viscosity; more viscous than ultramafic magma.
- They have black color.
- Their density is high.
- They are composed of pyroxene, calcium-rich plagioclase feldspar
- Examples of these rocks are gabbro and basalt.

3. Intermediate Igneous Rocks

- They have a **high silica content; 53-65% of SiO_2** .
- Before forming into igneous rocks, its magma has intermediate viscosity; more viscous than the mafic magma.
- Their color is gray.
- Their density is intermediate.
- They are composed of biotite, alkali feldspar and quartz.
- Examples of these rocks are diorite and andesite.

4. Felsic Igneous Rocks

- They have a **very high silica content; more than 65% of SiO_2** .
- Before forming into igneous rocks, its magma has high viscosity; more viscous than the intermediate magma.
- They have light color.
- Their density is very low.
- They are composed of quartz and alkali feldspar.
- Examples of these rocks are granite and rhyolite.

Rock types	Granite	Diorite	Gabbro	Peridotite				
								
Composition	FELSIC	INTERMEDIATE	MAFIC	ULTRAMAFIC				
Color	Light  Dark							
								

SiO ²	70%	60%	50%	40%
MgO	0.95%	2.5%	15%	48%
Major mineral content	Quartz Alkali Feldspar	Biotite Alkali Feldspar Quartz	Pyroxene Plagioclase Feldspar	Pyroxene Olivine

Figure 3. Differences of Igneous Rocks based on Composition

Based on the illustration, you will notice the differences of these four classifications of igneous rocks in terms of their color. Ultramafic has the darkest color and felsic has the lightest color. To sum, the higher the silica content is, the lighter its color while the lower the silica content is, the darker its color. Thus, amount of silica affects the color of the rocks.

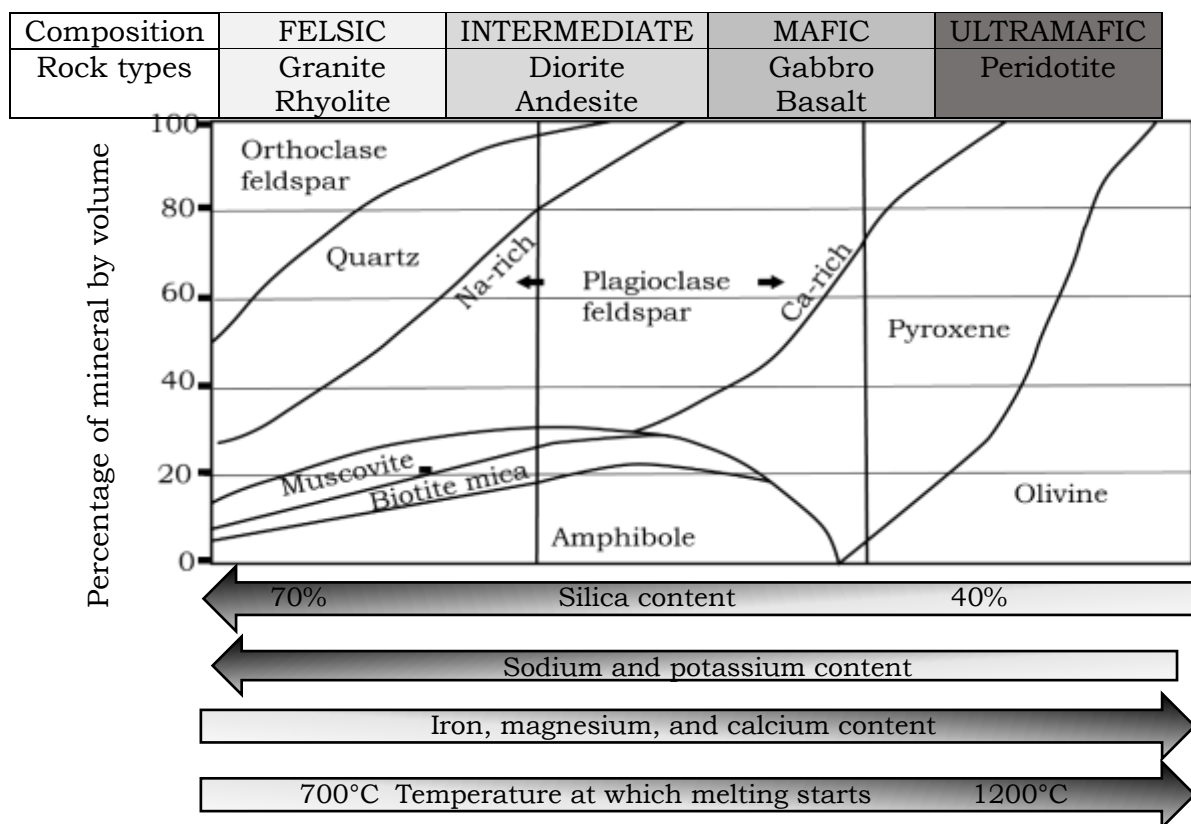


Figure 4. Differences of Igneous Rocks based on Composition in Relation to Silica Content and Temperature

This is another illustration showing the differences of ultramafic, mafic, intermediate and felsic igneous rocks; rock types, kind and percentage of minerals; percentage of silica content; and ranges of temperature.

Felsic has the highest silica content while ultramafic has the lowest silica content. On the other hand, felsic is exposed to 700 degree Celsius and ultramafic is exposed to 1200 degree Celsius. It means when igneous rock is exposed to extreme high temperature, its color is darker, while if it is exposed to lower temperature, its color is light.

What are the types of igneous rocks based on texture?

Igneous rocks have different textures. Texture of a rock is the size and arrangement of the minerals it contains.

- **Phaneritic texture** – Rocks have large minerals (example: granite)
- **Aphanitic texture**- The mineral grains are too small to see with the unaided eye (example: basalt)
- **Vesicular texture** – Rocks have many pits from gas escape (example: basalt)
- **Porphyritic texture** – Rocks have two (2) distinct grain sizes, large and small (example: andesite porphyry)
- **Glassy texture**- Rocks do have obvious minerals (example: obsidian)

What's More

Activity 3. Types of Igneous Rocks, Described!

Directions. Given are the different examples of igneous rocks. Supply the missing information to complete the table below.

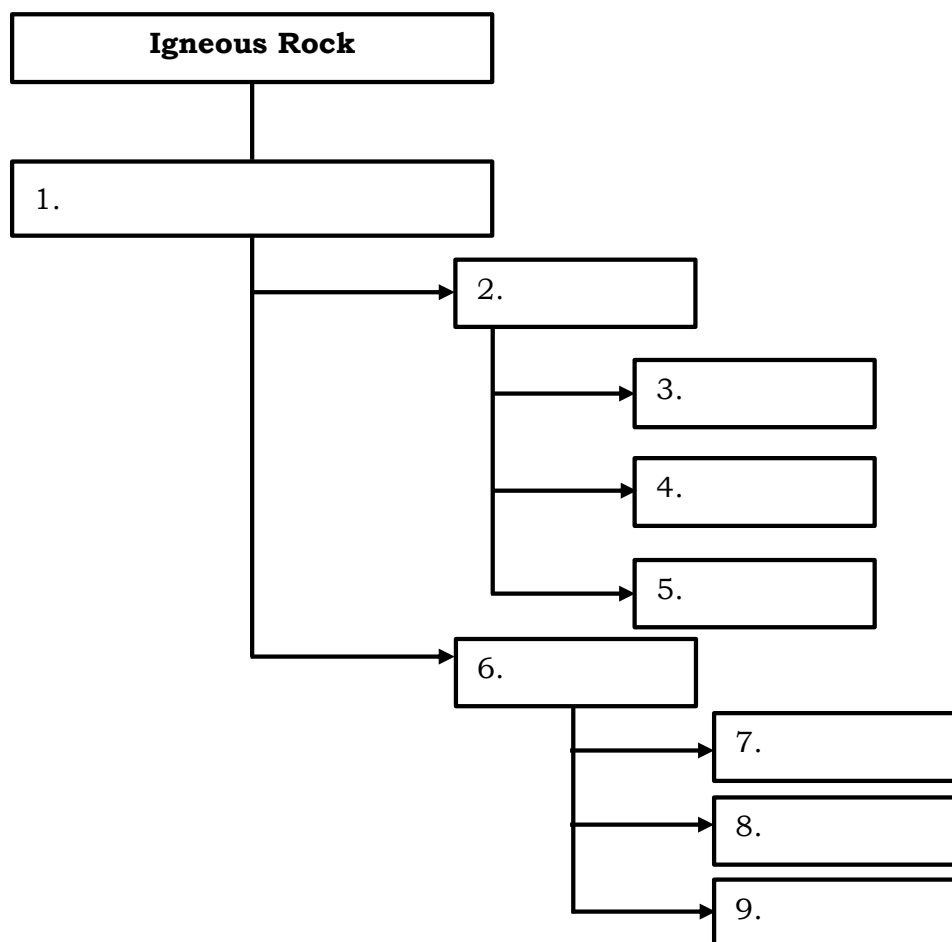
<i>Rock</i>	<i>Type of Igneous Rock (intrusive or extrusive)</i>	<i>Formed from (magma or lava)</i>	<i>Cooling rate (fast or slow)</i>	<i>Crystal size (small, large or no crystal)</i>
 Rhyolite	extrusive	1.	2.	small
 Gabbro	3.	4.	slow	large
 Granite	intrusive	5.	slow	6.
 Scoria	7.	lava	8.	No crystals

	Obsidian	9.	lava	fast	10.
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Activity 4. Concept Map

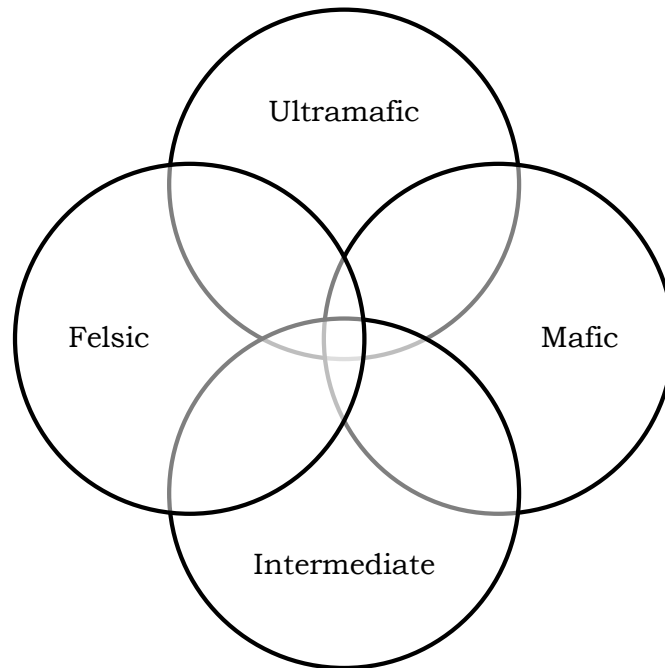
Directions. Complete the blank concept map by supplying the needed information using the given terms and phrases related to igneous rocks.

Extrusive	composed of magnesium and iron	magma cools slowly
Intrusive	lava cools quickly	small or no crystal form
large crystal form	composed of aluminum	form from cooling and solidification of lava and magma



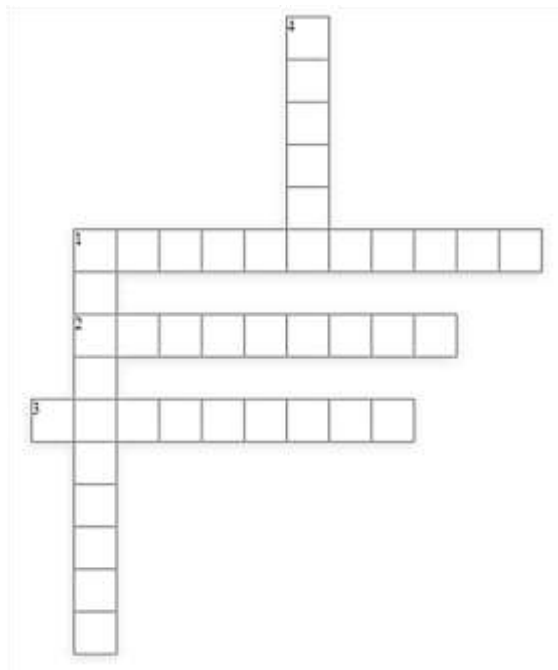
Activity 5. Venn Diagram

Directions. Compare and contrast the four classifications of igneous rocks based on composition.



Activity 6. Crossword

Directions. Fill-in the crossword puzzle with the words being described. Match the number of the sentences to the boxes of placed across or down the grid.



ACROSS

1. Rocks have two distinct grain sizes.
2. The mineral grains are too small to see with the unaided eye.
3. Rocks have many pits from gas escape.

DOWN

1. Rocks have large minerals.
4. Rocks do have obvious minerals

What I Have Learned

Activity 7. Complete Me!

Directions. Read the following statements and fill-in the blanks with the correct term or phrase.

1. The word igneous is derived from the Latin word for _____, *ignis* or *ignus*.
2. Igneous rocks are commonly found in the _____ and _____ the Earth, specifically in divergent boundaries, convergent boundaries, subduction zones and hotspots.
3. Igneous rocks are formed through the process of _____ and _____ of molten rocks; magma and lava.
4. When hot, molten rocks reach the surface of the earth, they undergo changes in _____ and _____ causing them to _____, _____ and _____.
5. In terms of formation, igneous rocks can be classified into two; _____ and _____ rocks.
6. Intrusive rocks are formed solidified _____ while extrusive rocks are formed from solidified _____.
7. Intrusive rocks cool _____ while extrusive rocks cool _____.
8. Intrusive rocks have _____ grains and crystals while extrusive rocks have _____ grains and crystals.
9. Examples of intrusive rocks are _____, _____, and _____.
10. Examples of extrusive rocks are _____, _____, _____, and _____.
11. Igneous rocks can also be classified according to their composition. They are composed of _____.
12. If there is _____ of silica in the magma, its minerals will precipitate.
13. If there is _____ of silica in the magma, its minerals will not precipitate and will not be present in the igneous rocks.
14. There are four classifications of igneous rocks based on silica content; _____, _____, _____ and _____.
15. _____ has the highest amount of silica while _____ has the lowest.
16. _____ is the most viscous while _____ is the least.
17. _____ has the darkest color while _____ has the lightest
18. _____ is the densest while _____ is the lightest.
19. _____ is exposed to the highest temperature while _____ is exposed to the lowest temperature.
20. The higher the silica content is, the _____ the color is and the _____ the silica content is, the darker the color is.

What I Can Do

Activity 8. Apply It!

A. **Directions.** Go outside and collect 3 pieces of rock. Observe their color, shape, texture and other physical characteristics. You may crack or scratch the rock to observe them clearly. Then, record your data in the table below.

<i>Rocks (Drawing)</i>	<i>Type of Igneous Rock and its Characteristics</i>
1.	
2.	
3.	

B. **Directions.** Read the given statement and provide the answer.

You are in a community park. While walking, you have noticed that there are many rocks on the ground. From these rocks, how will you know if they are igneous rocks? What are the things you should consider in identifying igneous rocks?

Assessment

Directions. Read the following questions and choose the letter of the best answer. Write the chosen letter on a separate sheet of paper.

1. What Latin word was the term “igneous” derived from?
 - A. *ignus*
 - B. *lithos*
 - C. *meta*
 - D. *sedere*
2. What classification of rocks is formed from solidification and crystallization of molten rocks?
 - A. igneous rocks
 - B. metamorphic rocks
 - C. sedimentary rocks
 - D. all of the above
3. Which type of igneous rocks based on composition has the highest amount of silica content?
 - A. felsic
 - B. intermediate
 - C. mafic
 - D. ultramafic
4. Which of the following is/are the process/es of igneous rocks?
 - A. sedimentation
 - B. recrystallization
 - C. solidification and crystallization
 - D. solidification and recrystallization
5. Which of the following is NOT an extrusive igneous rock?
 - A. basalt
 - B. granite
 - C. obsidian
 - D. rhyolite
6. What happens to the molten rocks when they reach the Earth’s surface?
 - A. They flow continuously.
 - B. They cool down and solidify.
 - C. Their temperature remains the same.
 - D. They remain semi-liquid molten rocks.
7. Which type of igneous rock forms when magma hardens beneath Earth's surface?
 - A. clastic
 - B. extrusive
 - C. intrusive
 - D. non-clastic
8. Which type of igneous rock forms from lava on Earth's surface?
 - A. clastic
 - B. extrusive

- C. intrusive
 - D. non-clastic
9. Which of the following is NOT an intrusive igneous rock?
- A. diorite
 - B. gabbro
 - C. granite
 - D. obsidian
10. What is the size of the crystals if the rock cools slowly and forms below the Earth's surface?
- A. large
 - B. no crystal
 - C. small
 - D. none of the above
11. Which of the following is TRUE about intrusive rocks?
- A. They have fine grains.
 - B. They are usually dark.
 - C. They are formed from lava.
 - D. They have usually low density.
12. Which of the following is NOT true about extrusive rocks?
- A. They cool down quickly.
 - B. They have small crystals.
 - C. These are formed beneath the Earth.
 - D. Basalt and scoria are example of these rocks.
13. How are igneous rocks classified based on their origin?
- A. large or small crystals
 - B. plutonic and volcanic
 - C. coarse or fine grains
 - D. from magma or lava
14. How does the amount silica affect the color of igneous rock?
- A. It has no effect at all.
 - B. It doesn't matter what the color is.
 - C. The lesser the silica has, the lighter the color is.
 - D. The more the silica it has, the lighter the color is.
15. What type of igneous rock texture has large minerals?
- A. aphanitic
 - B. glassy
 - C. phaneritic
 - D. vesicular

Additional Activities

- A. **Directions.** Take some pictures of igneous rocks available in your barangay and make a collage. Write a short paragraph or description about your output.

- B. **Directions.** Read the quotation and write your interpretation about it.

“Sometimes we must be like stone, strong enough to stand on our own.”

- WhenEarthSpeaks

Answer Key

Assessment - A - A - A - C - B - B - C - B - D - A - B - C - D - D - C - D - C What I Can Do Activity 8 A. Answers may vary. B. Their color, density, grains, crystals, and location of the rocks Activity 7 - fire - surface, beneath - solidification, crystallization - temperature, pressure, cool, solidify, crystallize - intrusive, extrusive - magma, lava - slowly, quickly - large, small or no - gabbro, diorite, granite - basalt, obsidian, rhyolite, scoria	6. silica - oversaturation - undersaturation - ultramafic, mafic, intermediate, felsic - felsic, ultramafic - felsic, ultramafic - ultramafic, felsic - ultramafic, felsic - ultramafic, felsic - lighter, lower What's More Activity 3 - lava - fast - intrusive - magma - magma - large - extrusive - fast - extrusive - no crystals Activity 4 - form from cooling and solidification of lava and magma - intrusive - large crystal form - magma cools slowly - composed of magnesium and iron - extrusive - small or no crystal form - lava cools quickly - composed of aluminum	Activity 5 Answers may vary Activity 6 Across - porphyritic - aphanitic - vesicular Down - phaneritic - glassy What's in Activity 1 Across - metamorphism - regional Down - pressure - contact - heat What I Know - A - A - C - A - B - B - C - A - intrusive - large crystal form - magma cools slowly - composed of - magnesium and iron - extrusive - small or no crystal form - lava cools quickly - composed of What's New Activity 2 - grandmother and her granddaughter - place where Taal volcano can be seen - They are talking about rocks found in Taal volcano. - igneous rocks - granite
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Earth and Life Science

Movement of Plates and Formation of Folds and Faults

Earth and Life Science
Movement of Plates and Formations of Folds and Faults
First Edition, 2020

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What I Need to Know

This module was designed and written with you, the learner in mind. This aims to help you master the Nature of Earth and Life Science. The scope of this module permits can be used in 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 included lesson about the Movements of Plates and Formation of Folds and Faults.

After going through this module, you are expected to:

1. Identify the three types of plate movements from a short excerpt.
2. Expound three types of plate movement based on plate tectonics theory using an illustration.

Cite specific examples of land forms as outcomes of plate movement

What I Know

Directions. Read and analyze each statement and choose the letter which corresponds to the correct answer by shading the circle before each number.

- ☐ A ☐ B ☐ C ☐ D 1. What geologic feature will be formed if the continents riding on top of two converging plates collide?
- A. faults
B. mountain
C. island
D. ocean

- ☐ A ☐ B ☐ C ☐ D 2. This refers to the region where plates meet.
- A. fault
B. plate boundary
C. mountain
D. volcanic arc

- ☐ A ☐ B ☐ C ☐ D 3. Which type of plate boundary creates a zone of tension by moving the plates apart?
- A. convergent boundary
B. divergent boundary
C. transform fault
D. none of these

- ☐ A ☐ B ☐ C ☐ D 4. When two tectonic plates collide, the oceanic crust usually ~~subducts~~ subducts beneath the continental crust because it is
 A. denser than continental crust
 B. thicker than continental crust
 C. thinner than continental crust
 D. less dense than continental crust

- _____

 _____ 5. Predict what geologic features could result out of the direction of movement indicated in the arrows below. (There are three possible answers)



- ☐ A ☐ B ☐ C ☐ D 6. Which of the following diagrams shows transform fault boundary movement?
 A. 
 B. 
 C. 
 D. 

- ☐ A ☐ B ☐ C ☐ D 7. Which of the diagrams showing divergent fault movement?
 A. 
 B. 
 C. 
 D. 

- ☐ A ☐ B ☐ C ☐ D 8. New oceanic lithosphere forms at _____.
 A. convergent boundary
 B. divergent boundary
 C. transform fault
 D. none of these

- ☐ A ☐ B ☐ C ☐ D 9. In which type of plate boundary does the shallow focus earthquake occur?
 A. convergent
 B. divergent
 C. transform
 D. all of these

- ☐ A ☐ B ☐ C ☐ D 10. Which of the following is not associated with convergent plate movement/margin?

A. deep-focus earthquake
B. trench
C. valley
D. volcanic Arc

- ☐ A ☐ B ☐ C ☐ D 11. Which of the following is associated with discovery of seafloor spreading?

a. Mountains and Volcanoes are denser than mantle
b. Rotational pole of the earth has migrated or moved.
c. The crust of the continents is denser than the crust of the ocean
d. The crust of the oceans is very young relative to the age of the crust of the continents

- ☐ A ☐ B ☐ C ☐ D 12. Volcanic arcs are associated with _____.

A. convergent
B. divergent
C. transform
D. all of these

_____ 13. _____: Plates pull apart Transform: Plates move alongside

- ☐ A ☐ B ☐ C ☐ D 14. Folds: occurs when flat surface bent
Faults: _____

A. It forms from ~~subducting~~ plates
B. fracture or discontinuity in volume of rocks
C. Occur when plates moving alongside and toward to each other.
D. Occur when plates moving alongside and away from each other.

_____ 15. Valley: Low area between hills or mountains
_____: A chain of mountains. **CLUE:** EGRID

Lesson 1 Movement of Plates and Formation of Folds and Faults

This module contains topics about plate movement leading to the formation of folds and faults. Students must explain how the movement of plates leads to the formation of folds and faults by doing different activities included in this module. Likewise, concept about the Plate's movement is available for the students reference in doing each activity incorporated in the procedure.

What's In

Directions. Cross out the words which are not associated with plate tectonics. Then, put the remaining words and write your understanding below the box.

FAULT	WEATHERING	CONVERGENT
PLATES	SUBDUCTION	VOLCANIC ARC
RIDGE	MOUNTAIN	MESOSAURUS
FOLD	DIVERGENT	

<i>Words</i>	<i>Your Own Understanding</i>

Score:

What's New

Directions. Read and analyze the excerpt. Identify the three indicated types plate movements. Illustrate it on the box provided below (10 points).

TYPE OF PLATE BOUNDARIES

Studying plate boundaries is important because along these boundaries deformation of the lithosphere is happening. Divergent plate movement occurs when plates pull apart from each other. When two (2) plates diverge, pieces from such plates sink towards the Earth's mantle. On the other hand, convergent movement occurs when plates crush into each other and land crumples, forming trenches and mountains. Lateral or transform fault movement occurs when plates move alongside each other in different directions.

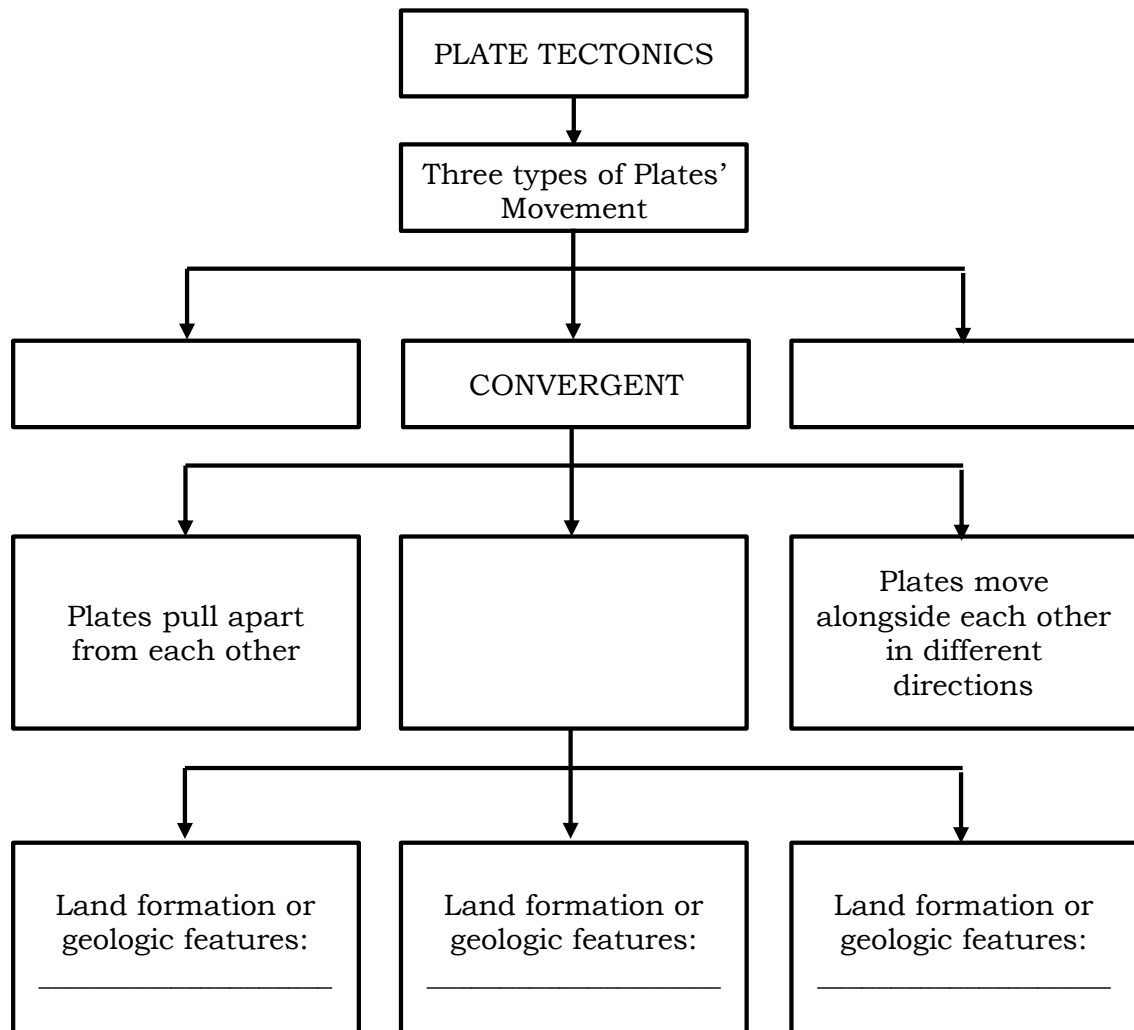
Illustration 1.

Illustration 2.

Illustration 3.

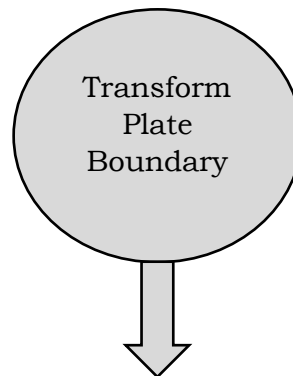
What is It

- A. **Directions.** Complete the diagram below by filling in the blank boxes with the corresponding terms/phrases.

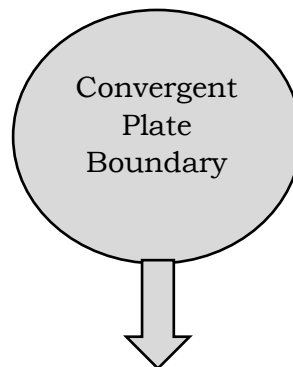


Score: _____

- A. **Directions.** Read and analyze the diagram below which will provide you background information about Plate Boundaries.



It is also called as strike slip fault boundary, the plates slide past each other horizontally. This is a type of boundary that cuts through California, the well-known San Andreas Fault. The San Andreas fault zone, which is about 1300 km long and is tens of kilometer wide, slice through two thirds of the length of California. Along with it, the Pacific Plate has been for 10 million years, at an average rate of about 5cm/yr (Pavico and Faraon, 2007, 193).



The heavier oceanic crust sinks below the lighter continental crust. It happens along convergent boundaries where plates are moving toward each other and sometimes one plate sink under another (subduction). Marianas Trench marks where the fast moving Pacific Plate converges against the slower moving Philippine Plate. This boundary is often sits of major volcanoes such as Mount Fuji in Japan. In a collision of two pieces of oceanic crust, the result is a chain of volcanic islands, of which Indonesia is a prime example. Where oceanic crust collides with a plate carrying continent, the result is a chain of volcanoes on the continent such as the Cascade of volcanic chain in Pacific Northwest of the US and the Andes Mountains of South America. When two continental crusts collide, the result is a range of mountains such as Himalayan Mountain yr (Pavico and Faraon, 2007, 193-194).

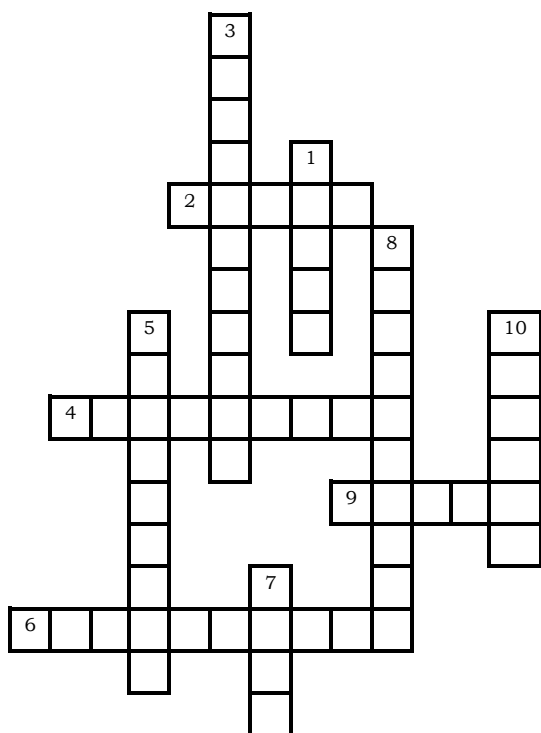


Divergent Plate Boundaries are boundaries where the earth's tectonic plates are moving apart. For most part, these boundaries are located on the ocean floors, where they form a continuous chain of volcanic mountains and rift called mid-ocean ridges that extend throughout the earth's oceans. Mid-Atlantic Ridge is good example which runs down the middle of the Atlantic Ocean. As the plates move apart, magma wells up to fill the space between them, and this is why divergent plate boundaries are the sites of volcanic activity. It is also a set where the earth's crust is growing (Pavico and Faraon, 2007, 194).

What's More

Activity A: Crossword Puzzle

Directions. Fill out the crossword puzzle with the correct terms using the given clues.



Across

2. Fracture or discontinuity in a volume of rocks.
4. Plates are moving away from each other.
6. Horizontal motion movement of plates.
9. A chain of mountains.

Down

1. Earth's crust and uppermost mantle
3. Chain of volcanoes formed from subducting plates.
5. Plates are moving toward each other and collide.
7. Occur when flat surface bent or curved.
8. A large landform formed from tectonic forces.
10. Low area between hills and mountain

Score: _____

Activity B: My Understanding of Plate Movement

Directions. Complete the paragraph below. The first part is already given.

Faults, folding, ridges, mountains, valleys and volcanic arc are formed when the plates move because

(5 points).

Criteria: 3 points: Appropriateness and relation to the topic
2 points: Neatness and free from grammatical errors.

Score:

Activity C: Plate Boundaries

Directions. Perform the activity below by following the instructions.

- There are two tables below. Table A includes three types of plate boundaries with their respective descriptions and illustrations while Table B is blank table where you can put your answer.
- Observe Table A by making sure that all the descriptions and illustration referring to specific type of plate boundaries are properly placed.
- In case you notice errors, rewrite the content of table A into table B with correct classification of all the descriptions.

Table A

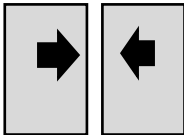
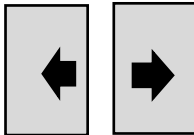
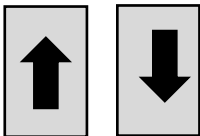
CONVERGENT	DIVERGENT	TRANSFORM
	When it occurs between two oceanic plates, one of those plates will subduct beneath the other.	Most of it are found in the ocean basin and connect offsets in the mid ocean ridges
Plates move apart	When it happens, the new crust is forming from magma that rises to the earth surface between the two plates	
Two plates are moving toward each other	Also known as strike slip or sliding boundaries	Best example of this plate is San Andreas fault
	Creating a zone of tension	Often sites of major volcanoes

Table B

CONVERGENT	DIVERGENT	TRANSFORM

Activity D: READ! ASK! RESPOND!

Directions. Read and Analyze the the diagram below. Take note of some important details which will be used in next activities or questions



READ

Plates move relative to each other and to fixed location in the mantle of the Earth. The absolute motion of the plates can lead to the formation of strings of volcanoes. On the other hand, their relative motion can lead to the different types of plate boundaries. If three plates meet in one place, they form a triple junction (Kasten 2012, 241)



ASK

1. What motion or movement can lead to the formation of strings of volcanoes?
2. What will be formed if the three plate boundaries meet in one place?



1

2.



Currently, the size of oceans and shape of continents are changed due to the movement of plates. Because of the movement of plates in North and South America, Pacific Ocean is becoming smaller. However, the Atlantic Ocean is becoming larger as North and South America move away from Europe and Africa. The Himalayas Mountains are becoming taller. The plate that includes Australia is now beginning to collide with the plate that includes Southeast Asia. India's plate is also colliding with Asia while Australia is moving farther away from Antarctica (Kasten 2012, 241).



1. What will happen to the Pacific Ocean if the North and South American Plates continue to move to the west?
2. What caused the enlargement of Atlantic Ocean?
3. What will happen to the Himalayas Mountains when two large landmasses, Eurasia and India driven by plate movement and collide?



1.

2.

3.

Score:

What I Have Learned

Directions. From the word pool given below, identify the term being described in the following statements.

- _____ 1. This phenomenon is created during transformation of plate's movement and it is a kinematic phenomenon caused by the relative density of oceanic lithosphere and relative weakness of asthenosphere.
- _____ 2. This plate's movement creates mountain and volcanic arc. Marianas Trench is also created by this movement.
- _____ 3. The movement of this plate is towards the opposite direction or moving away from each other.
- _____ 4. It is a process of rising up hot, dense liquid materials and creates new seafloor.
- _____ 5. This is a theory that supports that supports continental drift theory and seafloor spreading.

Plate Tectonic
Transform fault
Convergent

Seafloor Spreading
Divergent

Score:

What I Can Do

Directions. Supply the needed information by writing it on the space provided.

- A. "Everything happens for a reason." How will I relate the given quotation to the lesson?

B. In your area, what natural scenery do you think is a result of colliding plates?

C. How will you justify that plate tectonics or movement of plate boundaries is also beneficial to us?

(Cite your reference)

Assessment

Directions. Read and analyze each statement and choose the letter which corresponds to the correct answer by shading the circle before each number.

☐ A ☐ B ☐ C ☐ D

1. Movement plate boundaries results too many events or land formations, which of the following is the reason of mountain formations.

A. Converging Plates
B. Both A and B
C. Diverging Plates
D. Neither A

☐ A ☐ B ☐ C ☐ D

2. It is a region where plates meet.

A. Fault
B. Plate Boundary
C. Mountain
D. Volcanic Arc

☐ A ☐ B ☐ C ☐ D

3. There are three distinct types of plate boundaries, which of those types creates zone of tension by moving the plates apart?

A. Convergent Boundary
B. Transform Fault
C. Divergent Boundary
D. None of these

☐ A ☐ B ☐ C ☐ D

4. When two tectonic plates collide, the continental crust usually rise up over the oceanic crust because it is_____.

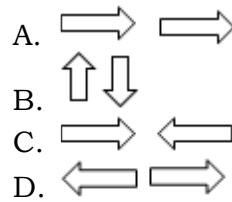
A. Denser than continental crust
B. Thicker than continental crust
C. Thinner than continental crust
D. Less dense than oceanic crust

☐ A ☐ B ☐ C ☐ D

5. Predict what geologic features could result out of this boundary.



- ☐ A ☐ B ☐ C ☐ D 6. Which of the following diagrams shows the strike slip fault wherein San Andreas Fault which is bounded by North American Plate and the Pacific Plate is the best example?



- ☐ A ☐ B ☐ C ☐ D 7. Which of the following resulted to the formation of new crust from magma that rises to the earth's surface between the two plate boundaries?

- A. convergent boundary
- B. divergent boundary
- C. strike fault
- D. transform boundary

- ☐ A ☐ B ☐ C ☐ D 8. Which of the following resulted to the formation of new oceanic lithosphere?

- A. Convergent Boundary
- B. Divergent Boundary
- C. Transform Boundary
- D. None of these

- ☐ A ☐ B ☐ C ☐ D 9. Which type of plate boundary does the shallow focus earthquake occur wherein it appears to be associated with mid ocean ridges and mountain ranges?

- A. Convergent
- B. B. Divergent
- C. Transform
- D. All of these

- ☐ A ☐ B ☐ C ☐ D 10. Which of the following land formation or events is not connected to convergent plate movement/margin?

- A. deep-focus earthquake
- B. Trench
- C. Valleys
- D. Volcanic Arc

☐ A ☐ B ☐ C ☐ D 11. Which of the following is associated with discovery of seafloor spreading?

- A. Mountains and Volcanoes are denser than mantle
- B. Rotational pole of the earth has migrated or moved.
- C. The crust of the continents is denser than the crust of the ocean
- D. The crust of the oceans is very young relative to the age of the crust of the continents

☐ A ☐ B ☐ C ☐ D 12. Convergent plate boundary creates land formations which later become scenery. Which of the following is one of the best examples of the land formations due to convergent plate boundary?

- A. Arc
- B. Boundary
- C. Valley
- D. Volcanic Arc

13. Divergent: Plates pull apart_____: Plates move alongside

14. Faults: A fracture or discontinuity in volume of rocks

Folds: _____.

- A. It forms from subducting plates
- B. It occurs when flat surface bent
- C. Occur when plates moving alongside and toward to each other.
- D. Occur when plates moving alongside and away from each other.

_____ 15. _____: Low area between hills or mountains

RIDGES: A chain of mountains.

CLUE: YLLVAE

Score:

Additional Activities

- A. **Directions.** Conduct a short interview with one or two of your family members. Ask them about how they think the mountain, valley, ridges and volcanoes are formed. List all their responses. Afterwards, inform them on how those formations formed based on what you have learned from the lesson.

Interview Guide Format:

<i>Questions</i>	<i>Responses</i>	<i>Your Feedback</i>

- B. Based on the results of your interview, make a wide dissemination on how different landforms were created based on what you have learned into this module. You have two options to do it.

1. Flyers
2. Vlog which will be post on your social media account.

Rubrics:

5 points: Innovation (It should shows creativity)

10 points: Content (It should include explanations based on the lesson)

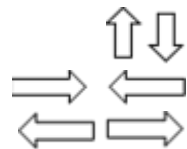
Answer Key

What is it?

A.



What's New



What's in

Words to be crossed out:
Weathering
Mesosaurus

What I Know

1. B
2. B
3. B
4. A
5. Mountains, and Trench
6. B
7. D
8. B
9. D
10. C
11. D
12. A
13. Divergent
14. B
15. RIDGE

What's More

A

1. Plate
2. Fault
3. Volcanic Arc
4. Divergent
5. Convergent
6. Transform
7. Fold
8. Mountain
9. Ridge
10. Valley

B. Your answer should touch the three movements of plates. Divergent, convergent and transform fault movement. Note: Rubrics is attached after the activity.

C

CONVERGENT	Two plates move toward each other. This causes the plates to collide. This can result in the formation of mountains and deep-sea trenches.	Two plates move toward each other. This causes the plates to collide. This can result in the formation of mountains and deep-sea trenches.
DIVERGENT	Two plates move away from each other. This causes the plates to pull apart. This can result in the formation of mid-ocean ridges and deep-sea trenches.	Two plates move away from each other. This causes the plates to pull apart. This can result in the formation of mid-ocean ridges and deep-sea trenches.
TRANSFORM	Two plates move past each other horizontally. This causes the plates to slide past each other. This can result in the formation of deep-sea trenches.	Two plates move past each other horizontally. This causes the plates to slide past each other. This can result in the formation of deep-sea trenches.

D.

1. Absolute motion
 2. Triple Junction
 3. Smaller
 4. North and South America move away from Europe and Africa
 5. Taller
 - 6.
- What I have Learned**
- 1 Transform Fault
 - 2 Convergent
 - 3 Divergent
 - 4 Seafloor Spreading
 - 5 Plate Tectonics

Assessment

What I can Do

B.

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

Students own understanding or based on research.

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Earth and Life Science

Formation of Rock Layers

Earth and Life Science
Formation of Rock Layers
First Edition, 2020

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What I Need to Know

The content of this module focuses on the concepts of rock layer formation and its correlation. Every rock layer is, for the most part, one of various parallel rock layers that lies upon another which exhibits specific or similar characteristics.

Since the concept about rocks and its types were discussed in the previous lesson, this module serves as a continuation of how rocks produce strata and what they may become once they are separated from its original rock layer. It also involves the possibilities of knowing the relative age of each rock layer due to the presence of fossils it contains.

The module is divided into two lessons, namely:

- Lesson1: Rock Layers
- Lesson 2: Correlation of Rock Layers

After going through this module, you are expected to:

- 1.describe how layers of stratified rocks are formed;
2. describe the different laws of stratigraphy;
- 3.determine how geologists correlate rock layers;
4. reflect on human environmental practices that may contribute to the alterations on the Earth surface, particularly the rock layers; and
5. illustrate an outcrop of rock layers applying the law of stratigraphy.

What I Know

Before you use this module, take the **Pretest** below.

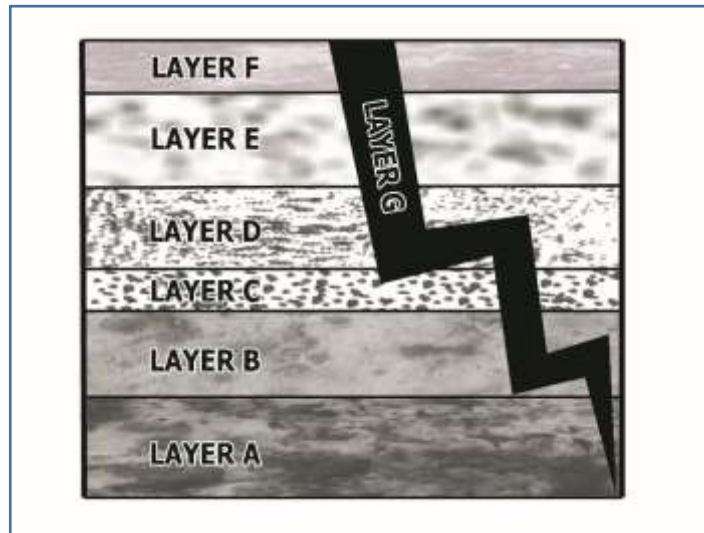
Directions: Read each item carefully. Choose the letter of the best answer and write the chosen letter on a separate sheet of paper.

1. Which field of science deals with the study of rock layers?
 - A. Geology
Petrology
 - B. Paleontology
 - C. Stratigraphy
2. Which processes most often cause fossil evidence to be preserved in rock?
 - A. melting and faulting
 - B. weathering and erosion
 - C. folding and metamorphism
 - D. cementation and deposition
3. Which of the following laws of stratigraphy gives emphasis on the assemblage of fossils embedded on rock layers?
 - A. Law of Conformities
 - B. Law of Superposition
 - C. Law of Faunal Succession
 - D. Law of Original horizontality
4. What can be concluded if a dike protrudes through several layers of rock?
 - A. A batholith resides nearby.
 - B. A volcano is within the area.
 - C. It is formed before the rock layer.
 - D. The rock layers are formed before the dike protrudes.
5. What can you infer when a sandstone comes in contact with a granite?
 - A. The granite is older than the sandstone.
 - B. The granite is younger than the sandstone.
 - C. The granite was intruded into the sandstone.
 - D. The granite and the sandstone have the same age.
6. Who proposed the Law of Uniformitarianism?
 - A. Aristotle
 - B. Nicolas Steno
 - C. James Hutton
 - D. James Chadwick

7. Which principle states that the physical, chemical, and biological processes that work today are the same forces that worked in the past?

- A. Principle of Intrusions
- B. Principle of Unconformities
- C. Principle of Uniformitarianism
- D. Principle of Original Horizontality

For item nos.8-10, refer to the diagram of rock strata to answer the questions that follow.



8. What principle of stratigraphy is depicted in the picture?

- A. Principle of Unconformities
- B. Principle of Uniformitarianism
- C. Principle of Original Horizontality
- D. Principle of Cross-cutting relationship

9. Which layer of rock is the youngest?

- A. Layer F
- B. Layer G
- C. Layer E
- D. Layer A

10. What is the correct sequence in the relative age of rock from youngest to oldest?

- A. Layer A, B, C, D, E, F, G
- B. Layer G, F, E, D, C, B, A
- C. Layer A, B, G, C, D, E, F
- D. Layer G, F, E, D, C, B, A

11. Which type of dating method can be used in rock layers applying the Law of Superposition?
- A. Radioactive Dating
 - B. Absolute Dating
 - C. Relative Dating
 - D. Isotopic Dating
12. According to the Law of Superposition, where are the oldest fossils usually found?
- A. somewhat near the surface
 - B. at the top of the rock layers
 - C. in the middle of the rock layers
 - D. near the bottom of the rock layers
13. Which principle uses dikes and faults in sequencing events?
- A. Inclusions
 - B. Faunal succession
 - C. Original Horizontality
 - D. Cross cutting relationship
14. Which of the following is NOT generally part of angular unconformity?
- A. Erosion
 - B. Folding
 - C. Metamorphism
 - D. Marine Regression
15. How is the principle of original horizontality described?
- A. All rocks were originally horizontal.
 - B. Each layer of rock is older than the one above it.
 - C. The original crust of the earth was almost perfectly flat.
 - D. Layers of sediments are deposited in a nearly horizontal orientation.

Lesson 1 Rock Layers

Are the current features of the Earth the same as they were 4.6 billion years ago? Well, the answer is no. The Earth had undergone geological alterations and evolutionary processes that changed its features. The exogenic and endogenic processes that happened in the surface and within the inner portion of the Earth may contribute to these alterations that occurred. The rocks are being studied by geologists because they contain clues of what the Earth had been in the past.

In this module, the formation of rock strata will be determined including the order of rock layers, the manner on how rock layers are formed or deformed due to physical factors and the age of rocks using the relative and absolute dating method.

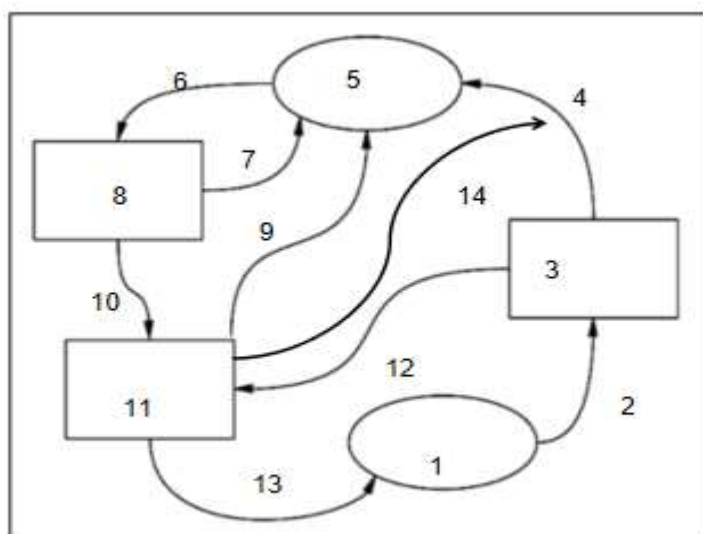
What's In

Before proceeding to the content of this module, let us first have a review on the learnings that you gained in our previous lesson related to rocks and rock cycle.

Try to complete the rock cycle using the terms and the processes given. Write the term/s in the box/circles and processes/events in between arrows to show the connections in the rock cycle.

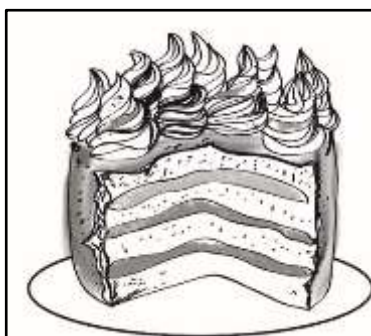
TERMS:
IGNEOUS ROCK
SEDIMENTARY
ROCK
METAMORPHIC
ROCK
MAGMA
SEDIMENTS

PROCESSES:
Weathering and Erosion
Melting
Deposition and Burial
Compaction and Cementation
Heat and pressure
Metamorphism
Solidification



ROCK CYCLE

What's New



If you will be given a cake for your birthday, how many layers do you wish to have? How many flavors do you want? What will be the order of flavor in each layer?

If you apply pressure on cakes, it will be deformed, flattened, or twisted. Just like the layers in the cake, rocks can also form layers due to sediments deposited on rocks or some forces that act on it which causes its deformation. These are forces that may bring alteration to rock layers or the change in its formation in the Earth's surface.

In geologic time, it covers the whole sweep of Earth's history, from how and when the earth was first formed, to everything that has happened on, in, and to the entire planet up to now.

In this module, descriptions, characteristics, and behavior of rock layers will be discussed. Relevant information will be given which serves as a guide as you go through with the lesson in the formation of rock layers.

What is It

The idea behind the concept that the Earth is billions of years old originated in the work of **James Hutton**. Hutton concluded that there are forces that changes the landscape of the Earth in the past. This conclusion is based on his observation in the geological processes that were taking place in his farm.

His Principle of Uniformitarianism states that the current geologic processes, such as volcanism, erosion, and weathering are the same processes that were at work in the past. This idea was refined by other geologists that although the process of the past and the present are the same, the rates of this process may vary over time. The Earth's history was studied using the different records of past events preserved in rocks. The layers of rocks are like the pages in our history books.

How are rock layers formed?

Stratified rocks, also known as derivatives rock, maybe fragmental or crystalline. These rocks are product of sedimentary processes. These are made of visible layers of sediments. The formation on rock layers depend on its stratigraphy and stratification.

Stratigraphy

- It is the branch of geology that deals with the description, correlation, and interpretation of stratified sediments and stratified rocks on and within the Earth.
- It is the study of the rock layers(strata).
- It will give you clues to the location of ancient seas, mountains, plateaus and plains.

Stratification

- It is also known as bedding, which is the layering that happens in sedimentary and igneous rocks formed at the surface of the Earth that comes from lava flows or other volcanic activity.
- It is expressed by rock layers (units) of a general tabular or lenticular form that differ in rock type.

As early as the mid 1600's, the Danish scientist **Nicholas Steno** studied the relative position of sedimentary rocks. Sedimentary rocks are formed particle by particle, bed by bed, and the layers are piled one on top of the other. These rock layers are also called strata.

Stratigraphic Laws

Stratigraphic laws are basic principles that all geologists use in decoding or deciphering the spatial and temporal relationships of rock layers. These includes the following: Original Horizontality, Lateral Continuity, Superposition, Cross Cutting, Law of Inclusions and the Law of Faunal Succession.

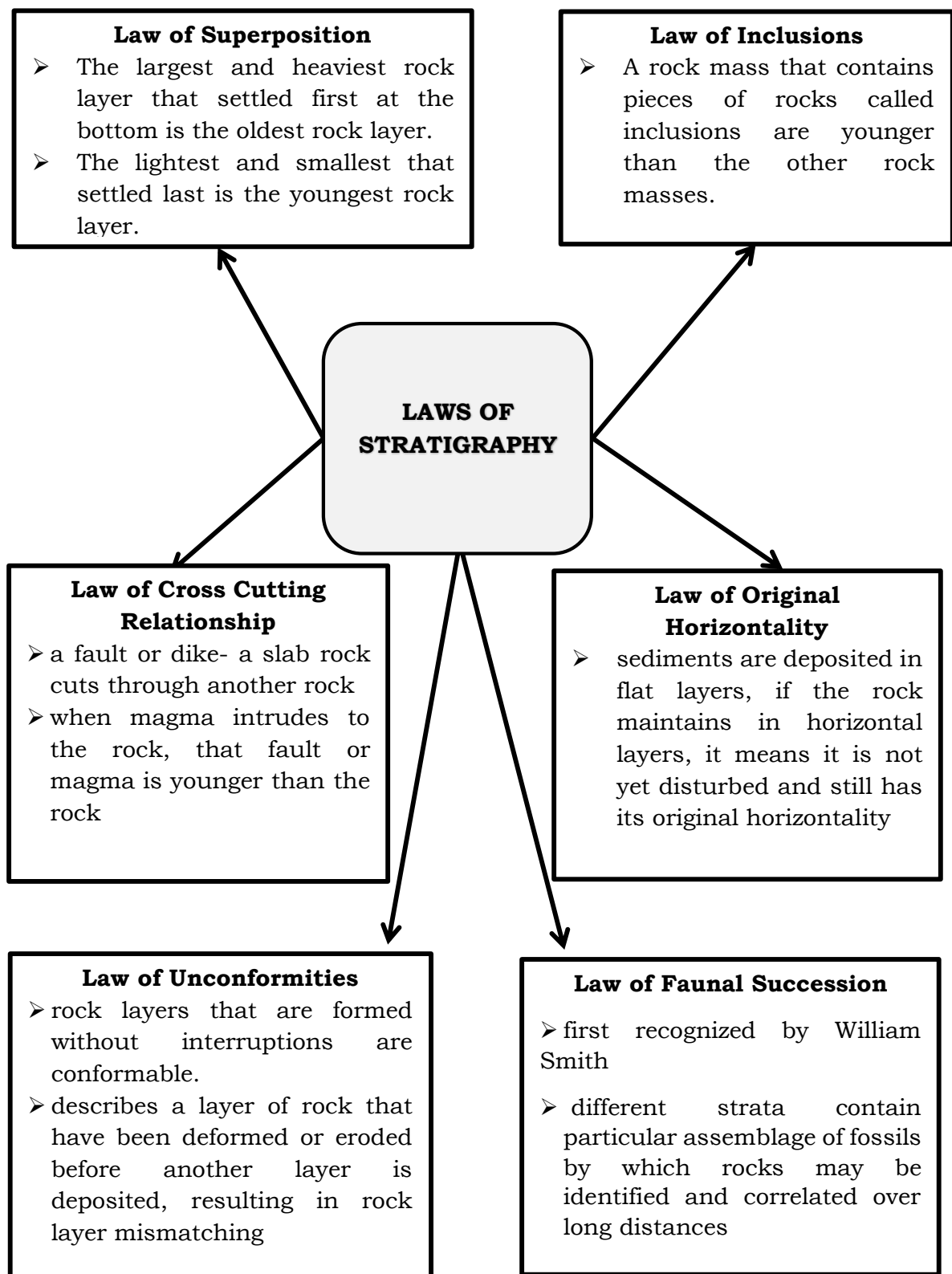
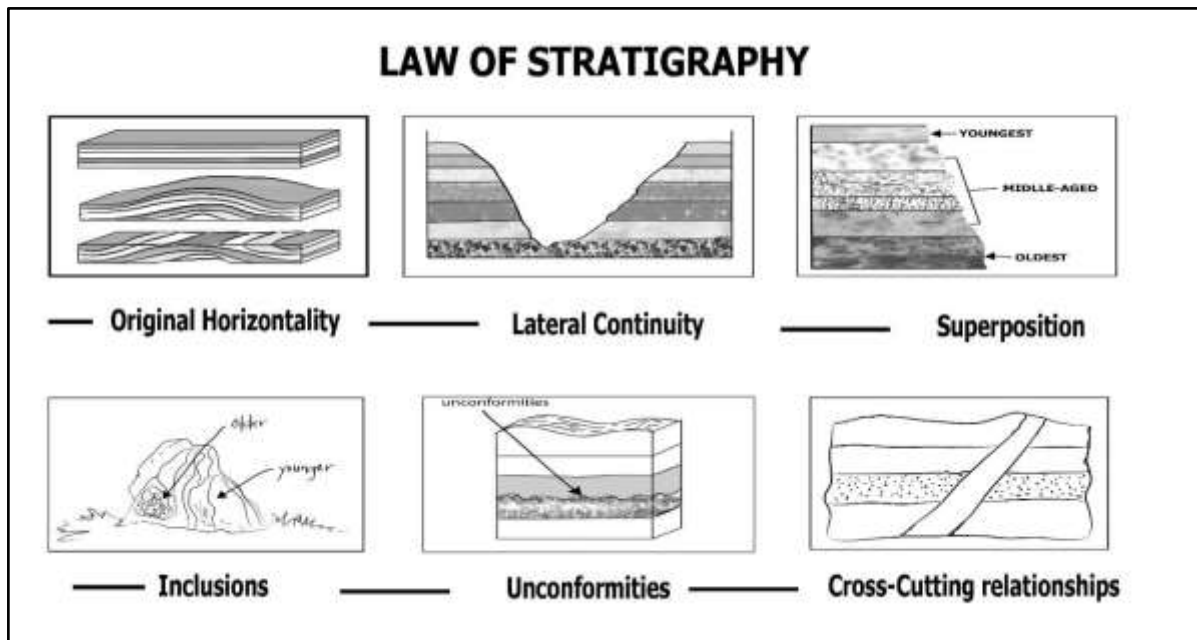
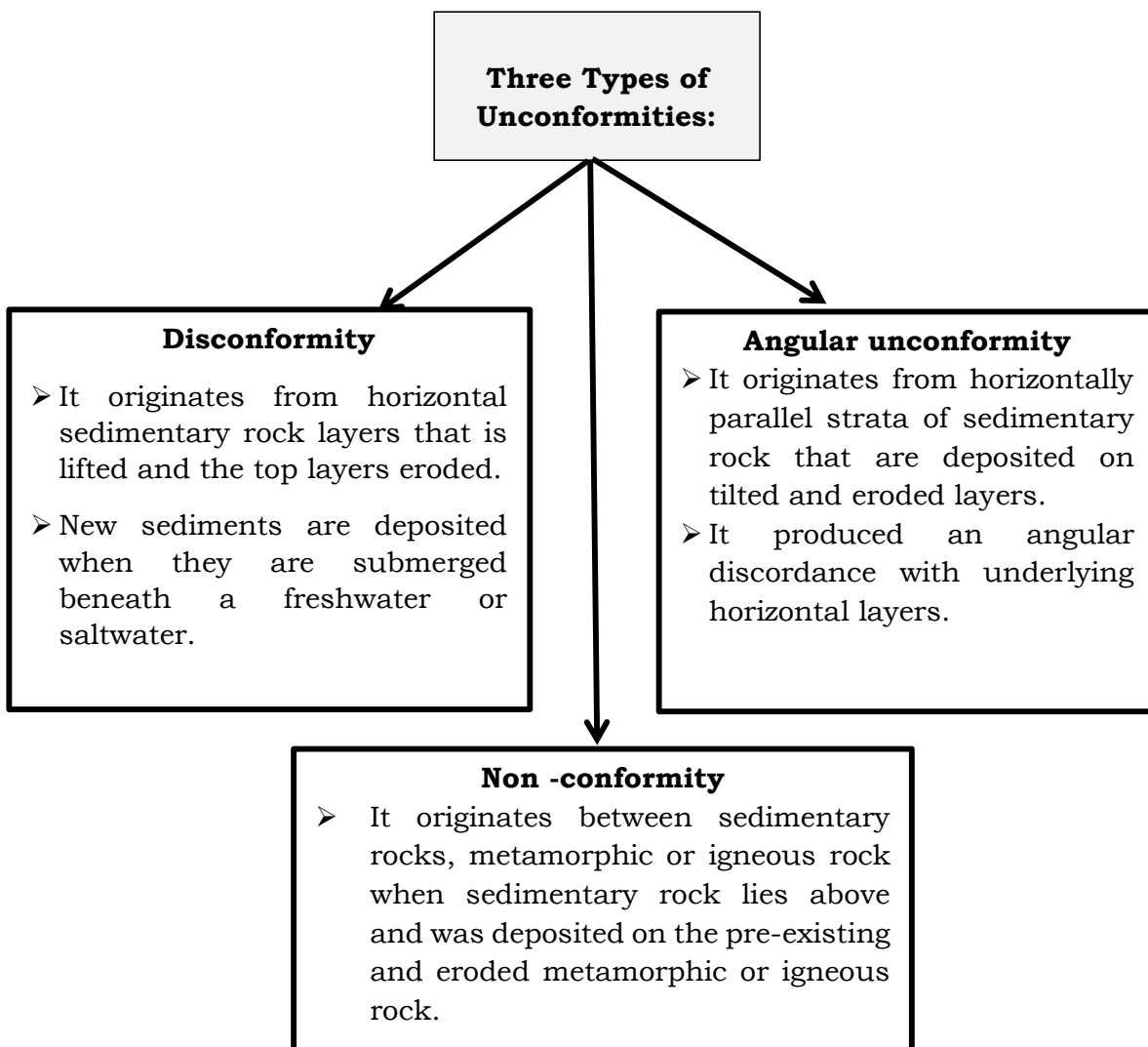


Figure 1. The Steno's Law of Stratigraphy



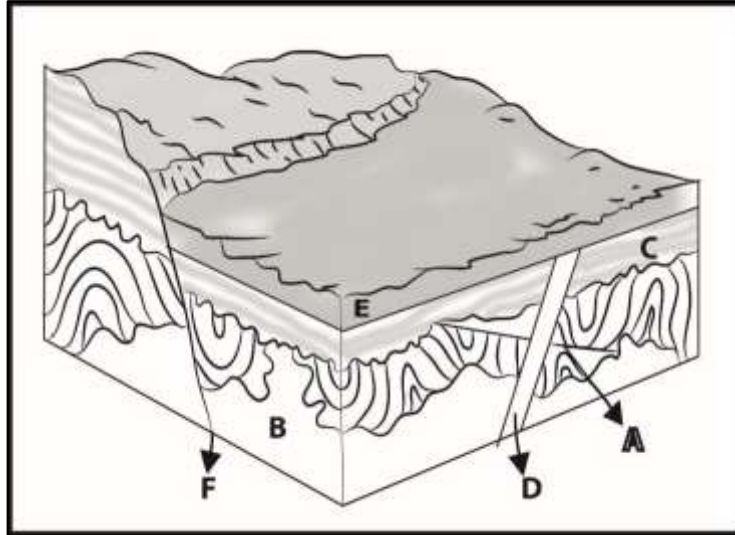
The Law of Stratigraphy shown -in Figure 1 indicates deposition, reshaping and deformations of the rock layers due to geological processes.



What's More

Activity 1.1 - Who's Older, Who's Younger?

The rock layers below labelled A to F undergo sedimentary process that results to changes in rock form. Use the diagram of a rock layer below to complete and answer the questions.



Guide Questions:

1. In what layer was the first rock formed? _____
2. What letter is the second layer of the rock? _____
3. What happens in the rock represented by letter D?(cutting,or insertiion)_____
4. What three layered letters is cut by letter D? _____
5. What takes place in letter F?(fault,folds) _____
6. What environmental factors occur in letter E?(weathering and erosion, volcanic eruption) _____
7. Which rock layer is the oldest? _____
8. Which rock layer is the youngest? _____
9. Which layer describes the law of horizontal continuity? _____
10. Which layer shows an angular conformity? _____

Activity 1.2 Word Pool

Read the words in the box and the statements below. Fill the blanks with the words/phrases that best complete the sentences.

cross-cutting	sedimentary
erosion	stratification
extrusive	superposition
fault	unconformity
intrusion	younger

1. The process in which sedimentary rocks are arranged in layer is called _____.
2. The law of _____ relationship happens when a layer of rocks torn apart and igneous rock fill in the spaces.
3. On the Earth's surface, weathering and _____ make rock fragments.
4. The law of _____ states that sedimentary rocks are layered from the oldest to the youngest and oldest rocks are found at the bottom.
5. A/an _____ is a break in the rocks that make up the Earth's crust, along which rocks on either side have moved past each other.
6. A/an _____ rock is formed when a magma never makes it to the surface.
7. In the law of _____, rock was uplifted, eroded from the surrounding rock, and will be replaced by sediments.
8. A/an _____ rock is formed by the accumulation, deposition, and cementation of organic particles or minerals.
9. When lava solidifies upon reaching the surface, it usually forms a/an _____ rock in rock layers.
10. Rock that form intrusions on other rocks is _____ than the other rock layer.

Activity 1.3 Match it!!!

Match the descriptions in Column A with the terms in Column B. Choose the letter of the correct answer.

COLUMN A	COLUMN B
1. Unconformities were sedimentary rock layers that are tilted forms a wave or angle in rock layers.	A. Superposition
2. Rock layers contains embedded fossils by which rock maybe identified.	B. Angular conformity
3. Magma intrude to the rocks, this magma is younger than the rock.	C. Cross cutting relationship
4. Exist between sedimentary and metamorphic rocks when sedimentary rocks lie above and were deposited in the pre-existing and eroded rocks.	D. Faunal Succession
5. Largest and heaviest rock layer that settled first at the bottom is the oldest rock layer:	E. Non conformity

Activity 1.4 Brain Pop

Study the rock strata in the right and try to answer the questions in the left.

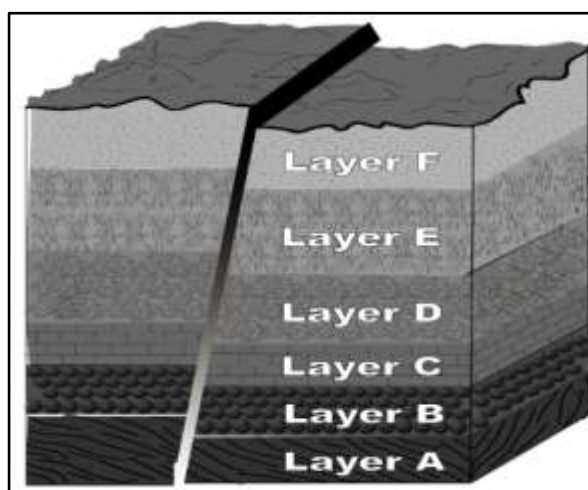
1. What geologic process takes place in cracks or breaks in the rock?

2. If an igneous rock is introduced in the breaks, what law of stratigraphy best explains this occurrence?

3. How will you characterize the dikes in the cracks, is it older or younger than layer F?

4. What law best describes the position of rock layers in layer A to F

5. Which is younger, layer F or the intrusions in the rock?



Lesson 2 Correlation of Rock Layers

Have you experienced playing or fitting cut out patterns or puzzle?

One of the evidences used by geologist in tracing the history of the Earth was with the identifications and the correlations of rock layers. Rock layers were subjected to alteration due to different geologic processes that act or apply on it. Such forces could result to tilting, uplifting, compression, and subductions of rock layers. These rock layers have the tendency to be separated from each other. One way of how these rock layers be identified is with the utilization of correlation.

Why do geologists need to correlate rock layers?

The history of earth is preserved in its rock layers. Unfortunately, no single location on earth has a continuous set of layers due to erosion or ceased deposition. Instead, geologists study rock sequences at many different places around the world, measure the depth of the layers, record what kind of rock is in each layer, and see if there are any fossils present. Geologists represent the layers of rock by drawing a picture of the sequence – this is called a **stratigraphic column**.

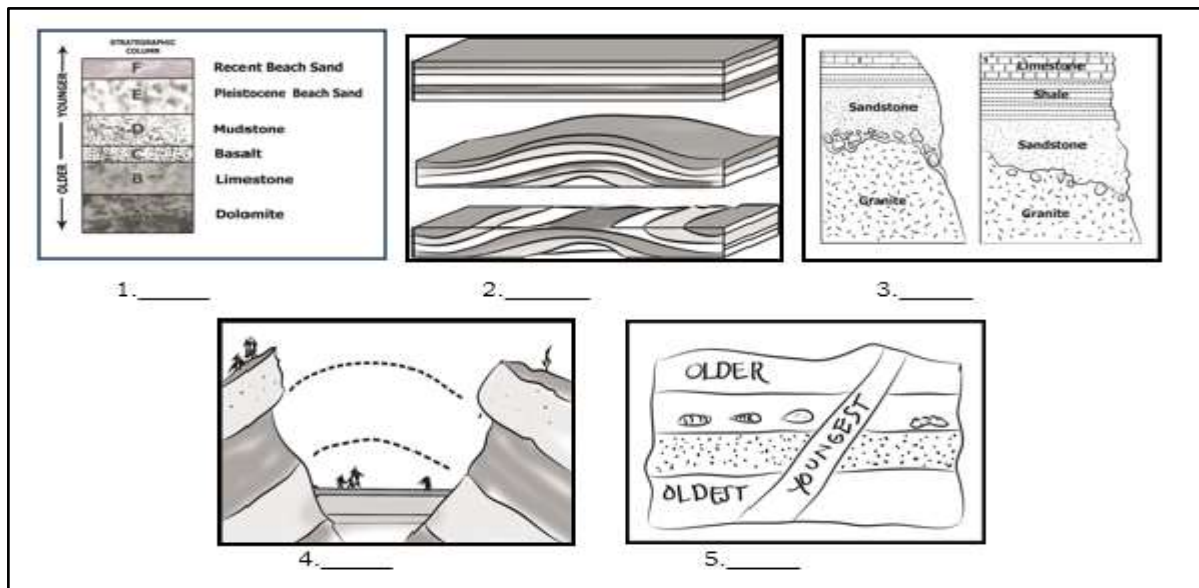
Geologists need to correlate rocks from one place to another to get more complete record of Earth's history over time. They try to determine the relative age of widely separated strata or rock layers. They used correlation trying to fit together sedimentary strata in different places just like a cut out puzzle.

What's In

In the previous lesson, you had learned that rock layers may undergo different formations due to several geologic process taking place in each rock layer. These concepts of stratigraphy are all stated in the Steno's Law of Stratigraphy.

Let us find out if you can still remember how this law can characterize each rock layer pictured below. Identify the pictures which is best explained by the Laws of Stratigraphy in the box below. Choose the letter of the correct answer.

- | | |
|-------------------------------|------------------|
| A. Original Horizontality | D. Superposition |
| B. Cross Cutting Relationship | E. Unconformity |
| C. Lateral Continuity | |



What's New

How do geologists correlate rock layers?

The process of showing that rocks or geologic events occurring at different locations are of the same age is called **correlation**. Geologists have developed a system for correlating rocks by looking for similarities in composition and rock layer sequences at different locations.

The geological technique of correlation provides information that have taken in Earth's history at various time that occurred. There are different methods in correlating rock layers, these includes:

1. Rock types and its characteristics

- color, texture, hardness, composition or its mineral content
- the harder and more densely packed the particles are, the older the rock and the deeper the layer it came from.

2. Index fossil

- also known as guide fossils or indicator fossils, are [fossils](#) used to define and identify [geologic periods](#) (or faunal stages)

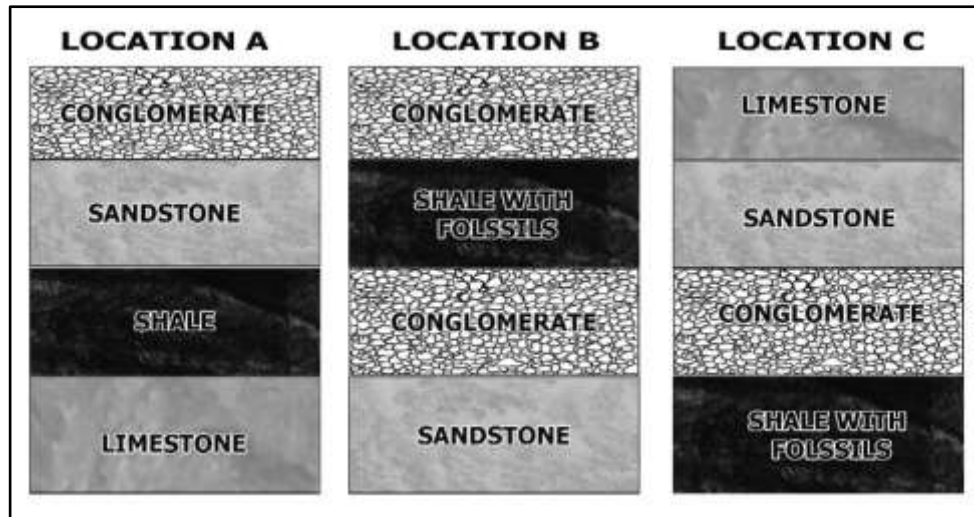
3. Bed rock

- a deposit of solid rock that is typically buried beneath soil and other broken or unconsolidated material (regolith).
- made up of igneous, sedimentary, or metamorphic rock, and it often serves as the parent material for regolith and soil.

How to match correlated rock layers?

Matching of rock layers may be determined by merely looking at its features. Look at the three columns of rock layers below. Let us determine how they are correlated.

Figure 2. Stratigraphic Column in Different Location



These three columns represent rock layers from three separate locations or outcrops. Some columns may be missing layers due to erosion. No single column represents a complete record. Your job is to line them up so a complete record of the region can be seen. Find one or more layers present in all columns that can be matched like a puzzle.

Figure 3. Stratigraphic Column Matching up of Rock Layers

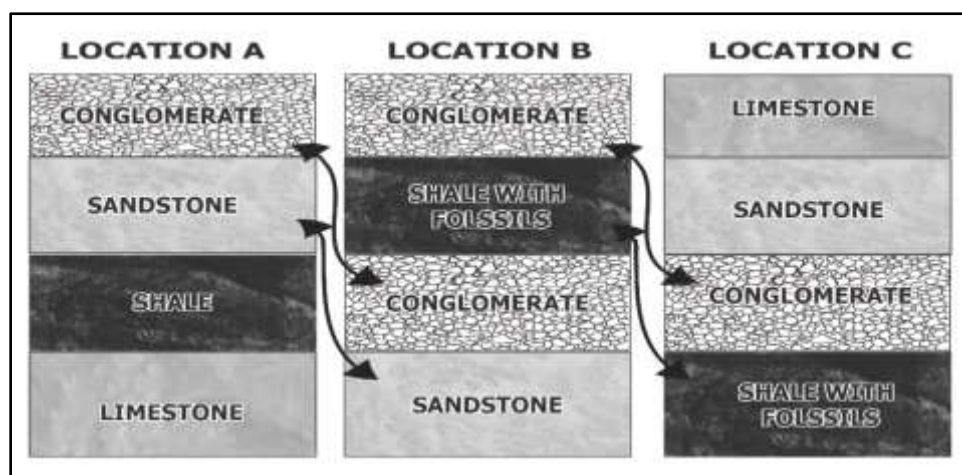
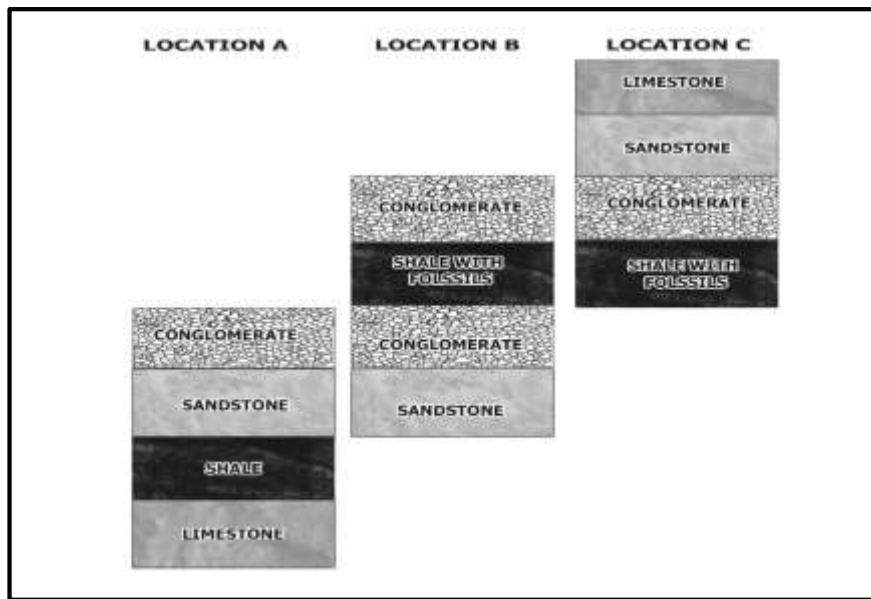


Figure 4. Strategic Column Fitting of the Rock Layers



After matching correlated rock layers, we can determine the relative age of each layer according to the law of superposition. Limestone in location A is the oldest and limestone in location C is the youngest rock layer. While those rock layers having the same composition, textures, and fossil content were considered as rock layers with the same age.

In matching up rock layers, superposition and cross-cutting are helpful. When rocks are touching one another, the lateral continuity rock layers aid to match up with the layers that are nearby. Geologists then match, or correlate, the different shorter sequences to create a geological column that spans further back into earth's past.

Correlations involve matching a particular rock unit in one exposure with its counterpart at a different locality. By correlating various rock vulnerability separated by great distances, geologic maps can be constructed and the original geographical extent of the rocks can be estimated.

Types of Correlation

A) Physical Correlation is accomplished by using number of criteria such as color, texture, and types of minerals contained within a stratum which make it possible for geologists to classify a particular stratum specifically.

B) Fossil Correlation is a principle that geologists use to determine the age of rock. It uses fossil with unique characteristics, such as geologically short lifespan and easily identifiable features and use this information to estimate the age of a rock layer in other areas that contain the same type of fossil or group of fossils.

There are fossils which are used to date the layers of rock that they are found in. Fossils that can be used in this way are called **index fossils**, and rock layers with the same index fossils in them can be correlated.

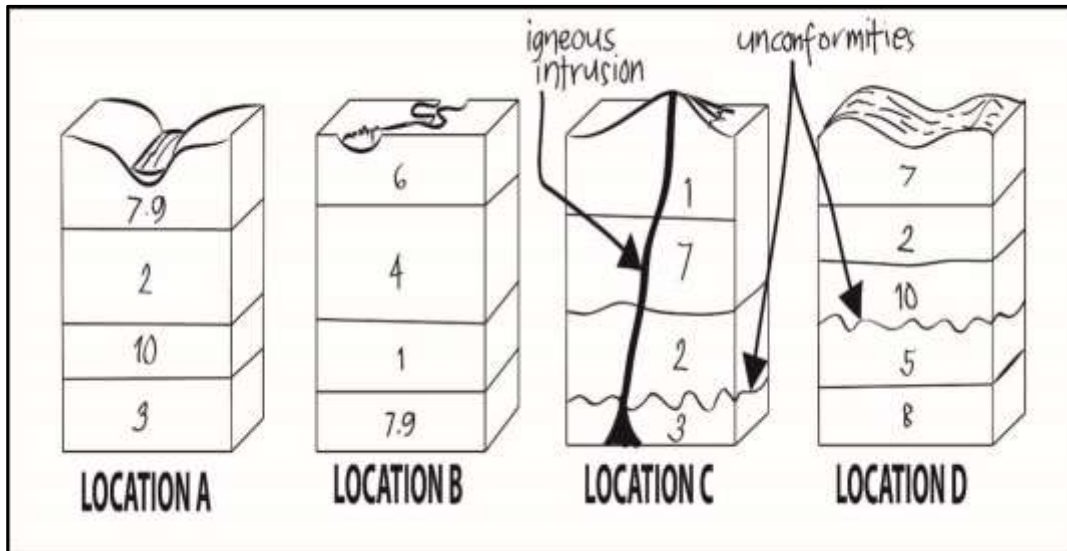
Criteria to be considered in identifying index fossils includes:

1. The fossilized organism must be easily recognizable and it must be easy to identify because of its uniqueness.
2. Fossils must be geographically widespread, or found over large areas so that it can be used to match rock layers separated by huge distances.
3. Fossils must have lived for only a short time, so that it appears in only horizontal layer of sedimentary rocks.

What's More

Activity 1.5 Mind Tickle

- A. Look at the columns of rock layers. Analyze each figure and answer the questions that follow.



Analysis:

1. Arrange the rock layer from oldest to youngest. Use the number in the designated rock layers.

Youngest _____

Oldest _____

2. Is the intrusion of igneous rock younger or older? _____
3. What rock layer is common in each rock column? _____

4. What environmental condition takes place in rock layer no.3? (fault, erosion)
5. In what earth's feature is the rock layer in outcrop C probably located?
(volcano, sea)
6. Which outcrop/s show examples of unconformity? _____
7. What type of igneous rock maybe deposited in outcrop C? (batholith, granite)
8. Which layer is considered as the beds? _____
9. Which outcrop/location shows subsidence? _____
10. What geologic process happens in outcrop B? (folding, fault)

B. Building Vocabulary Words

Unscramble the letters of the term/s being described by the given statement.

TERMS	DESCRIPTIONS
1. N T U I S O I R N	It is the action of process of forcing body of igneous rock between sedimentary rocks.
2. D X N E I S S O F L I	- It is used to define and identify geologic periods.
3. N E O R I S N O	-The action of surface processes that removes soil, rock, or dissolved material from one location to another.
4. K R O C Y S R L E A	It is made up of sedimentary and igneous rock that was formed at the Earth's surface.
5. N O R L T O I E C R A	The process of showing that rocks or geologic events occurring at different locations are of the same age.

What I Have Learned

Activity 1.6 Sum It Up!!!

Read the statement in each item and choose the correct answer in the parenthesis. Identify the law or principle of stratigraphy being described by the given statement.

1. A piece of granite contained within a sandstone would be (older, younger) than the sandstone.
This is an example of the Principle of _____.

2. A fault cutting through a series of layers of rocks is (older, younger) than the rock layers.
This is an example of the Principle of _____.
3. In a series of layers, the youngest layer is on the (bottom, middle, top) of the sequence.
This is an example of the Principle of _____.
4. Sedimentary rocks that are folded must be (older, younger) than the forces which deformed them.
This is an example of the Principle of _____.
5. In undisturbed layers of rocks, sediments that form sedimentary rock are deposited in horizontal layers that are (younger, older)
This is an example of the Principle of _____.

Things to Ponder

- Most sedimentary rocks are laid down in flat, horizontal layers.
- Stratigraphy is the science that deals with characteristics of layered rocks and how these rocks are used to trace the history of the Earth.
- Stratification is the layering that happens in sedimentary and igneous rocks which formed at the surface of the Earth that comes from lava flows or other volcanic activity.
- Rock layers are called strata.
- Law of cross-cutting relationships happens when a fault or dike or magma that intrudes into the rock, is younger than the rock.
- Law of inclusions is when the rock mass with inclusion is younger.
- Law of original horizontality is a flat rock that maintains its horizontal layer without being distracted for a long period of time.
- Law of superposition states that older rock layer is found at the bottom while younger rock layer is found at the top.
- Law of faunal succession states that different rock layers contain particular fossils by which the rocks may be identified and correlated.
- Law of unconformity implies a substantial gap or break in rock layer sequence due to uplift and erosion.
- Index fossil are [fossils](#) used to define and identify [geologic periods](#).

What I Can Do

From the lists of human activities/practices, tell how these practices may trigger the alterations of rock layers.

<i>Human Activities/Practices</i>	<i>How it will affect the rock layers?</i>
1. Mining	
2. Quarrying	
3. Kaingin system of farming	
4. Converting elevated areas into subdivisions and roads	
5. Forest denudation	

Analysis:

1. Which in the list of human practices can be considered as detrimental to human and other living things?
2. What will be the impact of this human practices in geological processes such as weathering and erosion?
3. How will you address the result of these practices and its magnitude to the government since your generation are considered as the hope of the motherland?

Assessment

Directions: Read each statement and choose the letter of the correct answer.

1. What is the relative position of oldest rock layer as stated in the principle of Superposition?
 - A. at top
 - B. at the bottom
 - C. at the middle
 - D. at random location

2. Which process is involved when sedimentary rocks are arranged in layer?
 - A. Foliation
 - B. Deposition
 - C. Sedimentation
 - D. Stratification

3. Which term in the list is associated with rock layers?
 - A. Defoliation
 - B. Extrusion
 - C. Intrusion
 - D. Strata

4. What type of rock/s usually undergo cross- cutting on rock layers?
 - A. Igneous Rock
 - B. Stratified Rock
 - C. Sedimentary Rock
 - D. Metamorphic Rock

5. Why is there a need for correlation of rock layers?
 - A. It provides information that the rock layers are connected to each other long ago.
 - B. Fossils embedded in the rock layers serve as a proof of their correlation.
 - C. It gives the relative age of the rocks.
 - D. All of the above

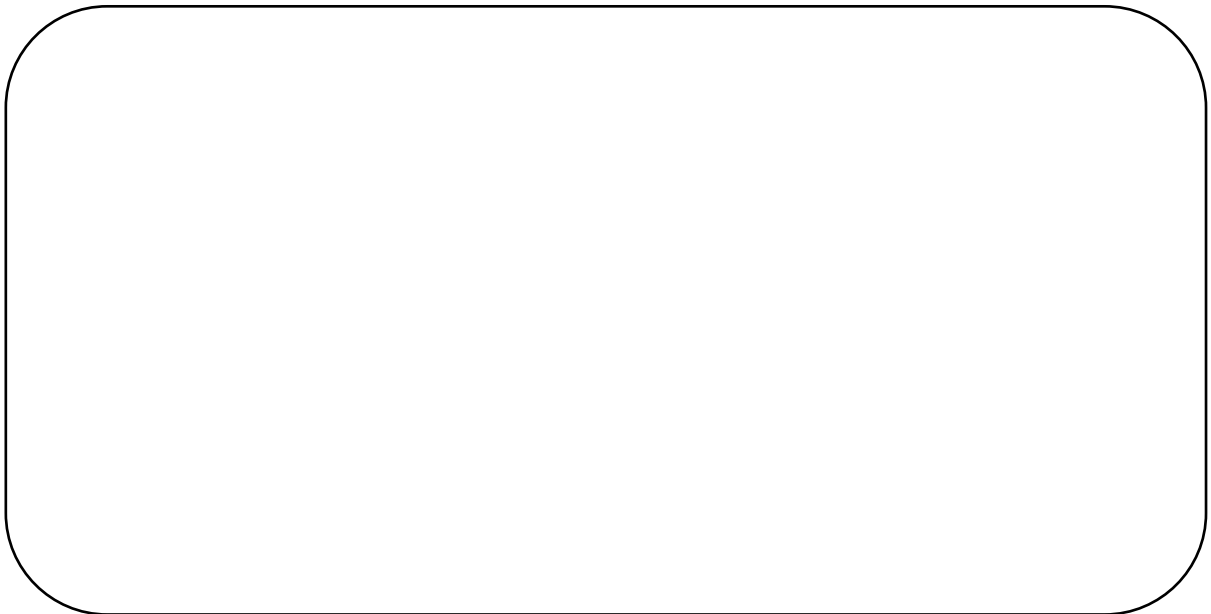
6. Which principles describes that geological processes operating at the present time are same processes that have operated in the past?
- A. Cross-cutting relationship
 - B. Original horizontality
 - C. Uniformitarianism
 - D. Inclusion
7. Which of the following shows a method of correlation?
- A. sequence of mineral content on rock
 - B. similarity of rock types
 - C. presence of index fossil
 - D. all of the above
8. If an igneous rock A cross cuts sedimentary rock B, what will be the relative age/position of igneous rock A?
- A. Igneous rock A will be on top of rock B.
 - B. Igneous rock A is older than sedimentary rock B.
 - C. Igneous rock A is younger than sedimentary rock B.
 - D. Igneous rock A is at the same age with sedimentary rock B.
9. Which of the following is NOT a type of unconformity?
- A. Angular
 - B. Uniformity
 - C. Disconformity
 - D. Nonconformity
10. When sedimentary rocks deposited in flat layers are left undisturbed it follows the statement in which of the given principles?
- A. Cross-cutting Relationship
 - B. Original Horizontality
 - C. Fauna Succession
 - D. Superposition

11. What can be inferred if you find an outcrop of mud cracks in gray shale?
It can be inferred that the area was once _____.
- A. a beach
 - B. a desert
 - C. a tidal flat
 - D. deep under the ocean
12. Which of the following occurrences alter rock layer quickly?
- A. earthquakes
 - B. rivers
 - C. snow
 - D. rain
13. What makes index fossils so useful in identifying the relative age of rocks?
- A. They are short-lived.
 - B. They are radioactive.
 - C. They are old enough to be analyzed.
 - D. They are present in both young and older rocks.
14. Which type of conformities state that sedimentary rocks, when tilted or folded, are overlain by more flat-lying layer of rock?
- A. Angular Conformity
 - B. Disconformity
 - C. Nonconformity
 - D. Inclusion
15. What will be the position of the youngest beds in an undisturbed sedimentary deposits?
- A. They stay at the bottom.
 - B. They are found on the top rock layer.
 - C. Youngest beds are separated from sedimentary deposits.
 - D. Neither b or c

Additional Activities

Illustrate an outcrop of a rock layer applying the principle or the laws of stratigraphy similar to your previous activity. Use the legend of what will be present in these particular layers in the outcrop. The guide of what you're going to put in your outcrop are found in the table below. Indicate them in your outcrop or block diagram. Be creative in presenting your output. Place your illustration in the box.

Label	Description
Lost before tilt	This was the last layer to be formed before the rocks tilted.
Oldest rock	The rock layer is below all the others.
Youngest rock	This is the younger rock above all the others.
Second oldest rock	The rock layer is just above the oldest.
Thinnest rock	It is the thinnest rock layer found between the fifth and the third rock layer
Above the erosion	This layer forms on top of earlier rocks after it was tilted and eroded away.



Answer Key

LESSON 1: Rock Layer What I Know 1. D 2. D 3. C 4. A 5. A 6. C 7. C 8. D 9. B 10. B 11. B 12. D 13. D 14. C 15. D ROCK LAYER What's in 1. Magma 2. Solidification 3. Igneous Rock 4. Weathering and Erosion 5. Sediments 6. Deposition and burial 7. Weathering and erosion 8. Sedimentary rock 9. Weathering and erosion 10. Metamorphism 11. Metamorphic Rocks 12. Heat and pressure 13. Melting 14. Weathering and erosion What's More ACTIVITY 1.1 1. B 2. A 3. Cutting 4. C,A,B 5. Fault 6. Erosion 7. A 8. E 9. C 10. B	ACTIVITY 1.2 1. Stratification 2. Cross-cutting Relationship 3. Erosion 4. Superposition 5. Fault 6. Intrusion 7. Unconformity 8. Sedimentary 9. Extrusive 10. Younger ACTIVITY 1.3 1. B 2. D 3. C 4. E 5. A Activity 1.4 1 Fault 2. Cross cutting 3. Younger 4. Superposition 5. Intrusion is younger LESSON 2: CORRELATION What's In 1. D 2. A 3. E 4. C 5. B ACTIVITY 1.5 A Youngest - 6 1 7.9 2 10 3 5 8 Oldest 2. Younger 3. Layer 7 4. Erosion 5. Volcano 6. Location C & D 7. Batholith 8. Layer 8 9. Location A or Outcrop A 10. Folding	ACTIVITY 1.5 B 1. Intrusion 2. Index fossil 3. Erosion 4. Rock layers 5. Correlation What I've Learned 1. Unconformity, younger 2. Cross cutting, younger 3. Superposition, top 4. Angular conformity 5. Original horizontality, younger Assessment 1. B 2. D 3. C 4. A 5. D 6. C 7. D 8. C 9. D 10. B 11. D 12. A 13. D 14. C 15. B
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Earth and Life Science

Relative and Absolute Dating

Earth and Life Science – Senior High School
Relative and Absolute Dating
First Edition, 2020

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What I Need to Know

This module was designed and written with you in mind. It is here to help you master the different methods in determining the age of stratified rocks. 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 covers:

- Lesson 1 – Relative and Absolute Dating

After going through this module, you are expected to:

1. differentiate relative from absolute dating through pictures presented; and
2. compare relative and absolute dating using comparison chart.

What I Know

Directions. Read the following questions and choose the letter of the correct answer. Write the chosen letter on a separate sheet of paper.

1. Which of these is the best indication of the relative age of a rock layer?
 - A. the thickness of the layer.
 - B. the chemical make-up of the layer.
 - C. the distance of the layer on the surface.
 - D. the position of the layer compared to other layers.
2. The absolute age of an igneous rock can best be determined by _____.
 - A. examining the environment in which the rock is found
 - B. examining the rock's relative position in a rock outcrop
 - C. comparing the amount of decayed and undecayed radioactive isotopes
 - D. comparing the size of crystals in the upper and lower parts of the rock
3. In an undisturbed rock file, the oldest rock is found _____.
 - A. on the topmost
 - B. at the bottom
 - C. upper part
 - D. lower part

4. The principle of horizontality is based on the observation that sediment usually accumulates in _____ layers.

- A. horizontal
- B. straight
- C. vertical
- D. round

5. Which of the following makes use of the position of rocks to determine its age?

- A. Relative Dating
- B. Absolute Dating
- C. Radioactive Dating
- D. Radiometric Dating

6. Which type of dating method can be used on rock layers by applying the Law of Superposition?

- A. Relative Dating
- B. Absolute Dating
- C. Radioactive Dating
- D. Radiometric Dating

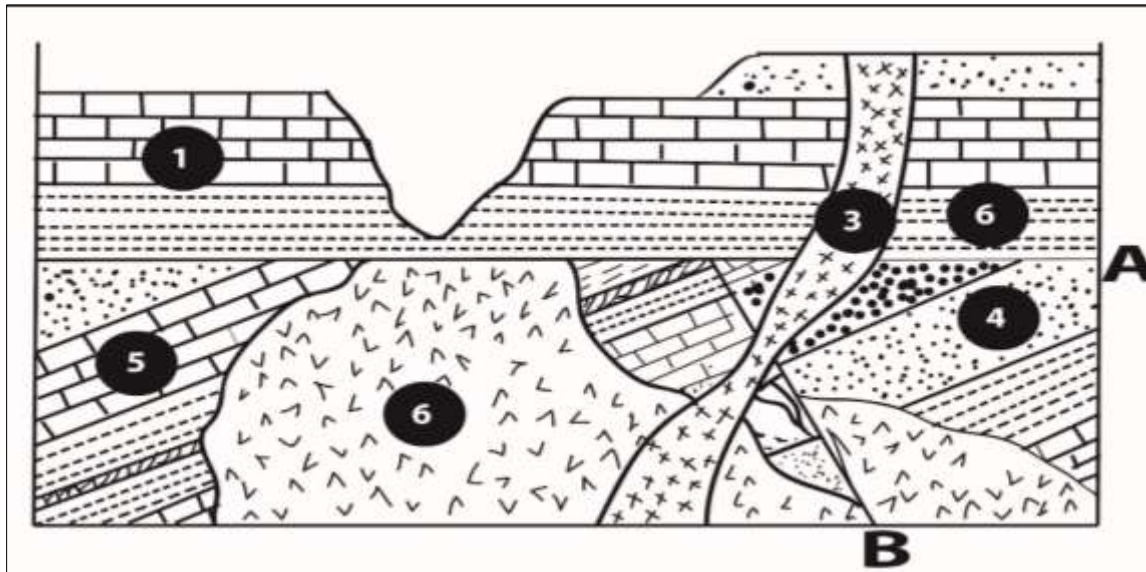
7. Which was the first method used to determine ages of rock and fossils?

- E. Relative Dating
- F. Absolute Dating
- G. Radioactive Dating
- H. Radiometric Dating

8. What is the difference between an absolute date and a relative date?

- A. An absolute date refers to a year or a range of years while a relative date indicates a chronological order.
- B. A relative date is derived from radiometric dating techniques while an absolute date comes from guesswork.
- C. A relative date refers to a year or a range of years while an absolute date indicates a chronological order.
- D. An absolute date involves testing of sedimentary rocks while relative date involves testing of igneous rocks.

Refer to the diagram below and answer the questions that follow.



9. Which layer of the rocks follows the principle of superposition?
 - A. Layer 1
 - B. Layer 3
 - C. Layer 4
 - D. Layer 6
10. Which layer of the rocks shows the cross-cutting relationship?
 - A. Layer 1
 - B. Layer 3
 - C. Layer 4
 - D. Layer 6
11. What method of Rock Dating is used in giving rocks an actual date?
 - A. Relative Dating
 - B. Absolute Dating
 - C. Historical Dating
 - D. Geological Dating
12. Which of the following is NOT true about Relative Dating?
 - A. quantitative method of dating
 - B. principles to recognize the relative ages of rocks
 - C. used stratigraphy method (oldest found at the bottom and youngest at the top)
 - D. used to arrange geological events and the rocks they leave behind in sequence
13. Which of the following is a principle of Relative Dating?
 - A. Principle of Half-life
 - B. Principle of Layering
 - C. Principle of Superposition
 - D. Principal of Floral Succession

14. Which of the following is NOT true about Absolute Dating?

- A. quantitative method of dating
- B. principles to recognize the relative ages of rocks
- C. used to give rocks an actual date or date range, in number of years
- D. use radiometric method by radioactive decay: concept of isotopes and concepts of half- life

15. What method of Rock Dating is using stratigraphy method?

- A. Relative Dating
- B. Absolute Dating
- C. Historical Dating
- D. Geological Dating

Lesson 1 Relative and Absolute Dating

How old is it? This might be the first question that will enter your mind when you see an old rock or artifact. Certainly, that is one of the first thing that a geologist wants to know.

Geologists find ways on how to determine the age and traces of history from the large number of artifacts and monuments bestowed upon us by older civilization.

There are methods and techniques used by geologists to help them determine the age of the materials that evolved in the past. In this lesson, the relative and absolute dating processes will be discussed.

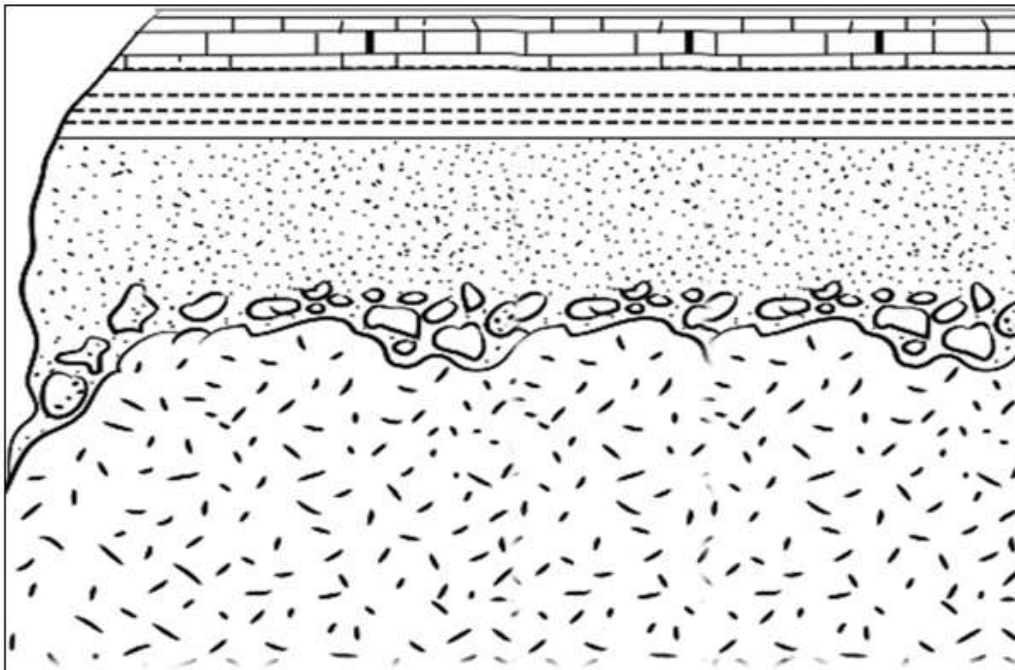


Figure 1. Rock Layers ¶

What's In

Activity 1: Solving the Earth's Puzzle!

Directions. Find and encircle relevant words from the puzzle. Then, write an appropriate sentence using the identified words.

A	F	F	E	N	D	F	I	N	D	C
D	R	O	C	K	S	A	J	H	T	O
M	F	S	R	E	L	A	T	I	V	E
A	H	S	A	R	A	G	L	S	U	A
B	H	I	O	T	I	E	A	T	S	R
C	G	L	R	Z	Y	S	Y	O	A	T
A	B	S	O	L	U	T	E	R	N	H
D	A	B	S	P	I	O	R	Y	O	R
E	F	S	U	L	I	T	S	O	C	O

Guide Questions:

1. How did you find the activity?

2. What are the difficulties encountered in finding words? How about in making a sentence?

3. Can we relate solving puzzle in solving the history of Earth? How?

What's New

We have learned that geologic time is measured in two ways: relative and absolute age. Relative date or age measurement refers only to the order in which events occurred. On the other hand, absolute age is age in years. It tells the order in which events occurred and the exact amount of time that has passed since they occurred.

Activity 2: What's in the Stack of Rock?

Directions. Look at the diagram of a rock layer. Focus on the sediment layer.

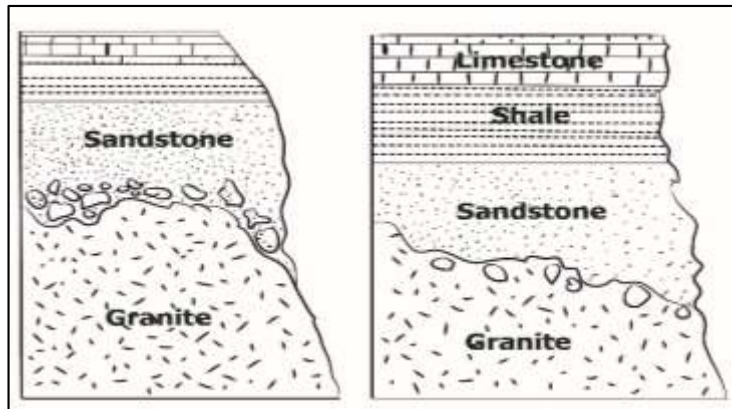


Figure 1. Sedimentation

Guide Questions:

1. How will you describe the rocks in the illustrations?

2. What is/are the use/s of this layering to the geologists?

3. At which pile of rock can you find the oldest? youngest?
Justify your answer.

4. Can you determine the relative age of the rock based on the layering?
How about absolute age?

5. What does the thickness of each layer indicate?

What is It

Relative Age

Prior to absolute age measurements, geologists used field observations to determine the relative ages. They used simple principles in order to get the relative ages. The following are the principles used by the geologists:

The **principle of original horizontality** is based on the observation that sediment usually accumulates in horizontal layers. Tectonic forces tilted or folded rocks into an angle after it was formed.

The **principle of superposition** states that sedimentary rocks become younger from bottom to top. This is because younger layers of the sedimentary always accumulate at the top of the layers. In figure 4, rocks number 5 are oldest and rocks in 1 are the youngest.

The **principle of crosscutting** relationships is based on the fact that rocks must exist before anything else happened like intrusions or dike-cutting across rocks. In figure 5, the cut rock layers are older than the rock that cuts across them.

The **principle of faunal succession** states that species succeeded one another through time in a definite and recognizable order and that the relative ages of sedimentary rocks can be therefore recognized from their fossils. The absence or the presence may be used to give a relative age of the sedimentary where they are found.

The **principle of lateral continuity** explained that layers of sediment are continuous. Layers with same rocks but separated by a valley or erosion are initially continuous.

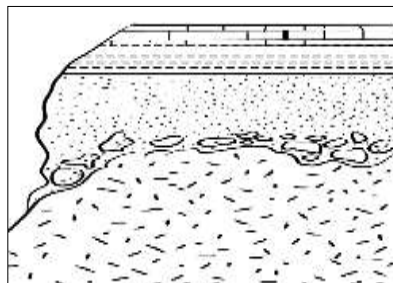


Figure 2. Horizontal layers

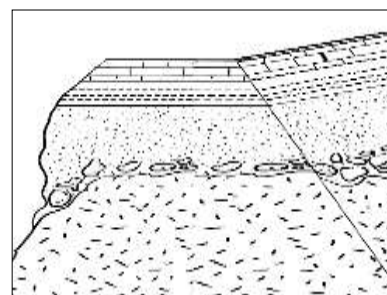


Figure 4. Tiltation after deposition into horizontal layers

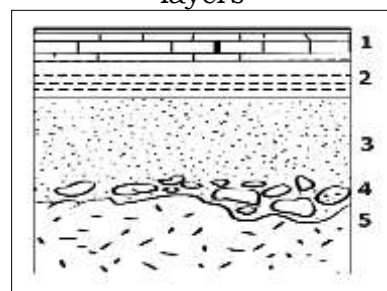


Figure 5. The principle of superposition

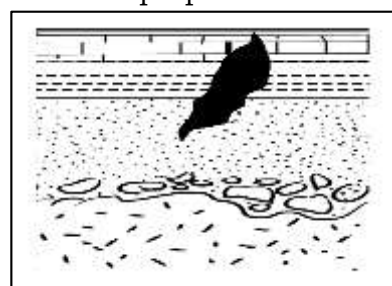


Figure 6. Horizontal layers with dikes

Activity 3: A. Who's the Oldest?

Directions. Use the letters in the diagram below to determine the age of rocks applying the method of relative dating. List the rock layers from youngest to the oldest relative to age.

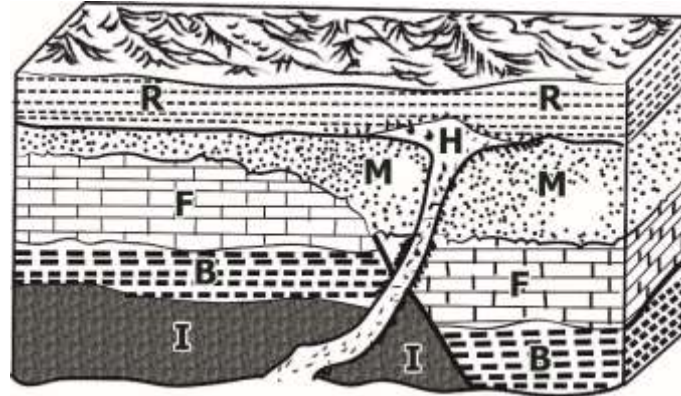


Figure 7. Rocks layers and dikes

Guide Questions:

1. In the law of superposition, which layer is the oldest?

—

2. What is the relative age of igneous rock in layer H? (younger or older)

—

3. What is the youngest rock layer?

—

4. What law/principle is represented by layer H as it passes through layer M, F, B, and I?

—

5. Which rock layer is older, layer B or layer F?

B. How many years?

Directions. Refer and analyze the diagram below to answer the provided questions.

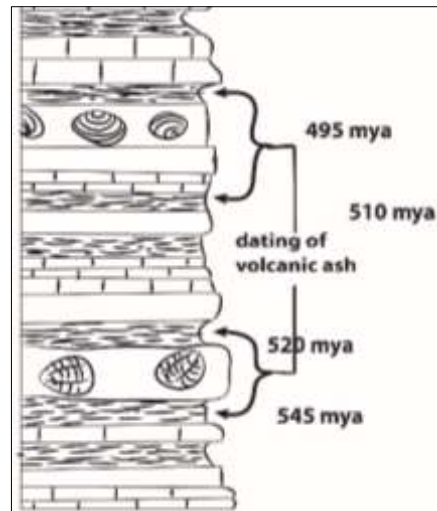


Figure 8. Rock Layers and Fossils

1. How old was the youngest rock layer?

2. How about the oldest rock layer?

3. What method is used in determining the age of rocks and fossils based on the diagram?

Absolute Age

Since change is the only thing that is permanent, the measurement of absolute age or exact date became a challenging task to the scientists. But they found a natural process that occurs at constant rate and accumulates its record of the radioactive decay of elements in rocks.

Radioactive elements decay because they are composed of unstable isotopes that decompose spontaneously. Each atom has a certain probability of decaying at any time. It has half-life or time for it to decompose into half.

Radioactivity is not affected by geologic process and easily measured in the laboratory. Aside from those, daughter isotopes accumulate in rocks. The longer the rock exists, the more daughter isotopes accumulate. The process of determining the absolute ages of rocks and minerals by measuring the relative amounts of parent and daughter isotopes is called radioactive dating.

e.g. a form of uranium changes (decays) to lead

In the previous example, the parent element is uranium (U) and the daughter element is lead (Pb).

Again, the process of radioactive decay can be used for dating rocks because: *Radioactive decay proceeds at a constant, regardless of changes in conditions such as temperature, pressure, or the chemical environment.*

Here are the commonly used radioactive isotopes in radioactive dating.

Table 1.1 Some Used Isotopes for Radiometric Dating

Parent Isotope	Daughter Isotope	Half-life (Years)	Effective Dating Range (Years)	Materials that Can be Dated Using this Isotope
Carbon-14	Nitrogen-14	5730	100-50000	Wood, shells, or anything that was once alive, Trapped Carbon dioxide
Potassium-40	Argon-40 Calcium-40	1.3 billion	40,000-4.6 billion	Muscovite Biotite Volcanic rock
Uranium 238	Lead 206	4.5 billion	10 million-4.6 billion	Zircon
Uranium 235	Lead 207	710 million	10 million-4.6 billion	Uranite

Half-Life

It is almost impossible to say when the last of the parent atoms will decay, but the time taken for half the atoms to decay is comparatively easy to predict. The half-life of a radioactive decay process is the time taken for half the original parent atoms to decay.

The length of half-life is a unique feature of each decay process. The half-life of the uranium is 713 million years. This means that if an igneous rock contained 1000 atoms of U-235 when it solidified:

After 713 million years, it would contain 500 atoms of U-235 and 500 atoms of the daughter element for the decay process, Pb-207.

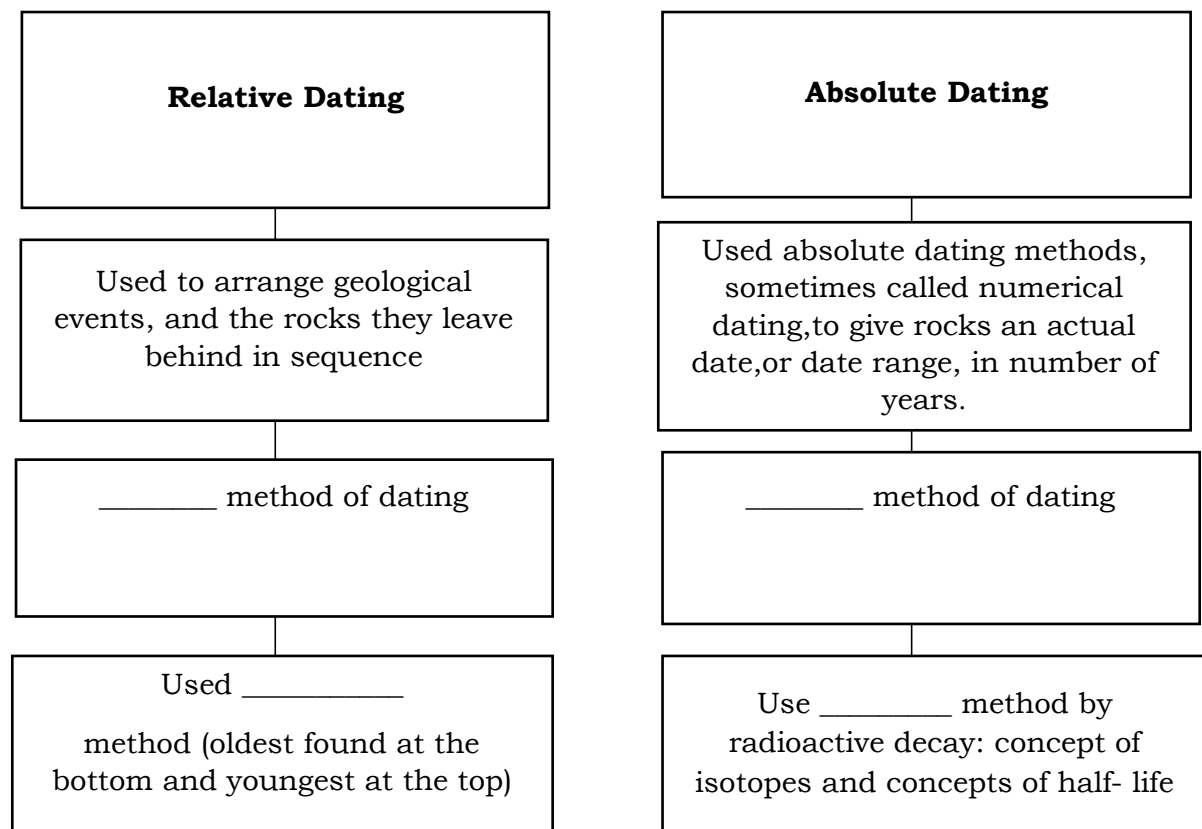
The proportion of parent atoms/daughter atoms present in an igneous rock gives the age of the rock — or the number of million years since the rock solidified

What's More

Activity 4: Relative vs. Absolute

Age of rocks can be determined by using two methods. These methods are absolute and relative dating.

Directions. Complete the concept map to show the differences between the two methods of dating.



Activity 5: Read and Fill!

Directions. Place the missing letters that best complete the term being described by each statement.

__b__l u__e D __ __i__g	1. It is used to determine the age of a material by using numeric values.
C__o__s C__t__i__g	2. It states that the geologic feature which cuts another is younger of the two features.
R__la__i__e __a__i__g	3. It is used to determine the relative age of rock layers.
__up__r__o__i__i__n	4. This law states that the younger layer is at the top and older layer of rocks are at the bottom.
Se__im__nt__ry __ o__ks	5. These are rocks that usually form deposits that files up and hardened.

What I Have Learned

1. In determining the age of rocks in relative dating, it follows the different principles such as: _____, _____, _____, _____ and _____.
2. _____ dating is used to arrange geological events, and the rocks they leave behind in sequence.
3. _____ dating is used to give rocks an actual date, or date range, in number of years.
4. Relative dating uses stratigraphy method while absolute dating uses _____ method by radioactive decay.
5. The _____ of a radioactive decay process is the time taken for half the original parent atoms to decay.

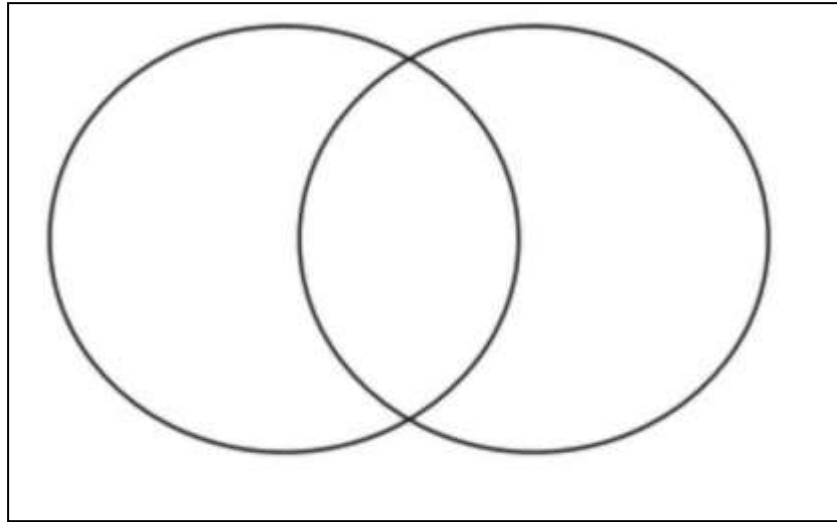
WORD POOL

Relative	Absolute	Superposition	Original Horizontality
Radiometric	Crosscutting	Stratigraphy	Lateral Continuity
Doubling	Half-life	Isotopes	Faunal Succession

What I Can Do

Activity 6: Venn Diagram

Directions. Fill in the Venn diagram to show the similarities and differences between absolute dating and relative dating. Use the words inside the word pool to complete the diagram.



Word Pool

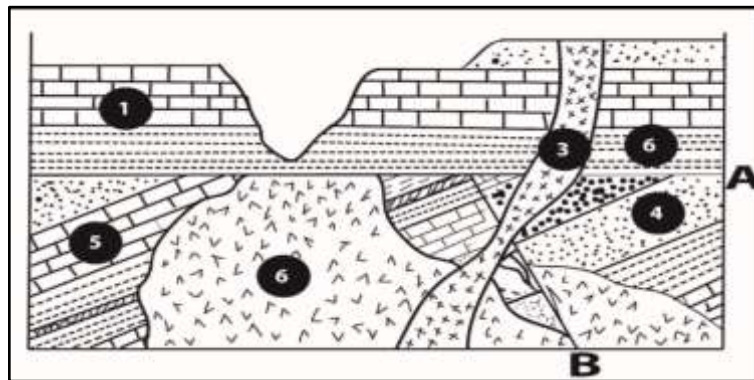
use of numeric value	qualitative method
quantitative method	use the position of rocks
radiometric method	stratigraphic method
used to tell the age of rocks	use sedimentary rocks
give an idea of the order of geologic events	does not give the true age of rocks

Assessment

Directions. Read the following questions and choose the letter of the correct answer. Write the chosen letter on a separate sheet of paper.

1. Which type of dating method can be used on rock layers by applying the Law of Superposition?
 - A. Relative Dating
 - B. Absolute Dating
 - C. Radioactive Dating
 - D. Radiometric Dating
2. Which was the first method used to determine ages of rock and fossils?
 - A. Relative Dating
 - B. Absolute Dating
 - C. Radioactive Dating
 - D. Radiometric Dating
3. What is the difference between an absolute date and a relative date?
 - A. An absolute date refers to a year or a range of years while a relative date indicates a chronological order.
 - B. A relative date is derived from radiometric dating techniques while an absolute date comes from guesswork.
 - C. A relative date refers to a year or a range of years while an absolute date indicates a chronological order.
 - D. An absolute date involves testing of sedimentary rocks while relative date involves testing of igneous rocks.
4. What method of rock dating is used in giving rocks an actual date?
 - A. Relative Dating
 - B. Absolute Dating
 - C. Historical Dating
 - D. Geological Dating
5. Which of the following is NOT true about Relative Dating?
 - A. quantitative method of dating
 - B. principles to recognize the relative ages of rocks
 - C. used to arrange geological events and the rocks they leave behind in sequence
 - D. used stratigraphy method (oldest found at the bottom and youngest at the top)

Refer to the diagram below and answer the questions that follow.



6. Which layer of the rocks follows the principle of superposition?
 - A. Layer 1
 - B. Layer 3
 - C. Layer 4
 - D. Layer 6
7. Which layer of the rocks shows the cross-cutting relationship?
 - A. Layer 1
 - B. Layer 3
 - C. Layer 4
 - D. Layer 6
8. Which of the following is NOT principle of Relative Dating?
 - A. Superposition
 - B. Floral Succession
 - C. Original Horizontality
 - D. Cross-cutting Relationship
9. Which of the following is NOT true about Absolute Dating?
 - A. It is a quantitative method of dating.
 - B. It uses simple principles to recognize the relative ages of rocks.
 - C. It is used to give rocks an actual date, or date range, in number of years.
 - D. It uses radiometric method by radioactive decay: concept of Isotopes and concepts of half- life.
10. What method of rock dating is using stratigraphy method?
 - A. Relative Dating
 - B. Absolute Dating
 - C. Historical Dating
 - D. Geological Dating

11. Which of these is the best indication of the relative age of a rock layer?
- A. the thickness of the layer
 - B. the chemical make-up of the layer
 - C. the distance of the layer on the surface
 - D. the position of the layer compared to other layers
12. The absolute age of an igneous rock can best be determined by _____
- A. examining the rock's relative position in a rock outcrop
 - B. examining the environment in which the rock is found.
 - C. comparing the size of crystals in the upper and lower parts of the rock
 - D. comparing the amount of decayed and undecayed radioactive isotopes
13. In an undisturbed rock file, the youngest rock is found_____.
- A. on the topmost
 - B. at the bottom
 - C. upper part
 - D. lower part
14. The principle of horizontality is based on the observation that sediment usually accumulates in _____ layers.
- A. horizontal
 - B. straight
 - C. vertical
 - D. round
15. Which of the following makes use of the position of rocks to determine its age?
- A. Relative Dating
 - B. Absolute Dating
 - C. Historical Dating
 - D. Geological Dating

Additional Activities

If you will be asked to determine the age of a rock, which method will you use?
Justify you answer.

Answer Key

What's More Activity 4 1. Qualitative / Quantitative 2. Stratigraphy / Radiometric dating Activity 5 1. Absolute dating 2. Cross-cutting 3. Relative dating 4. Superposition 5. Sedimentary rocks	What's in Activity 1 Rocks, Relative, Absolute Fossils, History, Earth, Ages Sentences may vary.	What I Know 1. D 2. C 3. B 4. A 5. A 6. A 7. A 8. A 9. D 10. B 11. B 12. A 13. C 14. B 15. A
What's New Activity 2 1. Horizontal layers 2. Give relative age of rock/fossils 3. Bottom/Topmost Reason: Original Horizontality 4. Yes, No 5. Thick, large deposition happened Thin, erosional activity worn the sediments	What is It Activity 3.a 1. Layer I 2. Younger 3. Layer R 4. Cross cutting relationship 5. Layer B Activity 3.b A. 495 mya B. 545mya C. Absolute dating	Assessment 1. A 2. A 3. A 4. B 5. A 6. D 7. B 8. B 9. B 10. A 11. D 12. D 13. A 14. A 15. A

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Earth and Life Science

Geologic Time Scale: Relative and Absolute Dating

Earth and Life Science
Geologic Time Scale: Relative and Absolute Dating
First Edition, 2020

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What I Need to Know

This module covers the scientific principles that the historical geologists used to describe the Earth's past. This will also serve as a guide to the clues that were left on Earth, the different events, and the time it took these events to happen which are depicted in the geologic time scale.

In this module, you will be able to determine the different divisions that comprise the geologic time scale which uses the two methods of record: the absolute and the relative dating.

The module is composed of the:

- Lesson: Geologic Time Scale: Relative and Absolute Dating

After going through this module, you are expected to:

1. Name the divisions of the geologic time scale.
2. Characterize each major and subdivisions in the geologic time scale.
3. Describe how relative and absolute dating provide evidence of geologic history.

What I Know

Before you use this module, take the **Pretest** below.

Directions: Read each item carefully. Choose the letter of the best answer and write the chosen letter on a separate sheet of paper.

1. Which division in the geologic time represents a time span of about 88%?
 - A. Cenozoic
 - B. Mesozoic
 - C. Paleozoic
 - D. Precambrian
2. Which of the following division in the geologic time scale is considered as the "Age of the Reptiles"?
 - A. Cenozoic
 - B. Mesozoic
 - A. Paleozoic
 - B. Precambrian
3. Which of these is the best indication of the relative age of a rock layer?
 - A. the thickness of the layer
 - B. the chemical makeup of the layer
 - C. the distance of the layer extends over the Earth
 - D. the position of the layer compared to other layers

4. In an undisturbed rock profile, where can the oldest be found?
 - A. in the middle
 - B. at the bottom
 - C. on the top
 - D. anywhere
5. In which of the given rocks is Radiometric dating least useful ?
 - A. granitic
 - B. basaltic
 - C. sedimentary
 - D. metamorphic
6. Which method was used in naming the subdivisions of the Earth's geology in a specific order?
 - A. isotopic dating
 - B. relative dating
 - C. absolute dating
 - D. radiometric dating
7. Which division in the geologic time shows evidence of molten rocks in the Earth's surface due to its high temperature?
 - A. Mesozoic Era
 - B. Precambrian
 - C. Miocene Epoch
 - D. Tertiary Period
8. What fraction of the Earth's history is embraced by the geologic time scale?
 - A. evolution of life
 - B. formation of Earth
 - C. formation of universe
 - D. formation of the solar system
9. How are the geologic eras largely determined?
 - A. earth's orbital position
 - B. shifts in the fossil record
 - C. average global temperature
 - D. distribution of rock sequences
10. In what geological periods did trilobites and other early arthropods appear?
 - A. Cambrian
 - B. Devonian
 - C. Permian
 - D. Eocene
11. In which geologic era do we currently live?
 - A. Cenozoic
 - B. Mesozoic

- C. Paleozoic
 - D. Proterozoic
12. From the lists of divisions in the geologic time scale, which is considered as the earliest?
- A. Hadean
 - B. Archaean
 - C. Quaternary
 - D. Phanerozoic
13. Which of the following does NOT represent the geologic time scale?
- A. the geologic history of universe
 - B. the fossil record of flora and fauna
 - C. the age of the Earth and its inhabitants
 - D. evolution of life dating back 4.6 billion years ago
14. What do you call the organism that is no longer existing on Earth?
- A. extinct
 - B. petrified
 - C. fossilized
 - D. sedimentary
15. Which geological era marks its end with the disappearance of the dinosaurs?
- A. Precambrian
 - B. Mesozoic Era
 - C. Miocene Epoch
 - D. Tertiary Period

Lesson 1 Geologic Time Scale

Deposition of sediments contribute to reshaping the surface of the Earth. Deposits are laid down by different environmental factors such as volcanic eruption, erosion, weathering debris of rocks (clay and silts) and even all its fossil content and historical information.

Earth history including its rock strata, the rock study, and discovery, as well as the fossils, are engraved in one of the most important materials known as geologic record. The geologic time scale is the “calendar” for events in Earth’s history.

The importance of Geologic time scale was, it serves as standard timeline used to describe the age of rocks, fossils, and the events that formed them. A device which is of great help to the science of geology owed to the explorations and studied made by the geologists that were recorded.

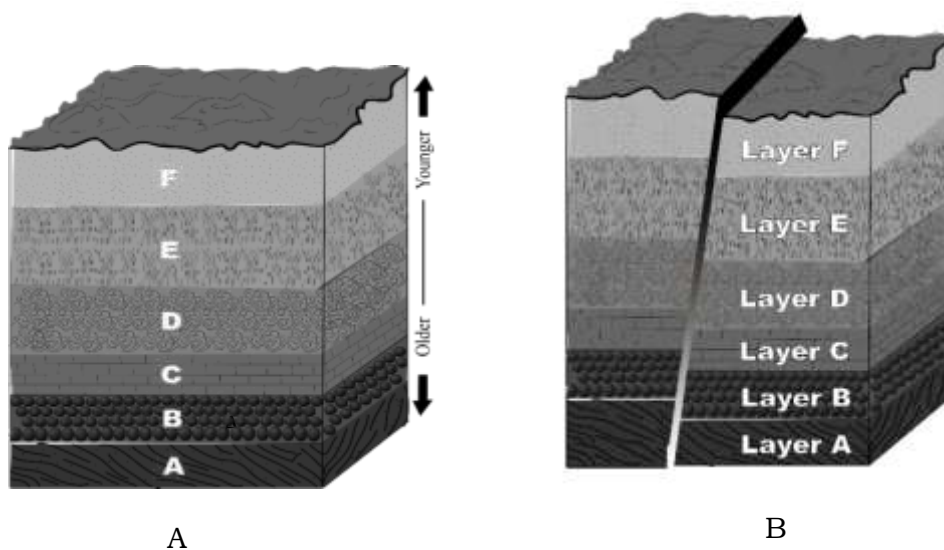
The necessity of knowing how life began in the past, the events, and principles behind the Earth's history enable us to conform with the alterations or consequences that we might encounter or experience in the near future. As a part of the new generation, we should be appreciative and accept that all things that are present in our time were the outcome of Earth's history.

What's In

In the previous lessons, you had learned that stratified rocks are products of sedimentary process which include weathering and erosion of pre-existing rocks. Wherein, these sediments will be transported by the agent of erosion such as water, wind, or ice, and deposited in seas and acted upon by the process of compaction and lithification. As time goes by, these sedimentary rocks will form layers or stratification representing periods of deposition of sediments. Based on this, there are several laws that governed stratigraphy as proposed by Nicolas Steno.

Nicolas Steno's Law of Stratigraphy opens our eyes to the world of rock layers and its formation. It also shows how endogenic and exogenic geological processes cause alteration in rocks that lead to the formation and deformation of rock layers.

Let us find out if you can still recall how these laws are depicted in the rock strata. Identify the law of stratigraphy the following diagrams represent.



Guide questions:

1. What laws of stratigraphy does the picture in letter A tell us?
2. In picture B, new rocks were introduced. What law is best explained in this kind of rock stratum?
3. How old is the rock that was intruded in stratum B?
4. What geologic processes existed in stratum B which causes its deformation?
5. If you want to determine the age of the rocks in the rock layer, what method are you going to use?

What's New

Sequence Drill

In a sequential manner, make five to seven relative events that happened in your life. For example, the day you were born, the day your brother or sister was born, or your first date with your boyfriend or girlfriend. Write your answer in the table below.

<i>Time Scale</i>			
<i>Relative Scale</i>		<i>Absolute Scale</i>	
I was born		I was born	Example (Jan.28,2001)

The way the relative events are arranged in your data is similar to how the geologists studied the Earth's history: its geological timescale of Earth's age and how it is determined.

What Is It

Since the beginning, geologists have been studying the Earth to unwrap the secrets of the past. They have been analyzing rock samples gathered from different continents in the world including its layers and its correlation with the fossils. This helps in relating the sequence of events in the Earth's history which is clearly presented in the geologic time scale.

The geologic time scale is divided into a series of time intervals which are equal in length. These time intervals are different from that of a clock. They are divided according to the significant events in the history of Earth such as the mass extinction of a large population of fauna and flora.

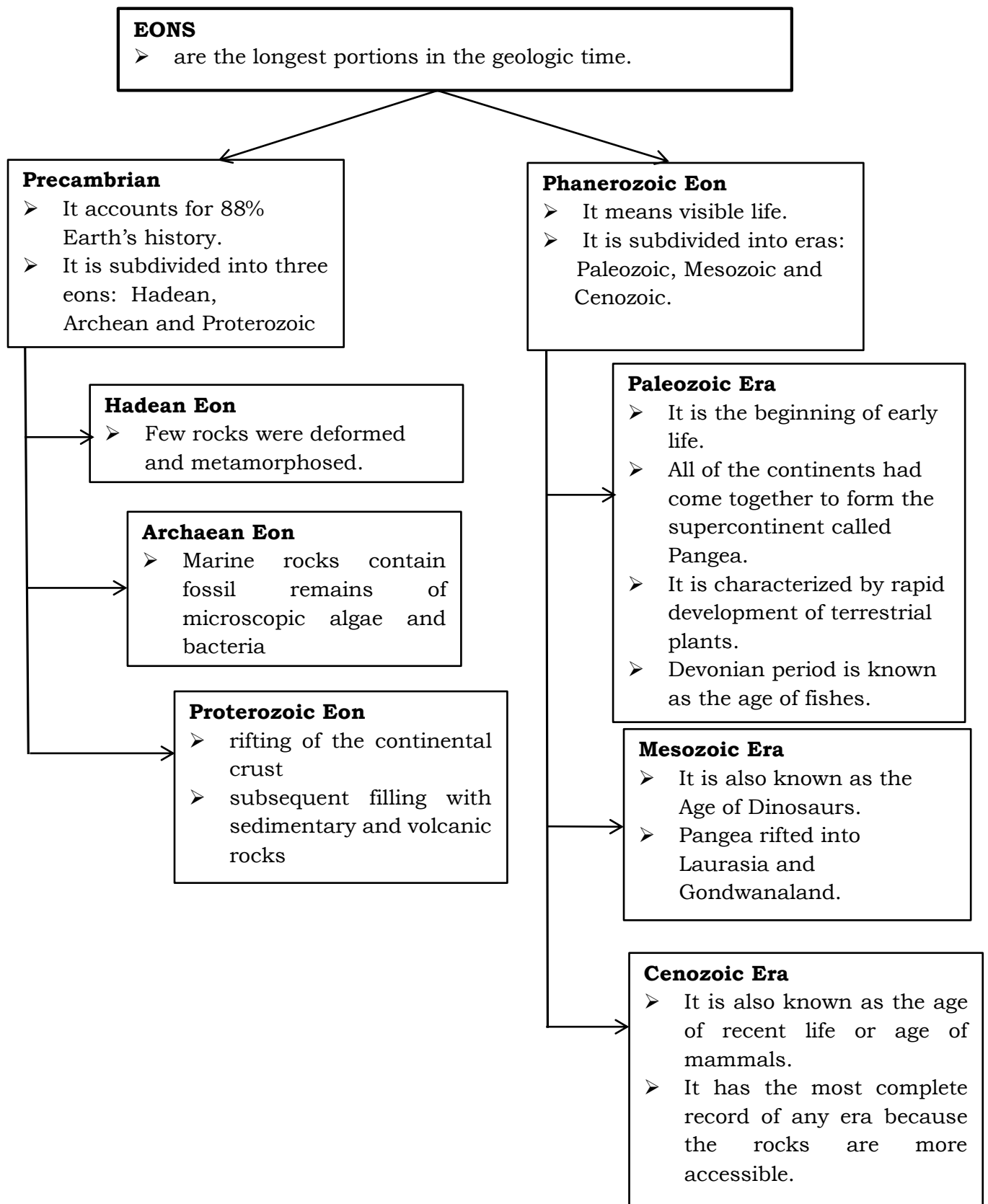
Table 2. Geologic Time Scale

<i>Eons</i>	<i>Era</i>	<i>Period</i>	<i>Epoch</i>	<i>Age (Mya)</i>
	Cenozoic	Quaternary	Holocene	0.01
			Pleistocene	1.8
			Pliocene	5.3

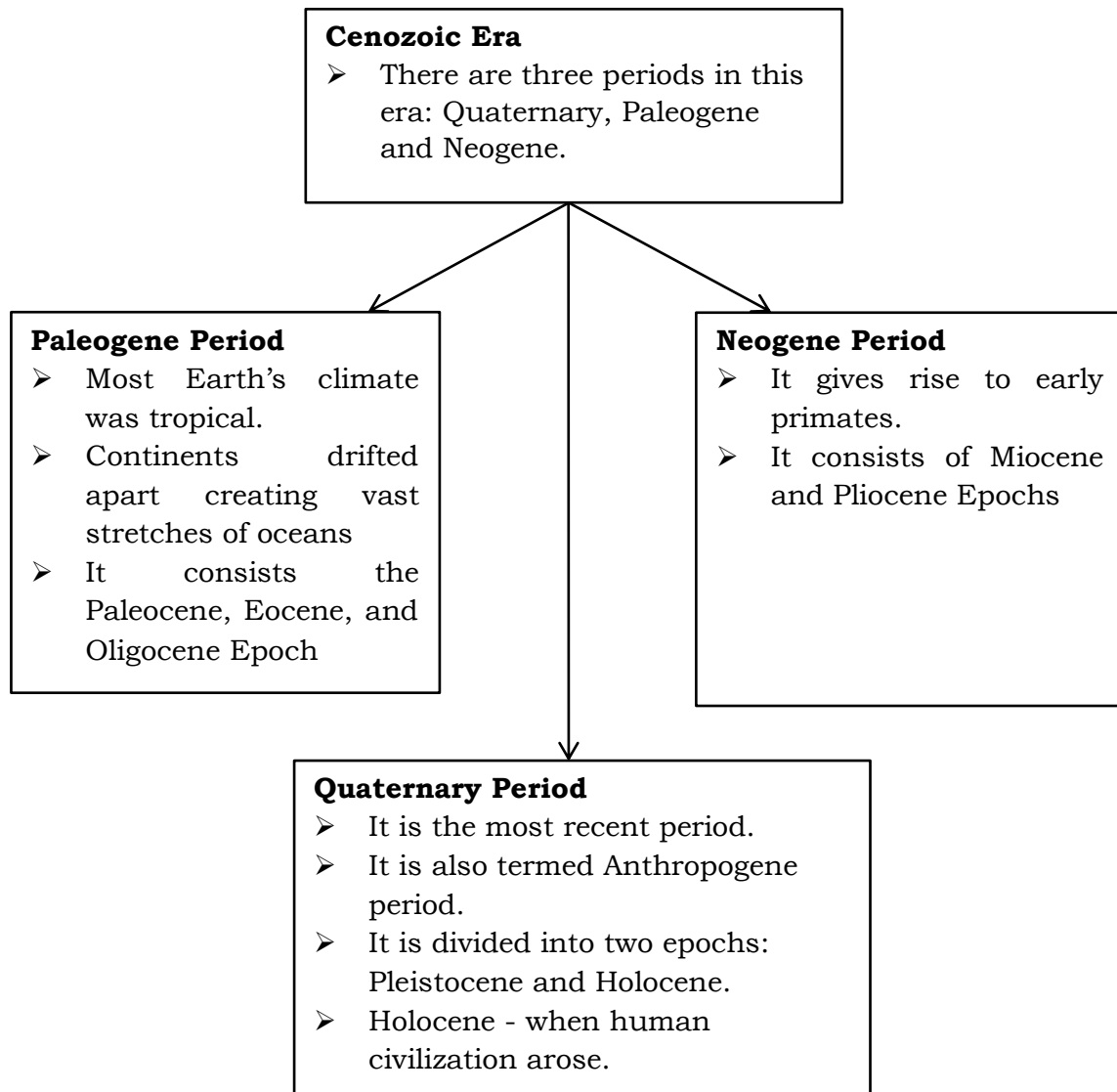
Phanerozoic			Tertiary	Miocene	23.0
				Oligocene	33.9
				Eocene	55.8
				Paleocene	65.5
		Mesozoic	Cretaceous		145
			Jurassic		200
			Triassic		251
		Paleozoic	Permian		299
			Pennsylvanian		318
			Mississippian		359
			Devonian		416
			Silurian		444
			Ordovician		488
Cambrian			542		
Precambrian	Proterozoic		bacteria and blue green algae		2500
	Archean		oldest fossil		3800
	Hadean		Beginning of earth		4600

The table represents the divisions of the geologic time in Earth's history are separated into eons, periods, and epochs. The Earth's age which is 4.6 billion years was separated into different span of time to handily indicate the events.

DIVISION IN THE GEOLOGIC TIME SCALE



DIVISION OF THE CENOZOIC ERA



Relative and Absolute Dating

Scientists first developed the geologic time scale by studying rock layers and index fossils. The information gathered by the scientists placed the Earth rock strata in order by relative age. Geologic time is often discussed in two forms: relative time and the absolute time.

Relative time is a subdivision of the Earth's geology in a specific order based upon the relative age relationships (commonly, vertical or stratigraphic position). These relative time can be established usually on the basis of fossils. On the other hand, absolute time refers to the numerical ages in millions of years or some other measurement. These are obtained by radioactive dating methods performed on appropriate rocks.

Relative time can be referred to as its physical aspects found in rocks while the absolute time refers to the measurements taken upon those to determine the actual time it expired. The time scale is depicted in its traditional form with the oldest at the bottom and the youngest at the top.

What's More

Activity 1.1 It's a Date

- Fill in the data table to show the number of millions of years each era lasted based on relative and absolute dating. Choose your answer from the given choices below.

- a. 4.048 mya c. 299 mya e. 4,600mya
b. 69 mya d. 184mya

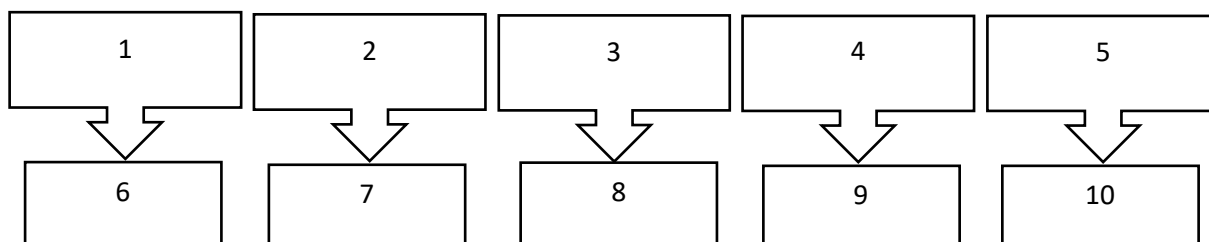
<i>The Divisions of Geologic Time</i>	<i>Percent</i>	<i>Millions of years</i>
The Age of the Earth	100%	
A. Cenozoic Era	1.5%	
B. Mesozoic Era	4%	
C. Paleozoic Era	6.5%	
D. Precambrian Time	88%	

Guide Questions:

- Based on the data table, which is the oldest era? _____
- How old is the shortest era? _____
- How old is the Cenozoic Era? _____
- What dating method is applied in the activity? Why? _____
- Where can we apply the relative dating method? _____

Activity 1.2 You Complete it

Complete the timeline of the geologic time scale starting from the oldest to recent time. Indicate each division and year. Use the data table in Activity 1.1 as reference.



Activity 1.3 Word Pool

Identify the term being described by the given statement. Select your answer from the word pool below.

Geologic record	Eons	Dinosaurs
Relative dating	Cenozoic	Sedimentary
Absolute dating	Holocene	Devonian
Archaean	Paleozoic	

- _____ 1. It is where all traces of history of earth is recorded in rocks that make up the crust.
- _____ 2. It is a way on how the age of rocks and fossils can be determined by its numeric value.
- _____ 3. It is the largest division in the geologic time scale.
- _____ 4. It refers to the rocks that are deposited and used in dating method.
- _____ 5. It is used to determine the geological events in rock strata.
- _____ 6. It refers to prominent reptiles that evolved during Mesozoic Era.
- _____ 7. The fitting of supercontinent Pangea happened in this era.
- _____ 8. The present human evolved during this age.
- _____ 9. It refers to the age of the fishes.
- _____ 10. Ancient bacteria and blue green algae existed during this age.

What I Have Learned

Activity 1.4 Vocabulary Building

Make a concept definition map for each of the vocabulary terms listed below. Write the term in the central box. Fill in the other boxes by answering the questions. The first term is done for you.

What information does it give?

gives clues about Earth's past

FOSSIL

What are some of its characteristics?

Usually found in sedimentary rock

Shows only hard parts of plant or animal

Shows changes in life and the environment

- A. Fossil
- B. Geologic Time Scale
- C. Relative Dating
- D. Absolute Dating

Things to Ponder

- Geologic time scale is a timeline that illustrates Earth's past.
- Geologic time scale describes the order of duration of major events on Earth for the last 4.6 billion years.
- Geologic time scale was developed after the scientist observed changes in the fossils and rocks going from oldest to youngest sedimentary rocks.
- Geologic time scale was divided into four divisions which include the Eons, Era, Period, and Epoch.
- Eons is the largest division in the geologic time scale.
- Relative dating or age is the order of the rocks from oldest to youngest.
- Relative dating does not determine the exact age of rock or fossils but does learn which one is older or younger than the other.
- Relative age of rocks based on the order gives its physical division in the geologic time scale.
- Absolute dating or age measures the amount of radioactive elements in rocks to give the ages to each division of time in the geologic time scale.
- Absolute time refers to the numerical ages in millions of years or some other measurement.

What I Can Do

Make a diary noting the important events that happened in your life for the day which you can associate with the geologic time scale.

<i>DATE</i>	<i>DAYS OF THE WEEK</i>	<i>EVENT/ACTIVITY</i>
	Monday	
	Tuesday	
	Wednesday	
	Thursday	
	Friday	
	Saturday	
	Sunday	

Assessment

Directions: Read each statement and choose the letter of the correct answer. Shade the circle that corresponds to the correct answer.

1. What information does the geologic time record provide?
 - A. the rate of fossil formation
 - B. the thickness of sedimentary rock layers
 - C. the time since the evolution of dinosaurs
 - D. the life forms and geologic events in Earth's history
2. How do geologists separate time into period?
 - A. by the time the fossil is discovered
 - B. by looking at the relative time of a fossil
 - C. by special events that have happened in that period
 - D. by counting the years that a fossil has been preserved
3. What do you call the method of placing geologic events in sequential order as determined by their position in the rock record?
 - A. correlation
 - B. uniformitarianism
 - C. relative dating
 - D. absolute dating
4. How important is absolute time?
 - A. It is useful if fossils are present.
 - B. It gives a specific date in an object.
 - C. It gives a non-specific date in an object.
 - D. It only gives the sequence in which events have taken place.
5. Which of the following is the primal in absolute dating method?
 - A. fossils
 - B. radioactive decay
 - C. educated estimates
 - D. cross-cutting relationships
6. Which method is primarily used to establish the geologic time scale?
 - A. calculation of beta decay of isotopes
 - B. correlation of rock types across vast
 - C. calculation of alpha decay of isotope
 - D. distances correlation of magnetic signatures in rocks
7. Which of the following era is sometimes called "the age of fish" or "ancient life"?
 - A. Cenozoic
 - B. Mesozoic

- C. Paleozoic
 - D. Precambrian
8. What will be the sequence of division in the geologic time scale, if the order of position is from shortest to longest?
 - A. era, period, epoch
 - B. epoch, period, era
 - C. period, epoch, era
 - D. epoch, era, period
 9. Scientists use a criterion to decide where to place the boundaries between the major divisions of the geologic time scale. They consider major changes. Where can these major changes be found?
 - A. written in the fossil record
 - B. occurring in the solar system
 - C. in structure of the Earth's layer
 - D. in the arrangement of the continent
 10. In which division in the geologic time scale did the continents come together to form the supercontinent called Pangaea?
 - A. Paleozoic Era
 - B. Cenozoic Era
 - C. Triassic Period
 - D. Jurassic Period
 11. In what ways do eras differ from periods?
 - A. They are longer spans of time.
 - B. They are subdivided into epochs.
 - C. They have longer durations than eons.
 - D. They have boundaries marked by mass extinctions.
 12. Which epoch in the geologic time scale represents human lives in a very short period of time?
 - A. Eocene
 - B. Pliocene
 - C. Holocene
 - D. Pleistocene
 13. Why are fossils recorded in the geologic time scale said to be incomplete?
 - A. Remains of past organism decayed faster.
 - B. Absence of tools to be used for tracing.
 - C. Most organisms never became fossils.
 - D. All of the above
 14. In what way does the geologic time scale place Earth's rock in order?
 - A. by composition
 - B. by relative dating

- C. by absolute dating
- D. by decades and centuries

15, What makes fossil essential to the scientists and to the history of the Earth?

- A. It analyzes the composition of sedimentary rock
- B. It predicts what organisms will become extinct.
- C. It describes the history of past life and environment.
- D. It presents temperature of the oceans in different depths.

Additional Activities

Create your own representation of geologic time scale on rocks indicating the relative and absolute dating. Use discarded material in your output.

Answer Key

- What's More**
Activity 1.3
1. Geologic records
 2. Absolute dating
 3. Eons
 4. Sedimentary
 5. Relative dating
 6. Dinosaurs
 7. Paleozoic
 8. Holocene
 9. Devonian
 10. Archaean

- What's More**
Activity 1.4
1. Geologic Time Scale
 - timeline that illustrates Earth's past
 - Characteristics
 - divided into eons, era, period, epoch
 - uses the relative and absolute dating
 2. Relate dating
 - gives relative age of rocks
 - Characteristics;
 - Uses the position of rocks
 - follows the law of stratigraphy
 3. Absolute Dating
 - gives the numeric age of rocks

- Assessment**
1. D
 2. B
 3. C
 4. B
 5. B
 6. B
 7. C
 8. B
 9. A
 10. A

- What's More**
Activity 1.1 Its a Date
1. E
 2. A
 3. B
 4. D
 5. C
- Answer:
1. D
 2. A
 3. B
 4. Absolute dating
 5. Precambrian is the oldest era because it is located at the bottom.

- What's More**
Activity 2
1. Precambrian
 2. Paleozoic
 3. Mesozoic
 4. Cenozoic
 5. Recent time
 6. 4.048mya
 7. 299mya
 8. 184mya
 9. 69mya
 10. 4600mya

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Earth and Life Science

Geologic Timeline

Earth and Life Science
Geologic Timeline
First Edition, 2020

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What I Need to Know

This module was designed and written with you in mind. It is here to help you master the nature of Biology. 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 covers:

- Lesson 1 – Geologic Timeline

After going through this module, you are expected to:

1. Describe how the Earth's history can be interpreted from the geologic time scale.
2. Define fossils and its type.
3. Determine the guide fossils that are used to define and identify subdivision of the geologic time scale.
4. Track the Earth's history using the geologic time scale.
5. Identify the different divisions in the geologic time scale.

What I Know

Choose the letter of the best answer. Write the chosen letter on a separate sheet of paper.

1. Which of the following does NOT belong to Paleozoic Era?
 - A. Jurassic
 - B. Devonian
 - C. Cambrian
 - D. Ordovician
2. What do you call the remains or evidence used as markers when building up the geologic time scale?
 - A. fossil
 - B. minerals
 - C. sandstone
 - D. piles of rock

3. Why do most of the eons and eras end in “zoic”?
 - A. because these time periods were recognized by the plants present at that time
 - B. because these time periods were recognized by the animal life present at that time
 - C. A and B
 - D. none of the above
4. In what type of rocks are fossils made of?
 - A. igneous rock
 - B. sedimentary rock
 - C. metamorphic rock
 - D. all of the above
5. What do you call the person who studies fossils and ancient life?
 - A. biologist
 - B. archeologist
 - C. anthropologist
 - D. paleontologist
6. What do you call the process by which the remains of ancient living things are turned into rock?
 - A. fertilization
 - B. fossilization
 - C. fragmentation
 - D. metamorphosis
7. How were the scientists able to arrange the fossils they gathered?
 - A. They were able to arrange the fossils according to age.
 - B. They were able to arrange the fossils according to structure.
 - C. They were able to arrange the fossils according to chemical content.
 - D. They were able to arrange the fossils according to place of discovery.
8. In this era, the rocks formed have fossils of animals and plants such as dinosaurs, mammals and trees.
 - A. Cenozoic Era
 - B. Mesozoic Era
 - C. Paleozoic Era
 - D. Phanerozoic Era
9. In what era did the first skeletal elements, soft-bodies metazoans, and animal traces exist?
 - A. Cenozoic Era
 - B. Mesozoic Era
 - C. Paleozoic Era
 - D. Late Proterozoic

10. In this period, the first mammals and dinosaurs existed.
- A. Cretaceous
 - B. Permian
 - C. Jurassic
 - D. Triassic
11. In Paleozoic Era, in what period did the first vascular land plant exist?
- A. Cambrian
 - B. Devonian
 - C. Silurian
 - D. Ordovician
12. These marine animals lived inside their shells, taking up the whole inside of the long shell.
- A. echinoderms
 - B. gastropods
 - C. mollusks
 - D. Sea arthropods
13. In what phylum do crinoids belong?
- A. echinoderms
 - B. arthropods
 - C. gastropods
 - D. mollusks
14. These were marine arthropods and were made of chitin, like some insects and other organisms like lobsters.
- A. crinoids
 - B. trilobites
 - C. fossil clam
 - D. gastropods
15. These marine animals are bivalves with two symmetrical shells – the shells are mirror images of each other.
- A. crinoids
 - B. trilobites
 - C. fossil clam
 - D. gastropods

Lesson 1 Geologic Timeline

Fossils are the remains or evidence of prehistoric plants and animals that have fossilized. Fossils were used as markers when building up the geologic time scale. The names of most of the eons and eras end in “zoic”, because these time periods were recognized by the animal life present at the time. Rocks formed during the Proterozoic Eon have fossil evidence of simple organisms, such as bacteria, algae, and wormlike animals. In the Phanerozoic Eon, the rocks formed have fossils of animals and plants such as dinosaurs, mammals, and trees.

And with that, geologists have developed the geological time scale, which divides the Earth’s history into eons that are subdivided into eras, which are further divided into periods and then into epochs. The geologic time scale is the “calendar” for events in Earth’s history. It subdivides all time since the end of the Earth’s formative period as a planet (nearly 4 billion years ago) into named units of abstract time: in descending order of duration, which are eons, eras, periods and epochs.

The geologic time scale provides a system of chronologic measurement relating stratigraphy to time that is used by geologists, paleontologists and other Earth scientists to describe the timing and relationships between events that have occurred during the history of the Earth. The detailed studies made of rocks throughout the world have allowed geologists to correlate rock units globally, and break them into time units. The result is the Geologic Time Scale, usually presented in a chart like form with the oldest event and time unit at the bottom and the youngest at the top.

What’s In

Activity 1

Review the vocabulary words and complete the activity on the other side of this worksheet.

1. **Fossils** – remains of ancient life that have been turned to stone
2. **Body Fossils** – actual parts of plants and animals that have been turned to stone (i.e. bone, shells, leaves)
3. **Coprolite** – fossilized dinosaur dung (scat)
4. **Fossilization** – process by which the remains of ancient living things are turned to rock
5. **Paleontologist** – a scientist who studies fossils and ancient life
6. **Sedimentary Rock** – rock made of layers of tightly packed sand and clay
7. **Sandstone** – a type of sedimentary rock that is made of sand
8. **Trace Fossil** – a fossilized sign that a plant or animal once lived in an area (i.e. footprints, coprolite)

9. **Porous** – full of tiny holes that water, air, and light can pass through
10. **Mineralization** – to convert into a mineral substance; to fill with a mineral substance

Instructions: Fill in the blanks, using vocabulary words.

Jay, a famous **p** _____ **t** _____, was hiking in the Cordillera mountains searching for **f** _____, which are remains of ancient life that have turned to stone. All of a sudden, the ground shook beneath him. Jay ran over a hill and saw that there had been a huge landslide. He went over to look at the piles of rocks and saw layers of **s** _____ **s** _____, a type of sedimentary rock. Fossils are found in sandstone, so Jay was excited to search through the rocks! Just as he began to dig, he found fossilized bones. The bones had turned to stone through a process called _____ **s s** _____. Jay saw that the fossils belonged to an Apatosaurus. These bones are examples of **b** _____ **i l** _____, which are fossilized parts of plants and animals. Jay hiked further up the mountain and found fossilized dinosaur dung, called **c** _____. He also found a huge footprint, which is an example of a **t** _____ **f** _____. Jay carefully removed the fossils from the rocks and donated them to a museum.

Activity 2: Find Me

Directions. Encircle the 8 words listed below. Words may appear straight across, back-word straight across, up, and down.

COPROLITE

PALEONTOLOGIST

FOSSILS

MINERALIZATION

SEDIMENTARY

SANDSTONE

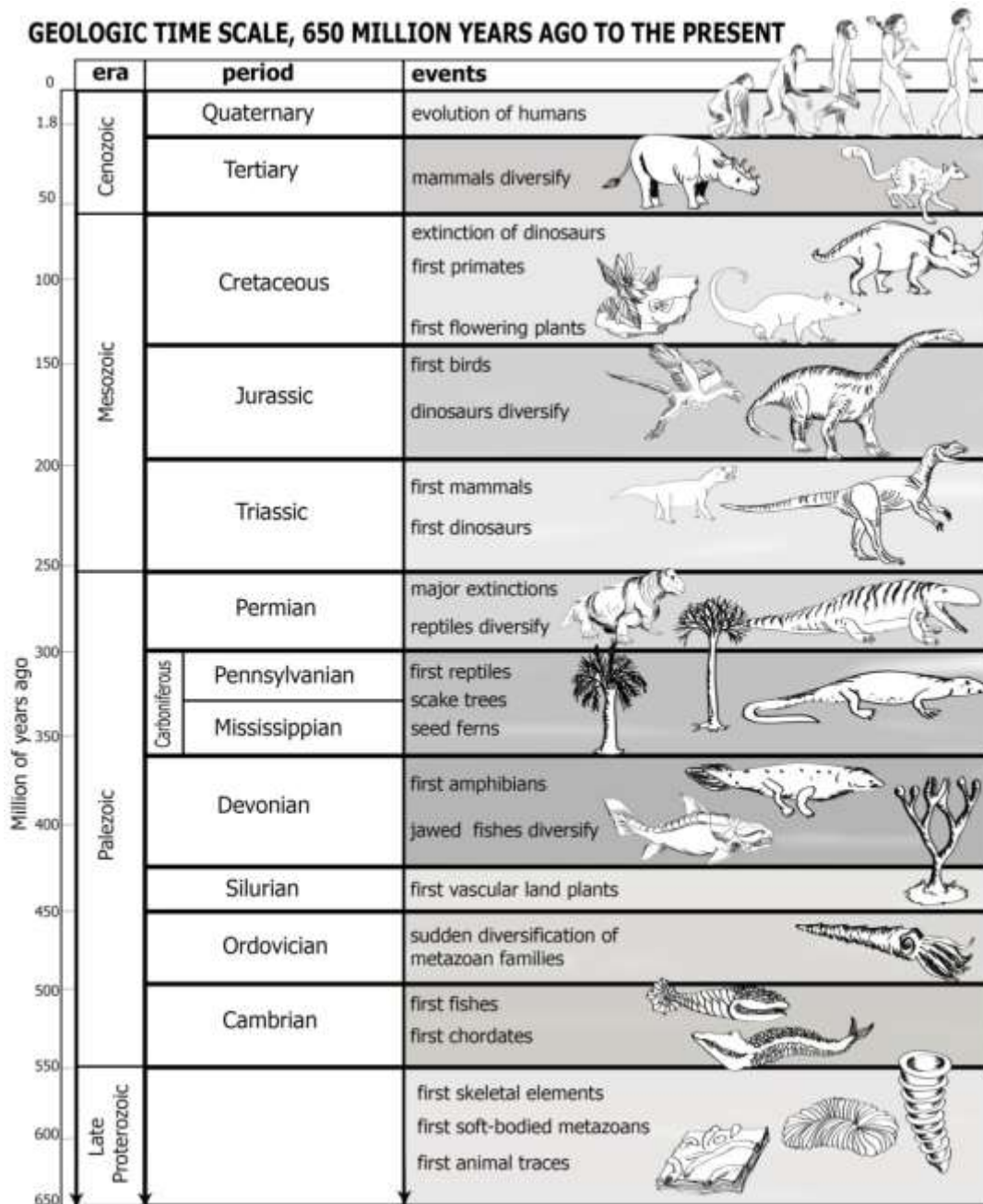
FOSSILIZATION

POROUS

L	N	O	I	T	A	Z	I	L	A	R	E	N	I	M
S	T	S	I	G	O	L	O	T	N	O	E	L	A	P
E	K	B	K	S	D	Z	U	I	L	I	H	K	M	F
D	C	L	T	J	Q	L	W	O	G	B	M	I	N	O
I	Y	E	I	N	M	P	Q	R	K	J	P	A	T	S
M	F	P	D	L	S	A	N	D	S	T	O	N	E	S
E	R	O	I	M	I	X	Y	U	E	R	J	P	J	I
N	D	K	S	Z	R	F	Z	T	J	A	X	T	Q	L
T	E	B	P	S	M	E	I	L	W	B	P	I	Y	I
A	Q	V	Y	E	I	L	X	V	Y	O	F	Q	V	Z
R	Z	I	K	F	O	L	P	M	R	A	M	R	G	A
Y	C	V	W	R	H	R	Y	O	K	V	F	I	L	T
M	L	S	P	Q	U	N	U	P	I	P	W	E	H	I
T	V	O	F	M	B	S	A	R	T	F	N	F	B	O
N	C	G	Z	U	R	N	L	O	N	I	H	O	A	N

Activity 3: Let's Trace

Look and analyze at the illustration below and answer the question listed below.



1. For how long has there been life on Earth?

2. For what percentage of time has life existed on Earth (round to the nearest whole number)?

3. For about how many years of geological time have humans existed on Earth?

4. For about how many years of geological time have the dinosaurs existed on Earth?

5. Did dinosaurs exist at the same time as humans?

6. How do scientists determine when an era begins and when it ends?

7. What is the purpose of making a geological timeline?

What's New

The Story of Fossils *by Patti Hutchison*

Imagine you are hiking in the woods. As you walk up a steep hill, you find a fossil. It is a mold of many tiny seashells. What would seashells be doing in the middle of the woods?

Most fossils are found in sedimentary rocks. These rocks form on the surface of the earth. They record the processes that have happened on the surface, including life. Scientists are able to arrange fossils according to age. This is called the fossil record. By studying the fossil record, scientists have found that the earth and its life forms have gone through many changes in the past.

Fossils have taught us how and when rock layers have formed. They have also helped scientists learn about life forms that have come and gone. Fossils have even taught us about the climate of the earth long ago.

The Geologic Time Scale is divided into huge blocks of time called eras. Eras are defined by major changes in the fossils found in the sedimentary rock layers that were formed during those time spans.

Activity 4

Directions: Read the story entitled **"The Story of Fossil"** by *Patti Hutchison*. Answer the guide questions stated below.

1. In what type of rocks are FOSSILS made of?

2. How do scientists arrange discovered fossils?

3. How did fossils help and teach scientist about the history of the earth?

4. Aside from geological aspect, what other aspects can be predicted by guide fossils? How? (climatic, organismic etc.)

What is It

Activity 5

Read and analyze the statements below. Write T if the statement is TRUE and F if the statement is FALSE.

- _____ 1. Scientists determine when an era begins and when it ends through geological timeline.
- _____ 2. Dinosaurs exist at the same time as humans.
- _____ 3. The purpose of making a geological timeline is to identify age of organism through its fossils.
- _____ 4. Quaternary period of geological time has humans evolved on Earth.
- _____ 5. Triassic Period of geological time have the dinosaurs existed on Earth.

What's More

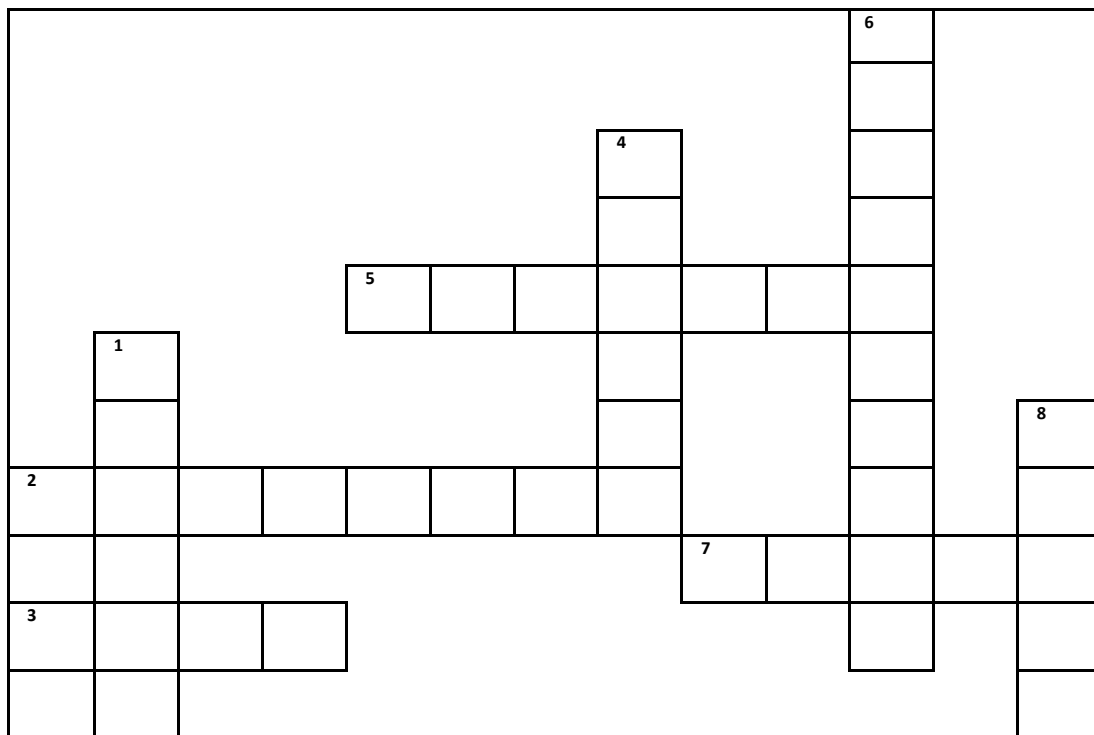
Activity 6

Directions: Write the division and period of the listed organism below. Refer to geological time scale.

	Era	Period
1. first vascular land plants	_____	_____
2. jawed fish diversity	_____	_____
3. evolution of humans	_____	_____
4. first chordates	_____	_____
5. mammals diversify	_____	_____
6. first primates	_____	_____
7. dinosaurs' diversity	_____	_____
8. major extinctions of reptiles' diversity	_____	_____
9. sudden diversification of metazoan families	_____	_____
10. first flowering plants	_____	_____

Activity 7: Crossword Puzzle

Directions. Complete the crossword by filling in the word that describes each clue.



Across:

2. with two symmetrical shells - mirror images of each other.
3. the term "crinoid" means
5. rocktype made of layers of sand and clay
7. multicellular organisms that often live in colonies

Down:

1. exoskeletons are made up of this material
4. lived inside their shells
6. phylum where starfish and sea urchins belong
8. individuality of coral is called ____.

What I Have Learned

Fill in the blanks. Read and analyze the statements below. Write the word that will complete the sentence/paragraph.

1. _____ are the remains or evidence of prehistoric plants and animals that have fossilized.
2. Fossils were used as markers when building up the geologic time scale. The names of most of the eons and eras end in “zoic” because these time periods were recognized by the _____ present at the time.
3. The geologic time scale is the “calendar” for events in Earth’s history. It subdivides all time since the end of the Earth’s formative period as a planet (nearly 4 billion years ago) into named units of abstract time: in descending order of duration, which are _____, _____, _____ and _____.
4. The _____ provides a system of chronologic measurement relating stratigraphy to time that is used by geologists, paleontologists and other Earth scientists to describe the timing and relationships between events that have occurred during the history of the Earth.
5. The Geologic Time Scale is divided into huge blocks of time called eras. Eras are defined by major changes in the fossils found in the _____ rock layers that were formed during those time spans.

What I Can Do

Activity 7

There are tables of fossils presented below. In the first box, choose an example and draw its physical structure. Second box and third box are references that serve as your guide to choose what organism you prefer to draw. Check the example. Good luck!

Example:

	Braching Tabulate Coral Age: Devonian (approximately 416 to 359 million years ago) Class: Anthozoa Moden Relatives: Corals still exists today.	Branching Tabulate Coral is a marine animal. Corals are multicellular organisms that often live in colonies. The individual animal is called a polyp. There are many different species of coral, with different forms, shapes, and sizes.
---	--	---

1.	TRILOBITE Age: Devonian (approximately 416 to 359 million year ago) Phylum: Arthropod Modern Relatives: Crabs, Spiders and insects	Trilobites were marine arthropods. The first trilobites show up in the fossil record dating back to about 525 million years ago. There were many different types of trilobites, ranging in size from 1mm to 72mm (28 inches long!) Trilobite species went extinct by 250 million years ago. Trilobite fossils are formed from the exoskeletons. These were made of chitin, like some insects and others organisms like lobsters. They split apart and shed their shell as they grow, just like lobsters do.
-----------	---	--

2.	Crinoid Age: Devonian (approximately 416 to 359 million years ago) Phylum: Echinoderm Modern Relatives: Starfish, sea urchins and sea cucumbers	Crinoids were marine animals. Its name means “Lily”. It is in the same phylum (Echinoderm) as starfish and sea urchins. Crinoids ate by filtering food out of the water with it arms. Its mouth and anus were next to each other in the calyx. It “rooted” in place with a holdfast. When crinoids die, their stems quickly break apart. The most common fossils of crinoids are the stem which is sometimes broken into little “cheerio” like pieces.
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3.	Gastropod Age: Cretaceous (Approximately 146 to 65 million years ago) Phylum: Mollusk Modern Relatives: Snails, Slugs and Whelks	Gastropods were marine animals. There were many different species of gastropods. All had coiled shells, but some were tightly coiled while some were loosely coiled. They had many different shapes and surface texture. The animals lived inside their shells, taking up the whole inside of the long shell. They could retract into their shells, covering the opening with their foot.
----	--	--

4.	Fossil Clam Age: Cretaceous (approximately 146 to 65 million years ago) Class: Bivalve Modern Relatives: Oysters, Scallops and Mussels	Fossil clams are marine animals. Clams are bivalves, with two symmetrical shells - the shells are mirror images of each other. Fossil clams range in size from a few millimeters to up to 2 meters (about 6 feet) in diameter. Clams lived inside their shells and had a muscular foot they used to borrow and move around. They lived in colonies on the ocean floor. Some clams had smooth shells while some were rough.
----	--	---

Assessment

Multiple Choice. Choose the letter of the best answer. Write the chosen letter on a separate sheet of paper.

1. These marine animals are bivalves with two symmetrical shells – the shells are mirror images of each other.
 - A. crinoids
 - B. trilobites
 - C. fossil clam
 - D. gastropods
2. How were the scientists able to arrange the fossils they gathered?
 - A. They were able to arrange the fossils according to age.
 - B. They were able to arrange the fossils according to structure.
 - C. They were able to arrange the fossils according to chemical content.
 - D. They were able to arrange the fossils according to place of discovery.
3. These were marine arthropods and were made of chitin, like some insects and other organisms like lobsters.
 - A. crinoids
 - B. trilobites
 - C. fossil clam
 - D. gastropods
4. What do you call the process by which the remains of ancient living things are turned into rock?
 - A. fertilization
 - B. fossilization
 - C. fragmentation
 - D. metamorphosis
5. In what phylum do crinoids belong?
 - A. echinoderms
 - B. arthropods
 - C. gastropods
 - D. mollusks
6. What do you call the person who studies fossils and ancient life?
 - A. biologist
 - B. archeologist
 - C. anthropologist
 - D. paleontologist

7. These marine animals lived inside their shells, taking up the whole inside of the long shell.
- A. sea arthropods
 - B. echinoderms
 - C. gastropods
 - D. mollusks
8. In what type of rocks are fossils made of?
- A. igneous rock
 - B. metamorphic rock
 - C. sedimentary rock
 - D. all of the above
9. In Paleozoic Era, in what period did the first vascular land plant exist?
- A. Silurian
 - B. Cambrian
 - C. Devonian
 - D. Ordovician
10. Why do most of the eons and eras end in “zoic”?
- A. because these time periods were recognized by the plants present at that time
 - B. because these time periods were recognized by the animal life present at that time
 - C. A and B
 - D. none of the above
11. In this period, the first mammals and dinosaurs existed.
- A. Cretaceous
 - B. Permian
 - C. Jurassic
 - D. Triassic
12. What do you call the remains or evidence used as markers when building up the geologic time scale?
- A. fossil
 - B. minerals
 - C. sandstone
 - D. piles of rock
13. In what era did the first skeletal elements, soft-bodied metazoans and animal traces exist?
- A. Cenozoic Era
 - B. Mesozoic Era
 - C. Paleozoic Era
 - D. Late Proterozoic

14. Which of the following does NOT belong to Paleozoic Era?
- A. Cambrian
 - B. Devonian
 - C. Silurian
 - D. Jurassic
15. In this era, the rocks formed have fossils of animals and plants such as dinosaurs, mammals and trees.
- A. Cenozoic Era
 - B. Mesozoic Era
 - C. Paleozoic Era
 - D. Phanerozoic Era

Additional Activities

Do you think that the average annual global temperature and carbon dioxide levels have been consistent throughout the history of earth? Justify your answer.

Answer Key

What I Know 1. A 2. A 3. B 4. B 5. D 6. B 7. A 8. D 9. D 10. D 11. C 12. B 13. A 14. B 15. C	What's in Activity 1 Paleontologist Fossils Sandstone Fossilization Body fossils Coprolite Trace fossil 6. Answer may vary according to student's perception Activity 2	Assessment 1. C 2. A 3. B 4. B 5. A 6. D 7. C 8. C 9. A 10. B 11. D 12. A 13. D 14. D 15. D
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What's It Activity 5 1. T 2. F 3. T 4. T 5. F	What's More Activity 6 Answer may vary according to student's perception	What's New Activity 3 Answer may vary according to student's perception Activity 4 1. Paleozoic - Silurian 2. Paleozoic - Devonian 3. Cenozoic - Quaternary 4. Paleozoic - Cambrian 5. Cenozoic - Tertiary 6. Mesozoic - Cretaceous 7. Mesozoic - Jurassic 8. Paleozoic - Permian 9. Paleozoic - Ordovician 10. Mesozoic - Cretaceous
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Earth and Life Science

Geologic Processes and Hazards

Earth and Life Science
Geologic Processes and Hazards
First Edition, 2020

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What I Need to Know

This module was designed and written with you in mind. It is here to help you master the geologic processes and hazards. 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.

In this module, we will describe the geologic processes and hazards happening in the community. Geologic processes like earthquake, volcanic eruption, and landslides lead to different hazards. A hazard refers to a potentially damaging physical event, phenomenon or human activity that may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation. Hazards are extreme natural events with a certain degree of probability of having adverse consequences.

The module covers:

- Lesson 1 – Geologic Processes and Hazards

After going through this module, you are expected to:

Describe the various hazards that may happen in the event of earthquakes, volcanic eruptions, and landslides.

What I Know

Directions: Read each statement and choose the letter of the correct answer. Write the chosen letter on a separate sheet of paper.

1. What is a potentially damaging physical event, phenomenon or human activity that may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation?
A. eutrophication C. landslide
B. geologic hazard D. poisonous gases
2. Which of the following describes the vibration of the ground during an earthquake?
A. ground shaking C. liquefaction
B. landslides D. tsunami
3. What do you call the hazard where giant waves move at speeds of up to 500 miles an hour and reach heights of hundreds of feet?
A. ground shaking C. liquefaction
B. landslides D. tsunami

4. What is the process during earthquake shaking where sand and silt grains in wet soil are rearranged and the water in the spaces between the grains is squeezed?
 - A. ground shaking
 - B. landslides
 - C. liquefaction
 - D. tsunami
5. What refers to the sliding down of a mass of earth or rock from a mountain or cliff?
 - A. ground shaking
 - B. landslides
 - C. liquefaction
 - D. tsunami
6. What natural hazard is involved when rock underground suddenly breaks along a fault causing tectonic movement?
 - A. volcanic eruption
 - B. earthquake
 - C. cyclone
 - D. hurricane
7. What natural hazard has the effects of reshaping new land, debris avalanche, destroyed forests, and death to many animals?
 - A. volcanic eruption
 - B. hurricane
 - C. earthquake
 - D. tsunami
8. What occurs when large amount of water quickly overflows a boundary?
 - A. regular flood
 - B. flash flood
 - C. landslide
 - D. tsunami
9. What causes an earthquake?
 - A. glacier
 - B. landslide
 - C. very large storm
 - D. a movement along fault
10. Which of the following is **NOT** a natural hazard?
 - A. hurricane
 - B. tsunami
 - C. house fire
 - D. earthquake
11. A natural physical process becomes a natural hazard when the process becomes _____.
 - A. dormant and inactive
 - B. scary
 - C. extreme and unpredictable
 - D. faster than usual
12. Which statement is true of earthquakes?
 - A. All of them can be prevented.
 - B. Weak ones can be prevented.
 - C. Some of them can be prevented.
 - D. None of them can be prevented.
13. What specific region of the world is characterized by the presence of active volcanoes, tsunamis, and earthquakes?
 - A. the ring of fire
 - B. the Eastern Europe
 - C. the North and South pole
 - D. Western Europe

14. Which of the following is true of a landslide?
- A. A landslide is a mass movement of rock fragments, soil, and debris downslope.
 - B. A landslide is associated with a volcanic eruption.
 - C. If debris from a landslide mixes with water, it will break apart and stop flowing.
 - D. All of the answers are true.
15. Which of the following is/are geologic hazard/s?
- A. earthquake
 - B. volcanoes
 - C. waves pounding on a coast
 - D. all of these are geologic hazards

Lesson 1 Geologic Processes and Hazards

What's In

Geology is the study of the Earth and its history. It involves studying the materials that make up the earth, the features and structures found on Earth, as well as the processes that act upon them. It also deals with the study of the history of all life living on the earth now.

How do geological processes occur?

Geological processes are naturally occurring events that directly or indirectly impact the geology of the Earth. Examples of geological processes include events such as plate tectonics, weathering, earthquakes, volcanic eruptions, mountain formation, deposition, erosion, droughts, flooding, and landslides. Geological processes affect every human on the Earth all of the time, but are most noticeable when they cause loss of life or property. These threatening processes are called natural disasters.

How about Geologic Hazards?

A geologic hazard is an extreme natural event in the crust of the earth that poses a threat to life and property, for example, earthquakes, volcanic eruptions, tsunamis (tidal waves) and landslides. It is a large-scale, complex natural events that happen on land. These hazards can cause immense damage, loss of property, and sometimes life. Geologic hazards can play a significant role when infrastructure is constructed in their presence. The unpredictable nature of natural geologic hazards makes identifying, evaluating, and mitigating against them a unique challenge.

Activity 1: Arrange Me

What do you see in the pictures below?

What do you call these hazards?

Following each picture are jumbled letters for you to rearrange. You may arrange them now by writing the letter in the box provided.



K I G N N R U O D H A S G

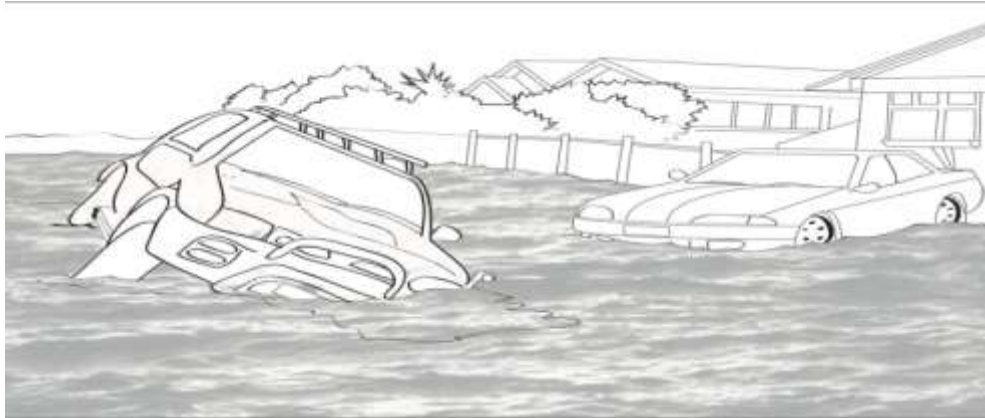
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Image 1 shows the vibration of the ground.



A M T S N U I

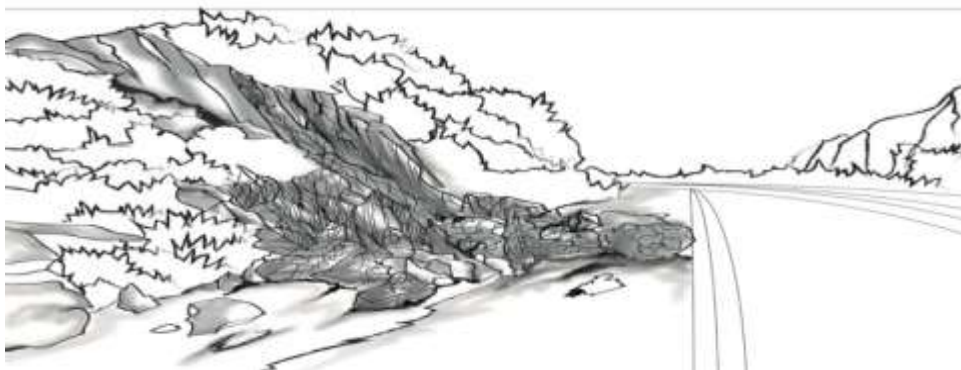
Image 2 presents giant waves caused by volcanic eruption.



Q L E F A T I O C N I

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Image 3 happened when soil liquefies during ground shaking.



N A S L D E S I D L

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Image 4 showed the movement of a mass of rock, debris, or earth down a slope.

Activity 2: Draw Me

Draw an erupting volcano on the box below.



Based from your drawing, can you name five (5) geologic hazards posed by an erupting volcano? Write your answer in the table below.

<i>Hazards Posed by an Erupting Volcano</i>	
1.	
2.	
3.	
4.	
5.	

What is It

Geologic processes and hazards are events which occur irregularly in time and space and cause negative impact on man and the environment. Earthquakes, volcanic eruptions, tsunamis (tidal waves), and landslides are the geologic hazards.

SIMPLIFIED CLASSIFICATION OF MAJOR GEOLOGIC HAZARDS

<i>Geologic Event</i>	<i>Hazards They Cause</i>
Earthquake	A. Ground shaking
	B. Surface faulting
	C. Landslides and liquefaction
	1. Rock avalanches
	2. Rapid soil flows
Volcanic Eruption	3. Rock falls
	D. Tsunamis
	A. Tephra falls and ballistic projectiles
	B. Pyroclastic phenomena
	C. Lahars (mud flows) and floods
	D. Lava flows and domes
	E. Poisonous gases

Earthquake is one of the most violent natural phenomena. According to the number of victims and destructive force, it exceeds all other natural disasters. Earthquakes also happen under the ocean and can cause tsunamis.

Earthquakes and volcanic eruption can trigger landslides, especially in areas with water saturated soils, a common characteristic of Cascadia. Landslides may result in falling rocks and debris that collide with people, buildings, and vehicles.

There were earthquakes that happened in the Philippines which were noticeably strong such as magnitude 6.9 in October 2019 which hit southern Philippines. Another one was 6.1 magnitude that struck the Island of Luzon in April of 2019. Recently, multiple earthquakes were felt when Taal Volcano erupted early in 2020.

Have you experienced an earthquake? What did you feel?

Probably, you will feel shaking of your body and even the entire surroundings which causes the ground shaking.

Listed below are the hazards caused by an earthquake:

- A. Ground shaking is one of the hazards resulting from earthquake, volcanic eruption, and landslides. Ground shaking is both a hazard created by earthquakes and the trigger for other hazards such as liquefaction and landslides. Ground shaking describes the vibration of the ground during an earthquake.
- B. Surface faulting is displacement that reaches the earth's surface during slip along a fault. It commonly occurs with shallow earthquakes; those with an epicenter less than 20 km. Surface faulting also may accompany aseismic creep or natural or man-induced subsidence.
- C. A landslide is defined as the movement of a mass of rock, debris, or earth down a slope. Landslides are a type of "mass wasting," which denotes any down-slope movement of soil and rock under the direct influence of gravity. The term "landslide" encompasses five modes of slope movement: falls, topples, slides, spreads, and flows.
- D. Liquefaction describes the way in which soil liquefies during ground shaking. Liquefaction can undermine the foundations and supports of buildings, bridges, pipelines, and roads, causing them to sink into the ground, collapse, or dissolve.
- E. Tsunamis are giant waves caused by earthquakes or volcanic eruptions under the sea. It can injure or kill many people and cause significant damage to buildings and other structures. The speed of tsunami waves depends on ocean depth rather than the distance from the source of the wave. Tsunami waves may travel as fast as jet planes over deep waters, only slowing down when reaching shallow waters.

What are volcanoes?

Volcanoes can be exciting and fascinating, but are also very dangerous. Any kind of volcano can create harmful or deadly phenomena, whether during an eruption or a period of dormancy. Volcanoes are natural systems and always have some element of unpredictability.

What about volcanic eruption?

A volcanic eruption occurs when magma is released from a volcano. Volcanic eruptions are major natural hazards on Earth. Volcanic eruptions can have a devastating effect on people and the environment.

These are the hazards caused by volcanic eruption:

- A. Tephra consists of pyroclastic fragments of any size and origin. It is a synonym for "pyroclastic material." Tephra ranges in size from ash (<2 mm) to lapilli (2-64 mm) to blocks and bombs (>64 mm).
- B. A pyroclastic flow is a dense, fast-moving flow of solidified lava pieces, volcanic ash, and hot gases. Pyroclastic flows form in various ways. A common cause is when the column of lava, ash, and gases expelled from a volcano during an eruption loses its upward momentum and falls back to the ground. Another cause is when volcanic material expelled during an eruption immediately begins moving down the sides of the volcano. Pyroclastic flows can also form when a lava dome or lava flow becomes too steep and collapses.
- C. Lahar is an Indonesian term that describes a hot or cold mixture of water and rock fragments that flows down the slopes of a volcano and typically enters a river valley. Lahars are extremely dangerous especially to those living in valley areas near a volcano. Lahars can bury and destroy manmade structures including roads and bridges.
- D. A flood is an overflow of water that submerges land that is usually dry. Floods can look very different because flooding covers anything from a few inches of water to several feet.
- E. Lava domes are formed by viscous magma being erupted effusively onto the surface and then piling up around the vent. Like lava flows, they typically do not have enough gas or pressure to erupt explosively, although they may sometimes be preceded or followed by explosive activity. The shape and size of lava domes varies greatly, but they are typically steep-sided and thick.
- F. Poisonous gases, the gases that are released during a volcanic eruption, come from deep within the Earth. The largest portion of gases released into the atmosphere is water vapor.

The Philippines has suffered from an inexhaustible number of deadly typhoons, earthquakes, volcanic eruptions and other natural disasters. This is due to its location along the Ring of Fire, or typhoon belt – a large Pacific Ocean region where many of Earth's volcanic eruptions and earthquakes occur.

Taal Volcano, on the island of Luzon in the Philippines, is the country's second most active volcano. It boomed to life on January 12, 2020, Sunday afternoon, spilling volcanic ash. Taal Volcano sent a massive plume of ash and steam spewing miles into the sky and pushed red-hot lava out of its crater, prompting the evacuation of thousands of people and the closure of Manila's airport. Hundreds of earthquakes were noted while the volcano was erupting. Flashes of lightning lit up the plume, lending the scene an otherworldly appearance.

Activity 3. Check Me Out

1. In the table below, put a check on the hazards that you have experienced in your locality. Then, explain why these hazards happened to our country.

<i>Ground shaking</i>	<i>Liquefaction</i>	<i>Landslides</i>	<i>Tsunami</i>

2. Why is the Philippines prone to geologic hazard? Write your answer on the space below.

Activity 4: List Me In

Identify and list down the hazards using published resources and personal observation. Write your answer in the table below.

<i>Published Resources</i>	<i>Personal Observation</i>
1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	
9.	
10.	

What I Have Learned

Activity 5: Places of Possible Hazards

5.1 The table below showed places where potential hazards may occur. Write the possible hazards for the given places.

IN THE CLASSROOM AND CORRIDORS: 1. 2. 3. 4. 5.	ON THE TERRITORY SURROUNDING THE SCHOOL 1. 2. 3. 4. 5.
IN THE SCHOOL BUILDING 1. 2. 3. 4. 5.	IN THE SETTLEMENT 1. 2. 3. 4. 5.

Guide Questions:

1. What will you do if you are: a.) in the classroom or corridor, b.) on the territory surrounding the school, c.) in the school building and d.) in the settlement when an earthquake happens?
2. Which places are the most dangerous?
3. Whose instructions should you follow? What should you do if you are alone?
4. It might happen that your family members are not nearby. Who should you call to receive help after an earthquake? Do you know the telephone numbers?

Activity 5.2 My Geologic Hazards Experience

Write at least four (4) hazards you have experienced in your locality. Then make a slogan on how these hazards affect the people as well as the environment.

What I Can Do

Hazards may pose danger to our lives. Let us be prepared and protect ourselves. As students, how are you going to protect your lives in times of hazards? In the table below, write a step by step procedure of preparing and protecting yourselves in times of geologic hazards.

<i>Step by Step Procedure of Preparing and Protecting Ourselves in Times of Geologic Hazards</i>	
1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	
9.	
10.	

Assessment

Directions: Read each statement and choose the letter of the correct answer. Write your answer on a separate sheet of paper.

1. Which of the following may result in falling rocks and debris that collide with people, buildings, and vehicles?
 - A. earthquake
 - B. land slide
 - C. tsunami
 - D. typhoons

2. Which of the following is NOT a volcanic hazard?
 - A. flooding
 - B. lahars
 - C. lava
 - D. pyroclastic flows
3. Which of the following is an example of a hazard associated with earthquake?
 - A. eutrophication
 - B. ground shaking
 - C. flooding
 - D. pyroclastic density currents
4. What is the main reason why the Philippines has suffered from numerous geologic processes and calamities?
 - A. its economic status
 - B. its location (Ring of fire)
 - C. Philippines is 3rd a world country
 - D. something to do with human population
5. Which of the following hazards undermine the foundations and supports of buildings, bridges, pipelines, and roads, causing them to sink into the ground, collapse, or dissolve?
 - A. eutrophication
 - B. ground shaking
 - C. liquefaction
 - D. pyroclastic density currents
6. Which of the following is **NOT** a natural hazard?
 - A. hurricane
 - B. tsunami
 - C. house fire
 - D. earthquake
7. Which of the following is/are geologic hazard/s?
 - A. earthquake
 - B. volcanoes
 - C. waves pounding on a coast
 - D. all of these are geologic hazards
8. What natural hazard is involved when rock underground suddenly breaks along a fault causing tectonic movement?
 - A. volcanic eruption
 - B. earthquake
 - C. cyclone
 - D. hurricane
9. What causes an earthquake?
 - A. glacier
 - B. very large storm
 - C. landslide
 - D. a movement along fault
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 - A. ground shaking
 - B. liquefaction
 - C. landslides
 - D. tsunami
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 - C. landslides
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A. volcanic eruption C. hurricane
B. earthquake D. tsunami
13. A natural physical process becomes a natural hazard when the process becomes _____.
A. scary
B. dormant and inactive
C. faster than usual
D. extreme and unpredictable
14. What is the process during earthquake shaking where sand and silt grains in wet soil are rearranged, and the water in the spaces between the grains is squeezed?
A. ground shaking C. liquefaction
B. landslides D. tsunami
15. What refers to the sliding down of a mass of earth or rock from a mountain or cliff?
A. ground shaking C. liquefaction
B. landslides D. tsunami

Additional Activities

List down the several geologic hazards that happened in our country and explain how these affect the people and the environment.

Answer Key

What I Know 1. B 2. A 3. D 4. C 5. B 6. B 7. A 8. B 9. D 10. C 11. C 12. D 13. A 14. D 15. D	What's In 1. GROUND SHAKING 2. TSUNAMI 3. LIQUEFACTION 4. LANDSLIDE	Assessment 1. B 2. A 3. B 4. B 5. C 6. C 7. D 8. B 9. D 10. D 11. A 12. A 13. D 14. C 15. B
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Earth and Life Science – Senior High School
Geologic Processes and Hazards
First Edition, 2020

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What I Need to Know

This module was designed and written with you in mind. It is here to help you master the nature of Earth and Life Science. 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 has one lesson:

- Lesson 2 – Geological Processes and Hazards

After going through this module, you are expected to:

1. identify places in the Philippines that are prone to geologic hazards like earthquakes, volcanic eruptions, and landslides using hazard map; and
2. explain why it is important to identify places that are prone to geologic hazards.

What I Know

Directions. Read the following questions and choose the letter of the correct answer. Write the chosen letter on a separate sheet of paper.

1. Which of the following is an example of geologic hazard?
A. tornado
B. earthquakes
C. flood
D. tropical cyclone
2. Where can you find the Pacific Ring of Fire?
A. Arctic Ocean
B. Indian Ocean
C. Pacific Ocean
D. Atlantic Ocean
3. What do you call the point of origin of an earthquake located just above the focus?
A. divergent
B. convergent
C. epicenter
D. transform
4. Which type of map shows the risk of particular area to certain threat?
A. hazard
B. physical
C. resource
D. topographic
5. What type of hazard is climate and weather related?
A. natural
B. biological
C. ergonomic
D. anthropogenic

6. What refers to the movement of rock, debris, and soil down a slope?
 - A. tsunami
 - B. landslide
 - C. typhoon
 - D. volcanic eruption
7. Which of the following geologic features makes the provinces of La Union and Pangasinan high risk to earthquakes?
 - A. Iba Fault
 - B. Manila Trench
 - C. Tablas Fault
 - D. Lianga Fault
8. Which of the following is responsible for plate movement?
 - A. gravitational force
 - B. radiation emitted by the Sun
 - C. convection current in mantle
 - D. attraction from the moon
9. All are examples of geologic hazards EXCEPT for _____.
 - A. typhoon
 - B. earthquakes
 - C. landslides
 - D. volcanic eruptions
10. Which of the following areas is the LEAST prone to earthquakes?
 - A. Tarlac
 - B. Cavite
 - C. Ifugao
 - D. La Union
11. Which of the following areas has the HIGHEST risk of volcanic-related disaster?
 - A. Sulu
 - B. Albay
 - C. Bataan
 - D. Biliran
12. Which of the following areas is LEAST at risk on landslide?
 - A. Cebu
 - B. Batangas
 - C. Manila
 - D. La Union
13. Which of the following is an example of natural hazard?
 - A. mining
 - B. deforestation
 - C. landslide
 - D. climate change
14. Which of the following factors makes the province of Benguet at risk to earthquake?
 - A. high population
 - B. presence of trees
 - C. bodies of water around
 - D. topography and mountains
15. Why do you think the Visayas islands are NOT at risk to earthquakes? Due to
 - A. lack of fault lines
 - B. the presence of islands
 - C. lack of mountains
 - D. the presence of plains

Lesson 2 Geological Processes and Hazards

The Philippines is an archipelago that is made up of 7641 islands and home to world-renown natural wonders and pristine water bodies. The country is in a unique location because it rests in the Pacific Typhoon Belt and Pacific's earthquake and volcano Ring of Fire. The Ring of Fire is a home to over 75% of the world's active and dormant volcanoes. Because of its geographic location, the Philippines is among the greatest hazard and disaster-prone countries in the world.

What's In

The Philippines is no stranger to natural hazards. Every year, thousands to millions of Filipinos are extremely affected by all forms of hazards such as earthquakes, typhoons, and volcanic eruptions. These natural hazards may result in multiple disasters.

Activity 1: Cause and Effect

Directions. Supply the blank boxes with the causes and effects from the given geologic hazards.

<i>Geologic Hazard</i>	<i>Causes</i>	<i>Effects</i>
Volcanic Eruptions		
Landslides		
Earthquakes		

What's New

Geologic Process

Geological processes can be described as natural forces that shape the physical makeup of a planet. These forces cause movements of plates in the Earth's crust, the area where humankind lives. As this processes occur from time to time, it poses continuous source of hazards to people, community and society.

Hazards

A hazard is a phenomenon caused by natural or human forces which poses threat to humans, animals, properties and environment. For instance, since the Philippines is located within the Ring of Fire, the country experiences many earthquakes and

volcanic eruptions compared to other countries. Making the country one of the most hazard-prone countries in the world.

Hazards can be classified as to natural and anthropogenic.

Natural: Earthquakes, volcanic eruptions, landslides and tsunamis (*climate and weather related hazards*)

Anthropogenic: Deforestation, mining and climate change (*man-made*)

Hazard Map

It is a map that illustrates the areas that are exposed or prone to a particular hazard. They are used for natural hazards such as landslides, flooding, volcanic eruption and tsunami. It is also used to mitigate the potential negative effects of these hazards

Activity 2: Point me

Every year, dozens of natural disasters strike our country. Some are just passing by and some even make history because of massive destruction.

Directions. Since disasters are all over the news, what are the places do you think that have been affected by geologic hazards for the past decade. Use the Philippine map on the right side. Write your answers in the box below.

Earthquakes
1.
2.
Volcanic Eruptions
1.
2.
Landslides
1.
2.



What is It

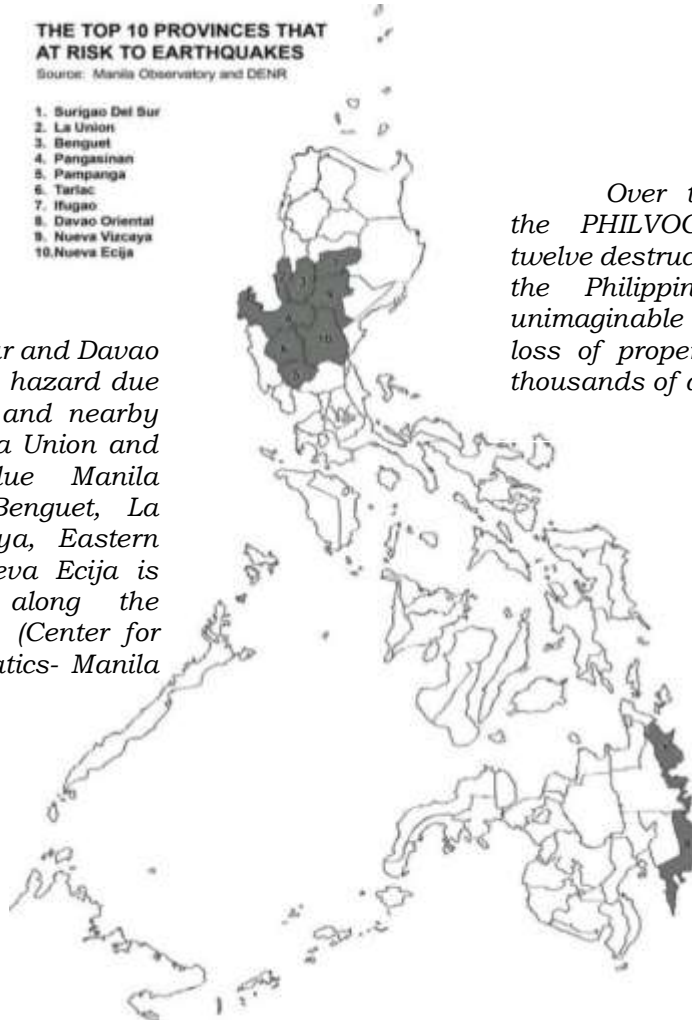
Now, you have learned that geologic location is the major reason why the Philippines is a hazard-prone country. The Philippine government partnered other private institutions to reduce the risk of hazards through producing hazard maps that are publicly available. For example, the partnership of news networks with the Philippine Institute of Volcanology and Seismology (PHIVOLCS). This partnership shares valuable and scientific information which increases the public's understanding on geologic hazards and risks associated with it.

Another is Manila Observatory, a private non-stock and non-profit research institution with the help of the Department of Environment and Natural Resources (DENR). This partnership produced hazard maps that show vulnerability of the country to environmental disasters.

Geophysical map

**THE TOP 10 PROVINCES THAT
AT RISK TO EARTHQUAKES**
Source: Manila Observatory and DENR

1. Surigao Del Sur
2. La Union
3. Benguet
4. Pangasinan
5. Pampanga
6. Tarlac
7. Ifugao
8. Davao Oriental
9. Nueva Vizcaya
10. Nueva Ecija



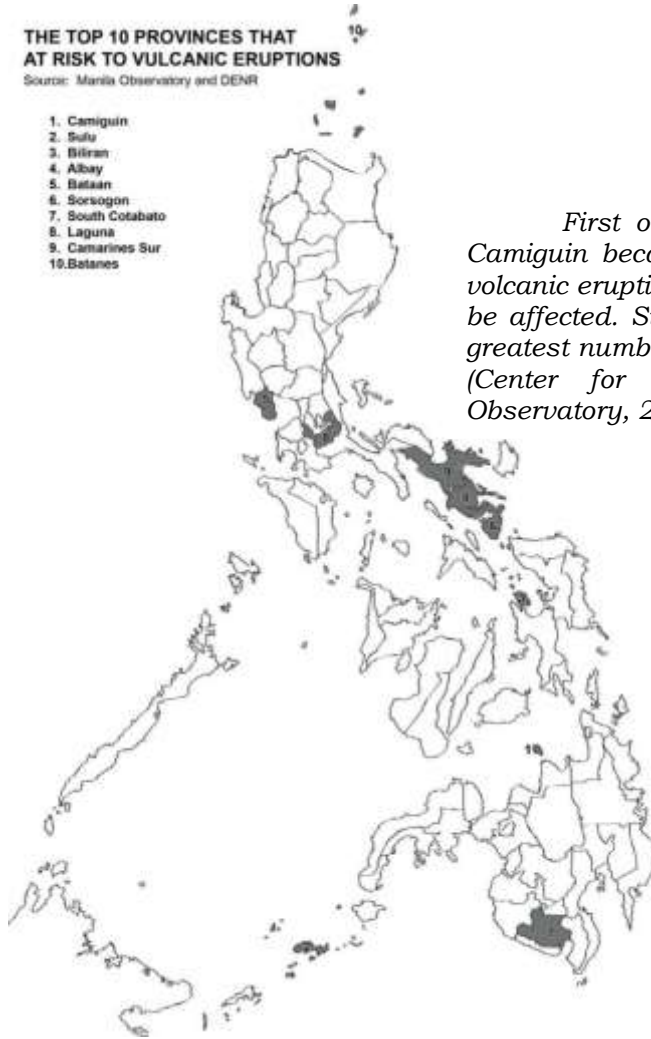
Surigao Del Sur and Davao Oriental are at risk to hazard due to Philippine Trench and nearby active faults, while La Union and Pangasinan are due Manila Trench. Moreover, Benguet, La Union, Nueva Vizcaya, Eastern Pangasinan and Nueva Ecija is due its location along the Philippine fault Zone. (Center for Environmental Geomatics- Manila Observatory, 2005)

Over the past decades, the PHILVOCS has recorded twelve destructive earthquakes in the Philippines that caused unimaginable effects, such as loss of properties, injuries, and thousands of deaths.

THE TOP 10 PROVINCES THAT AT RISK TO VULCANIC ERUPTIONS

Source: Manila Observatory and DENR

1. Camiguin
2. Sulu
3. Biliran
4. Albay
5. Bataan
6. Sorsogon
7. South Cotabato
8. Laguna
9. Camarines Sur
10. Batanes



First on the rank with the highest risk is Camiguin because the land area was so small. If volcanic eruption may occur, the whole province can be affected. Sulu ranks second because it has the greatest number of active and dangerous volcanoes. (Center for Environmental Geomatics- Manila Observatory, 2005)

TOP 10 MOST LANDSLIDE PRONE PROVINCES OF THE PHILIPPINES

Data Source: Department of Environment and Natural Resources

1. MARINDUQUE
2. RIZAL
3. CEBU
4. LA UNION
5. SOUTHER LEYTE
6. BENGUET
7. NUEVA VIZCAYA
8. BATANGAS
9. MOUNTAIN PROVINCE
10. ROMBLON



Most of the provinces in the Cordillera Administrative Region are included in the list of top 10 landslide-prone areas in the Philippines. Because the entire region is situated in and around Cordillera Mountain ranges. So, after massive and continuous rain or earthquakes, certain areas on the hills and mountains become delicate and weak which makes the region exposed to landslides as well as to other provinces that is why their area is classified as rugged and mountainous with prominent flatlands.

What's More

Activity 3: Identify me

Directions. Using the hazard map found on the previous pages, answer the following questions.

1. Identify the top 3 places in the Philippines that are hazard-prone to volcanic eruptions, earthquakes, and landslides. Justify your answers why they are most prone.
2. What is the importance of using a hazard map?

What I Have Learned

Activity 4: Complete me

Directions. Read the following statements and complete them by filling in with the correct term and/or phrase.

1. The Philippines experiences more earthquakes and volcanic eruptions because it is located in the _____.
2. Earthquakes and volcanic eruptions are known as _____ type of hazards.
3. Surigao Del Sur and Davao Del Norte are at risk to hazard due to _____ and _____.
4. Camiguin has the highest risk of effects of a volcanic eruption because the land area is too _____.
5. Man-made hazard is classified as _____.

What I Can Do

Activity 5: Hazard identification

Directions. Identify hazardous places during or after earthquakes on the following locations.

1. Home
2. Classroom and school building
3. Community (e.g. barangay, municipality or provinces)

The answer must be something similar to this:

In the community: Damaged roads and bridges

Assessment

Directions. Read the following questions and choose the letter of the correct answer. Write the chosen letter on a separate sheet of paper.

1. Which of the following is an example geologic hazard?
A. mining
B. deforestation
C. earthquakes
D. climate change
2. Which of the following maps is used to identify a place that is prone to disaster?
A. hazard
B. resource
C. physical
D. topographic
3. How do you classify climate- and weather-related hazards?
A. natural
B. chemical
C. biological
D. anthropogenic
4. Which of the following geologic features makes the provinces of La Union and Pangasinan prone at risk to earthquakes?
A. Iba Fault
B. Manila Trench
C. Tablas Fault
D. Lianga Fault
5. Which of the following provinces has the highest risk of volcanic eruptions based on DENR and Manila observatory report?
A. Bataan
B. Laguna
C. Sorsogon
D. Camiguin
6. Which of the following is NOT among the provinces with high proneness to landslide?
A. Cebu
B. Metro Manila
C. La Union
D. Mountain province
7. Which of the following is NOT included in the group?
A. mining
B. earthquakes
C. tsunamis
D. landslides
8. Which of the following area is LEAST prone to earthquakes?
A. Ifugao
B. Tarlac
C. Palawan
D. La Union
9. Which of the following provinces has the HIGHEST risk of volcanic-related hazard?
A. Sulu
B. Batangas
C. Laguna
D. Batanes
10. Which of the following is NOT an example of geologic hazards?
A. landslides
B. tropical cyclones
C. earthquakes
D. volcanic eruptions

11. Where can you find the Ring of Fire?
- | | |
|-----------------|-------------------|
| A. Arctic Ocean | C. Pacific Ocean |
| B. Indian Ocean | D. Atlantic Ocean |
12. Which of the following is an example of geologic hazard?
- | | |
|---------------------|----------------|
| A. tornado | C. flood |
| B. tropical cyclone | D. earthquakes |
13. What refers to the movement of rock, debris, and soil down a slope?
- | | |
|----------------|-----------------------|
| A. landslide | C. typhoon |
| B. earthquakes | D. volcanic eruptions |
14. Why do you think that majority of the Cordillera Administrative Region are included in the most landslide prone provinces in the Philippines? Because it is
- | | |
|-----------------------------------|----------------------------|
| A. near from the sea | C. near in mountain ranges |
| B. situated near active volcanoes | D. near NCR |
15. Which of the following area is LEAST prone to earthquakes?
- | | |
|-----------|-------------|
| A. Tarlac | C. Ifugao |
| B. Cavite | D. La Union |

Additional Activities

Activity 6: Interview me

Directions. Interview a family member, a relative, neighbor or anyone who experienced geologic hazards and answer the following questions below.

1. Have you ever experienced any form of geologic hazards such as volcanic eruptions, earthquakes, and landslides? How did you feel? What did you do during and after the situation?

2. If you have never experienced any form of hazards, look for someone who was able to witness and experience it first-hand. Ask them their feelings and thoughts during and after the hazard event. Also, ask them the things they did during and after the scenario.

Answer Key

What Can I Do Activity 5 Answers may vary among students Assessment 1. C 2. A 3. A 4. B 5. D 6. B 7. A 8. C 9. A 10. B 11. C 12. D 13. A 14. C 15. B Additional Activities Activity 6 Answers may vary among students	What's New Activity 2 Answers may vary among students What's More Activity 3 Earthquakes: Surigao Del Sur, La Union, and Benguit Volcanic eruptions: Camiguin, Sulu, and Biliran Landslides: Marinduque, Rizal and, Cebu Hazard map expose areas that are at risk to certain hazards. What I Have Learned Activity 4 1. Ring of fire 2. Natural 3. Philippine trench, active faults 4. Small 5. Anthropogenic	What I Know 1. B 2. C 3. C 4. A 5. A 6. B 7. B 8. C 9. A 10. B 11. A 12. C 13. C 14. D 15. A What I Know Activity 1 Cause: Possible answers Earthquakes -when rock underground suddenly breaks along a fault. Volcanic Eruptions -movement of tectonic plates causing magma to rises to the surface. Landslides -Slow weathering of rocks, soil erosion, earthquakes and volcanic activity Effects: Answers may vary among students
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Earth and Life Science

Geologic Processes and Hazards

Earth and Life Science – Senior High School
Geologic Processes and Hazards
First Edition, 2020

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What I Need to Know

This module was designed and written with you in mind. It is here to help you master the nature of Earth and Life Science. 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 covers:

Lesson 3: Geologic Processes and Hazards

After going through this module, you are expected to:

1. identify human activities that speed up or trigger landslides;
2. explain why it is important to identify human activities that speed up or trigger landslides; and
3. cite some precautionary measures in preparing for the landslides.

What I Know

Directions. Read the following questions and choose the letter of the correct answer.

Write the chosen letter on a separate sheet of paper.

1. What refers to the movement of rock down a slope?
A. wave
B. debris
C. tsunami
D. landslide
2. Which among the following human activities DOES NOT speed up or trigger landslide?
A. mining
B. planting of trees
C. overloading slopes
D. excavation or displacement of rock
3. Which of the following can trigger a landslide?
A. wind howl
B. earthquake
C. car accident
D. fire in a house

4. What refers to the exposure, processing and recording of archaeological remains?
- A. mining
B. excavation
C. quarrying
D. land pollution
5. What do you call the human activity that trigger landslides using explosives?
- A. land use
B. quarrying
C. mining
D. excavation
6. What can you hear when there is a sudden landslide?
- A. explosives
B. loud noise
C. rain water
D. rolling thunder
7. What makes road construction a possible cause of a landslide?
- A. slope excavation
B. use of heavy equipment
C. poor sanitation among workers
D. lack of personal safety gears
8. Which of the following is NOT an example of land use?
- A. surfing
B. farming
C. quarrying
D. house construction
9. What should be the initial reaction when there is a landslide?
- A. scream loudly
B. move away from the slope
C. call the emergency hotline
D. take a picture and post in internet
10. Which among the following can trigger a landslide even if there is no human activity present in an area?
- A. gravity
B. thunder
C. lighting
D. forest fire
11. How does a community in an urbanized area speed up landslide?
- A. planting trees
B. catching of wild animals
C. converting forest into farms
D. increasing the human population

12. Which among the following factors contributed MOST in a landslide during quarrying?
- A. blasting of rocks
 - B. polluting the rivers
 - C. use of heavy equipment
 - D. use of a variety of manpower
13. What makes a landslide dangerous to human lives?
- A. It is fast and unpredictable.
 - B. It can slowly diminish population.
 - C. It is as powerful as typhoon.
 - D. It can be avoided by running.
14. How can a community avoid the occurrence of a landslide in the future?
- A. avoid creating loud noises
 - B. call the emergency hotline
 - C. plant more trees in the slope
 - D. construct more buildings
15. Which among the following human activities can trigger a landslide?
- I. musical concert
 - II. building being demolished
 - III. woman dancing on top of a pole
 - IV. team of construction workers clearing trees for a new road
- A. I and III
 - B. II and IV
 - C. II, III and IV
 - D. I, II, III and IV

Lesson 3 Geological Processes and Hazards

Landslide is the movement of rock down a slope where human activities play an important role in speeding up or triggering its occurrences. This module will help determine and cite some human activities that may speed up or trigger landslides.

What's In

Activity 1: Loop Me In

What are the human activities that speed up or trigger landslides? Can you name some?

Directions. Encircle the word or group of words that speed up or trigger landslides

O	O	L	A	N	D	U	S	E	E
C	V	G	R	G	S	V	L	X	S
U	E	E	U	R	T	W	O	P	N
T	G	X	R	L	C	X	P	L	O
T	N	C	H	H	O	Y	E	O	I
I	I	A	I	F	N	A	S	S	T
N	N	V	B	K	S	Z	D	I	A
G	I	A	K	L	T	R	H	V	V
T	M	T	L	O	R	E	V	E	A
R	O	I	M	P	U	S	I	S	C
E	R	O	O	Q	C	T	J	T	X
E	E	N	N	R	T	U	M	R	E

What's New

Landslide is an occurrence in which soil, rocks and vegetal debris are transported suddenly or slowly down a slope due to insufficient stability. It may happen when there is continuous rainfall, earthquakes and/or volcanic eruption accompanied by a very loud noise

Landslide can be resulted from the failure of the materials to make up the hill slope, and get driven by the force of gravity. Landslide is also known as landslips, slumps or slope failure.

Below is an image of landslide due to human activities:

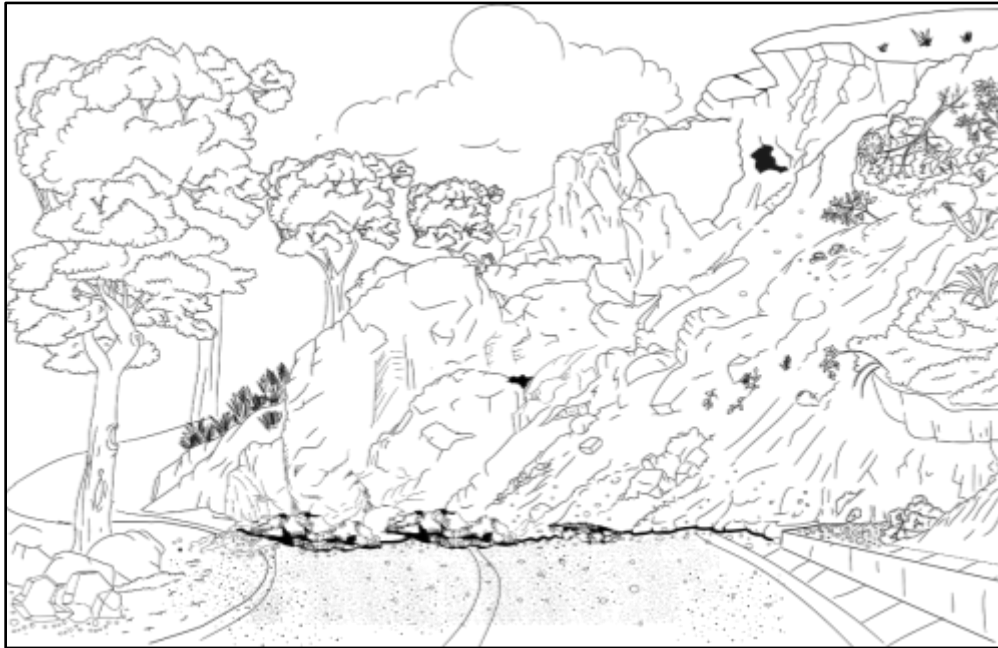


Figure 1. An illustration of landslide occurrence

Listed below are some of the human activities that speed up or trigger landslide:

- a. Overloading slopes
- b. Mining which uses explosives underground
- c. Excavation or displacement of rocks.
- d. Land use such as modification of slopes by construction of roads, railways, buildings, houses, etc.
- e. Quarrying which includes excavation or pit, open to the air, from which building stone, slate, or the like is obtained by cutting, blasting, etc.
- f. Land pollution which is the degradation of earth's land surface, exploitation of minerals and improper use of soil by inadequate agricultural practices.
- g. Excavation which pertains to exposure, processing, and recording of archaeological remains
- h. Cutting Trees that can lead to deforestation and may encourage landslide

Due to these human activities, several effects of landslides were noted. These cause property damage, injury and death and adversely affect a variety of resources. For example, water supplies, fisheries, sewage disposal systems, forests, dams and roadways can be affected for years after a slide event. The negative economic effects of landslides include the cost to repair structures, loss of property value, disruption of transportation routes, medical costs in the event of injury, and indirect costs such as lost timber and lost fish stocks. Water availability, quantity and quality can be affected by landslides. Geotechnical studies and engineering projects to assess and stabilize potentially dangerous sites can be costly.

Are we prepared in case of landslides? These are some precautionary measures to observe and follow in preparing for landslides:

- a. Stay alert and awake. Many debris-flow fatalities occur when people are sleeping.
- b. If you are in areas susceptible to landslides and debris flows, consider leaving if it is safe to do so.
- c. Listen for any unusual sounds that might indicate moving debris, such as trees cracking or boulders knocking together.
- d. If you are near a stream or channel, be alert for any sudden increase or decrease in water flow and for a change from clear to muddy water.
- e. Be especially alert when driving. Bridges may be washed out, and culverts overtop.
- f. Be aware that strong shaking from earthquakes can induce or intensify the effects of landslides.

What is It

Activity 2: List and Describe

Directions. On the box provided below, list down the human activities that cause landslides. Describe each one how they contribute to the cause of such hazardous event.

What's More

Activity 3: Share It

Directions. Have you experienced landslide in your community? What are the causes of such event? Share your experience. If not, kindly interview a person who has a first-hand experience to landslides and ask his feelings, thoughts and actions toward the event.

What I Have Learned

Activity 4: My Take in Landslides

Directions. In a short bond paper, prepare a poster showing human actions to be conducted to mitigate the hazards posed by landslides.

The following criteria will be used to evaluate the output:

- Connection to the topic 5 points
- Layout and design 5 points

- Neatness of output 5 points
- Organization 5 points
- TOTAL 20 points

Post your draft here

What I Can Do

Activity 5: My Share

Directions. People must be mindful and careful enough doing activities that may lead to occurrence of landslides. As a student, how will you do your part in preventing landslides as to information dissemination, awareness and mitigation planning?

Assessment

Directions. Read the following questions and choose the letter of the correct answer. Write the chosen letter on a separate sheet of paper.

1. Which of the following is NOT an effect of landslide?
A. damage to property C. death
B. injury D. extreme heat
2. What refers to the use of explosives underground?
A. mining C. quarrying
B. excavation D. land pollution
3. What refers to the movement of rock down a slope?
A. wave C. tsunami
B. debris D. landslide
4. What will you do when there is a sudden landslide?
A. stay alert and awake C. call the neighbor
B. wait for the rescue D. stay cool
5. What makes railway and building construction a possible cause of a landslide?
A. slope excavation C. poor sanitation among workers
B. use of heavy equipment D. lack of personal safety gears
6. Which among the following human activities speed up or trigger landslide?
A. mining C. watering the plants
B. planting of trees D. cooking
7. Which of following is the human activity that trigger landslides using excavation or pit?
A. land use C. mining
B. quarrying D. excavation
8. Which of the following is an example of land use?
A. surfing C. scuba
B. parasailing D. construction of houses
9. What should be the initial reaction when there is a landslide?
A. scream loudly C. call the emergency hotline
B. move away from the slope D. take a picture and post in internet
10. Which among the following can trigger a landslide even if there is no human activity present in an area?
A. gravity C. lighting
B. thunder D. forest fire

11. How does a deforestation speed up landslide?
- due to the planting trees
 - due to the cutting of trees
 - catching of wild animals
 - increasing the human population
12. Which among the following factors contributed MOST in a landslide during land pollution?
- blasting of rocks
 - improper use of soil
 - use of heavy equipment
 - use of a variety of manpower
13. What makes a landslide dangerous to human lives?
- It is fast and unpredictable.
 - It can slowly diminish population.
 - It is as powerful as typhoon.
 - It can be avoided by running.
14. Which among the following human activities can trigger a landslide?
- building being demolished
 - musical concert
 - team of construction workers clearing trees for a new road
 - woman dancing on top of a pole
- I and III
 - II and IV
 - II, III and IV
 - I, II, III and IV
15. How can a community avoid the occurrence of a landslide in the future?
- avoid creating loud noises
 - call the emergency hotline
 - plant more trees in the slope
 - construct more buildings

Additional Activities

Directions. Look for a news article concerning the occurrence of landslide. Identify the following elements in the news article:

Title: _____

Author: _____

Basic Information:

What? _____

Who? _____

When? _____

Where? _____

[illegible]

Answer Key

What I Know 1. D 2. B 3. B 4. B 5. C 6. B 7. A 8. A 9. B 10. A 11. C 12. A 13. A 14. C 15. B	What's in Activity 1 explosives excavation mining	Assessment 1. D 2. A 3. D 4. A 5. A 6. A 7. B 8. D 9. B 10. A 11. B 12. B 13. A 14. A 15. C
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Earth and Life Science

Hydrometeorological Phenomena and Hazards

Earth and Life Science – Senior High School
Hydrometeorological Phenomena and Hazards
First Edition, 2020

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What I Need to Know

This module was designed and written with you in mind. It is here to help you master the nature of Earth and Life Science. 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 has one lesson:

- Lesson 1 – Hydrometeorological Phenomena and Hazards

After going through this module, you are expected to:

1. identify places in the Philippines that are prone to hydrometeorological hazards like tropical cyclones, monsoons, floods, or *ipo-ipo* using hazard map; and
2. explain why it is important to identify places that are prone to hydrometeorological hazards.

What I Know

Directions. Read the following questions and choose the letter of the correct answer. Write the chosen letter on a separate sheet of paper.

1. What is the highest signal number can be found on PAG-ASA's revised storm earning system?
A. 3
B. 5
C. 7
D. 9
2. What is the English term for *bagyo*?
A. storm
B. typhoon
C. thunderstorm
D. tropical depression
3. Which of the following is NOT included in the group?
A. flood
B. tornado
C. typhoon
D. tsunami
4. What is described as the region of the calmest weather at the center of tropical cyclone?
A. eye
B. inner bands
C. eye wall
D. epicenter
5. What do you call to the cyclones occurring in the North Atlantic Ocean?
A. typhoon
B. tornado
C. hurricanes
D. thunderstorm

6. When does the Southwest Monsoon usually occur in the Philippines?

A. March - May	C. October - March
B. July - December	D. June – September

7. What is the main cause of tornadoes?

A. Floods	C. Hurricanes
B. Thunderstorm	D. Tropical Storm

8. Which among the following is the MOST damaging result of a tropical cyclone?

A. Rain	C. Flood
B. Storm surge	D. High winds

9. What year did typhoon Haiphong land in the Philippines?

A. 1881	C. 1867
B. 1991	D. 2013

10. Which region in the Philippines is the most exposed to tropical cyclones?

A. Region I	C. Region III
B. Region V	D. Region XI

11. Which of the following reasons makes Pampanga the province that is most prone to flood?

A. low lying area	C. facing towards the sea
B. highly populated	D. composed of mountains

12. Which of the following places of is LEAST likely at risk for typhoon?

C. Albay	C. Batangas
D. Cagayan	D. Sorsogon

13. What makes BICOL region prone to typhoon?

A. facing towards the Pacific Ocean	C. has lots of rivers
B. composed of mountains	D. low lying areas

14. If you would like to settle to a province that is least prone to typhoon and flood, which among the following provinces will be a good option?

A. Albay	C. Maguindanao
B. Tarlac	D. Negros Oriental

15. What year did typhoon Yolanda landed in the Philippines?

A. 2000	C. 1988
B. 2013	D. 2016

Lesson 3 Hydrometeorological Phenomena and Hazards

The Philippines has a tropical and maritime climate. Annually, the country is visited by an average of 20 typhoons, five to nine of which are highly destructive. The Philippines is situated in the Pacific typhoon belt thus, the country is highly prone to hydrometeorological hazards. Oftentimes, multiple hazards occur simultaneously.

What's In

Previously, we learned that geologic processes cause different hazards such as earthquakes, volcanic eruption and landslides. These has caused unimaginable impact to people and their properties. Being situated in in the tropics, the Philippines is found to be more exposed and vulnerable to hydrometeorological hazards compared to other countries. Philippines is also a tropical country with only wet and dry seasons.

Activity 1: Find Me

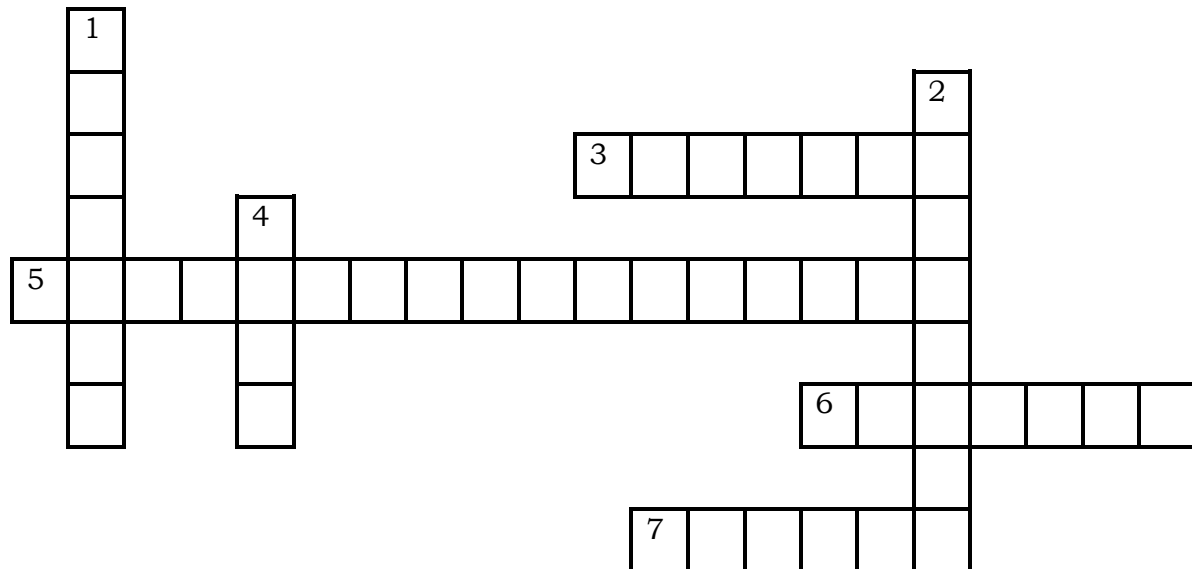
Directions. Locate and encircle words that are related to human activities that speed up or trigger landslides. Terms can be found horizontally, vertically, diagonally or even backward.

P	M	S	H	P	O	L	L	U	T	I	O	N	P	K
I	N	I	E	S	J	V	Z	W	F	R	Q	U	I	Y
H	O	X	N	P	S	U	J	Z	C	U	T	Z	P	O
G	I	O	X	Z	O	U	H	E	L	E	J	H	V	Z
I	T	M	G	K	H	L	Q	Z	M	N	M	E	Q	F
S	A	F	I	W	B	M	S	I	Q	E	R	E	U	R
L	V	M	T	S	S	W	R	V	T	L	Z	C	A	L
Z	A	T	A	X	M	F	L	C	O	Z	T	Y	R	N
I	C	Y	L	I	K	W	U	A	A	E	I	K	R	S
D	X	M	N	I	E	Q	D	O	H	N	I	H	Y	Y
J	E	O	Z	K	E	I	F	Y	Y	I	E	U	I	N
Y	O	A	U	C	N	T	P	I	M	I	N	I	N	G
U	S	S	P	G	Q	K	C	G	D	N	A	L	G	Q
E	E	W	P	G	U	X	B	Z	X	I	D	I	V	J
E	K	G	Q	M	D	Q	S	T	G	B	U	I	W	D

What's New

Activity 2: Decode Me

Directions. Presented below is a crossword puzzle. Using the jumbled letters as clues, rearrange them to decipher a term that fits in the corresponding boxes across and down.



Across

3. IOP-IPO
5. CIATRLPO SELCONYC
6. DGTHRUO
7. SLDFOO

Down

1. RHAZASD
2. OSOSONMN
4. KRIS

What is It

Hydrometeorological hazards

They are brought by extreme meteorological and climate phenomena that includes tropical cyclones, thunderstorms, tornado (*ipo-ipo*) drought, and floods.

Tropical cyclones

Tropical cyclones are known in various names depending on the country where you live. In the Western North Pacific around the Philippines, Japan, and China the storms are known as typhoons, while in the North Atlantic Ocean and the Eastern North Pacific they are referred to as hurricane. Here are the top five destructive typhoons to ever hit the country: Typhoon Haiphong (1881), Typhoon Haiyan (Yolanda) (2013), Tropical storm Thelma (Uring) (1991), Typhoon Bopha (Pablo) (2012), and Typhoon Angela (1867).

Monsoons

A monsoon is a seasonal wind and rains pattern, and the word “monsoon” believed to be originated from the Arabic word *mawsim* (season), via Portuguese and the Dutch *monsun*. There are two known monsoons in the Philippines that occur every year: Summer Southwest (*Habagat*) and Winter Northeast Monsoon (*Amihan*).

1. *Amihan*: brings cloudless skies and nippy mornings during the dry season (October to late March)
2. *Habagat*: brings heavy rains and some deadly typhoons (June to September)

Floods

Flood is as an abnormal progressive rise in the water level of a stream that may result in the over-flowing by the water of the normal confines of the stream. A flood can vary in size, speed of water, and duration.

Tornado (*Ipo-ipo*)

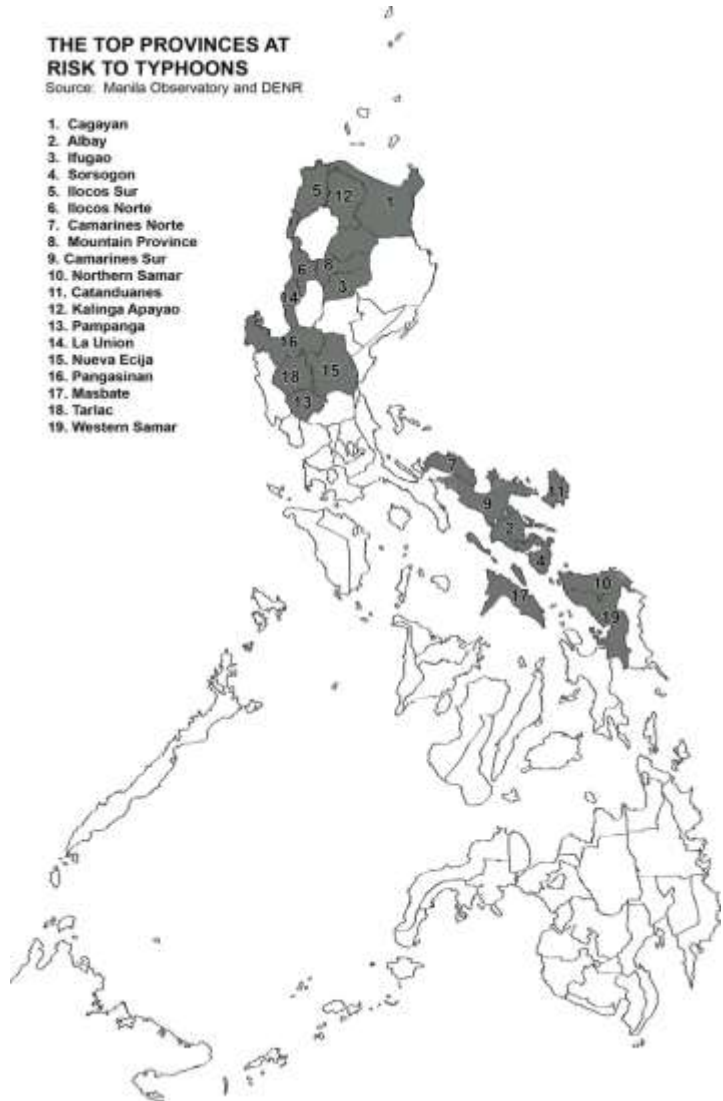
A tornado is a narrow, violently rotating column of air that extends from a thunderstorm to the ground. The main cause of tornadoes are thunderstorms though tornadoes are not common in the Philippines, still it can occur at any time of the year.

Northern Luzon, Southeastern Luzon and Eastern Visayas are the areas highly at risk to the occurrence of tropical depressions, tropical storms, typhoons and super typhoons.

THE TOP PROVINCES AT RISK TO TYPHOONS

Source: Manila Observatory and DENR

1. Cagayan
2. Albay
3. Ifugao
4. Sorsogon
5. Ilocos Sur
6. Ilocos Norte
7. Camarines Norte
8. Mountain Province
9. Camarines Sur
10. Northern Samar
11. Catanduanes
12. Kalinga Apayao
13. Pampanga
14. La Union
15. Nueva Ecija
16. Pangasinan
17. Masbate
18. Tarlac
19. Western Samar



Did you know?

Typhoon Haiphong in 1881, ranks as number one deadliest typhoon that crossed the Philippines.

TOP 10 FLOOD PRONE PROVINCES

Source: Manila Observatory and DENR

1. Pampanga
2. Nueva Ecija
3. Pangasinan
4. Tarlac
5. Maguindanao
6. Bulacan
7. Metro Manila
8. North Cotabato
9. Oriental Mindoro
10. Ilocos Norte



Pampanga, Nueva Ecija, Tarlac, and Bulacan provinces make Region III as the most exposed region in the country to tropical cyclones.

What's More

Activity 3: Identify me

Directions. Familiarize yourself with the hazard map from previous page and answer the following questions.

1. Identify the places in the Philippines that are both prone to typhoons and floods. Justify your answers.
2. What is the importance of using hazard map?

What I Have Learned

Activity 4: Complete me

Directions. Read the following statements. Complete them by filling in the blanks with the correct term or phrases.

1. Seasonal wind and rain pattern phenomena are referred as _____.
2. In average, ____ typhoons visited Philippines every year.
3. In the Philippines, tropical cyclones are popularly known as _____.
4. In 1988 the deadliest typhoon ever hit in the Philippines is _____.
5. The most flood-prone province in the Philippines is _____.

What I Have Learned

Activity 5: Hazard identification

Directions. Identify the situation that put humankind at risk on the following locations:

1. Home
2. Classroom
3. Community (e.g. barangay, municipality or provinces)

The answer must be something similar to this:

In the community: mining and quarrying may speedup landslides

Assessment

Directions. Read the following questions and choose the letter of the correct answer. Write your answer on a separate sheet of paper.

1. What is the name of the deadliest typhoon ever hit the Philippines in 1881?
A. *Uring* C. *Angela*
B. *Thelma* D. *Haiphong*
2. What monsoon brings cloudless skies and nippy mornings during the dry season?
A. easterlies C. winter northeast
B. summer southwest D. low pressure area
3. What are the two seasons in the Philippines?
A. wet and dry C. summer and winter
B. hot and cold D. autumn and spring
4. Which of the following is the MOST exposed region in the country to tropical cyclones?
A. Region I C. Region III
B. Region II D. Region IV
5. What ocean is located in the eastern part of the Philippines in which most typhoons are originated?
A. Arctic C. Pacific
B. Indian D. Atlantic
6. Which of the following is an EXCEPTION on the variation of flood?
A. size C. speed
B. color D. duration
7. Which of the following is NOT a hydrometeorological hazard?
A. cyclone C. monsoon
B. typhoon D. tsunami
8. What is the highest category in the typhoon warning signal system in the Philippines?
A. 2 C. 4
B. 3 D. 5
9. What is the usual movement of typhoon that is coming from the Pacific Ocean?
A. northwest C. southern
B. southwest D. northern
10. Which among the following provinces has high risk to typhoons?
A. Albay C. Sorsogon
B. Masbate D. Pampanga

11. Which among the following provinces has low risk in flood?
A. Tarlac
B. Bulacan
C. Marinduque
D. Maguindanao
12. What makes Palawan an ideal province to live in relation to hydrometeorological hazard?
A. high risk in typhoon but low risk in flood
B. low risk in typhoon but high risk in flood
C. low risk both in typhoon and flood
D. high risk both in typhoon and flood
13. Which of the following is MOST likely be affected by typhoon originated from the West Philippine Sea and is moving northeast?
A. Albay
B. Palawan
C. Zamboanga
D. Negros Occidental
14. Why is the Philippines frequently visited by typhoon all year-round? Because it is
A. highly populated
B. composed mostly of islands
C. located near the Pacific Ocean
D. near the western hemisphere
15. Samer would like to settle to a province that is LEAST prone to typhoon and flood, which among the following provinces will be a good option?
A. Albay
B. Tarlac
C. Palawan
D. Pampanga

Additional Activities

Activity 6: Interview me

Directions. Read and answer the following.

1. Have you ever experienced any form of hydrometeorological hazards such as tropical cyclones, monsoons, floods and *ipo-ipo*? How did you feel? What did you do during and after the situation?

2. If you have never experienced any form of hydrometeorological hazards, look for someone who was able to witness and experience it first-hand. Ask them their feelings and thoughts during and after the hazard event. Also, ask them the things they did during and after the scenario.

Answer Key

What's In Activity 1 Possible answers Mining, Land use, excavation, quarrying, land pollution and overloading slopes. What I Know 1. B 2. B 3. D 4. A 5. C 6. D 7. B 8. B 9. A 10. C 11. A 12. C 13. A 14. D 15. B	What I have Learned Activity 4 1. Monsoons 2. 20 3. Hydrometeorological 4. Haiphong 5. Pampanga What's more Activity 3 Pampanga, Nueva Ecija and Tarlac What's New Activity 2 Across 3 ipo-ipo 5 tropical cyclones 6 drought 7 floods Down 1 hazard 2 monsoons 4 risk	Additional activities Answers may vary among students Assessment 1. D 2. C 3. A 4. C 5. C 6. B 7. D 8. D 9. A 10. A 11. C 12. C 13. B 14. C 15. C What Can I Do Activity 5 Answers may vary among students
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Earth and Life Science

Marine and Coastal Processes

Earth and Life Science
Marine and Coastal Processes
First Edition, 2020

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The module is composed of one lesson, namely:

- Lesson 1 – Effects of Marine and Coastal Processes

After going through this module, you are expected to:

1. describe how marine and coastal processes result to coastal hazards; and
2. explain how coastal erosion, submersion and saltwater intrusion occur.

What I Know

Directions. Read the following questions and choose the letter of the best answer. Write the chosen letter on a separate sheet of paper.

1. Based on the recent estimate of the National Mapping and Resource Information Authority (NAMRIA), how many islands does the Philippines have?
 - A. 7,107
 - B. 7,330
 - C. 7,450
 - D. 7,641
2. What are the two ions that mainly compose seawater?
 - A. hydrogen and potassium
 - B. hydrogen and oxygen
 - C. sodium and chlorine
 - D. nitrogen and phosphorus
3. Which of the following is NOT a coastal process?
 - A. waves
 - B. storm surge
 - C. tides
 - D. landslide

4. Which of the following is NOT an example of ecosystem present in the marine environment?
 - A. mangroves
 - B. seagrass
 - C. dipterocarps
 - D. coral reef
5. What can be attributed to the melting of the iceberg in the polar region?
 - A. rising temperature
 - B. ozone depletion
 - C. chemicals in the atmosphere
 - D. all of the above
6. What refers to the study of the processes associated with marine and coastal ecosystem?
 - A. Biology
 - B. Chemistry
 - C. Oceanography
 - D. Physics
7. Which of the following forces is responsible for tides?
 - A. gravitational
 - B. electrical
 - C. nuclear
 - D. frictional
8. What refers to the rising of seawater due to pressure and wind associated with a storm?
 - A. tides
 - B. crustal movement
 - C. storm surge
 - D. waves
9. What refers to a steep rock face?
 - A. cave
 - B. stack
 - C. cliff
 - D. bar
10. What do you call the vibrations or shaking of the Earth's surface caused by the rapid movement of rocks in the crust?
 - A. shadow zones
 - B. earthquakes
 - C. tsunami
 - D. hot spot

11. What do you call the most common feature formed by wave deposition?
- A. stack
 - B. tombolo
 - C. beach
 - D. spit
12. Which of the following fields of science is concerned with the study of weather and climate as well as the processes involved in it?
- A. Hydrology
 - B. Marine Science
 - C. Meteorology
 - D. Limnology
13. Which of the following is attributed to the rising of sea level?
- A. snow
 - B. continents
 - C. glaciers
 - D. crust
14. These are caused by heavy and steady rains and poor drainage system in low-lying areas.
- A. drought
 - B. floods
 - C. cyclones
 - D. hurricane
15. All of following statements about coastal processes is true EXCEPT
- A. Beach is prone to erosion.
 - B. Erosion only occurs in the upland areas.
 - C. Wind is a contributory factor to storm surge.
 - D. Ocean waves cause water to move in the seashore

Lesson 1 Processes

The coast is one of the most dynamic parts of the Earth's surface. It contains some of the world's sensitive and threatened ecosystems such as mangroves and beach forest, seagrass and coral reefs. The dynamics of the marine environment result to different processes that affect human communities and organisms in the coastal ecosystem. Some of these processes result to natural hazards.

Marine systems are referred to as the world's oceans while coastal systems refer to the interface between oceans and land, extending seawards to about the middle of the continental shelf and inland to include all areas strongly influenced by the oceans (Millennium Ecosystem Assessment, 2005). About 23% of the world's population live within 100 km of the coast and about 10% live in extremely low-lying areas. Many of these processes like coastal erosion, storm surges, coastal flooding, and tsunamis.

Figure 1. Beach coast in Calatagan, Batangas (*Photo taken by M. Cudiamat*)



What's In

You have learned previously that marine systems are much broader compared to coastal systems. Coastal processes are activities that regularly happen in the marine ecosystem as influenced by the weather, climate and the adjacent landscape. Let us check if you still remember the different marine and coastal processes through this review.

Activity 1: Word Decoding

Directions. Rearrange the jumbled letters and identify the term being referred to in each of the following items. Write your answer on the space provided.

1. These are caused by the gravitational pull between the moon and Earth.

E	I	T	S	D
---	---	---	---	---

2. They are formed by the wind and storm in the ocean.

S	W	V	E	S
---	---	---	---	---

3. This is caused by the melting of glaciers and iceberg.

E	V	L	E	L
---	---	---	---	---

E	S	A
---	---	---

E	S	I	R
---	---	---	---

4. It refers to the motion of the outermost shell of the Earth.

S	A	C	U	R	L	T
---	---	---	---	---	---	---

N	T	E	V	M	O	M	E
---	---	---	---	---	---	---	---

5. This is the rising of the seawater due to atmospheric conditions.

U	R	E	G	S
---	---	---	---	---

R	M	T	O	S
---	---	---	---	---

Activity 2: My Picture of Human and Coastal Environment

Directions. On the box provided below, draw a coastline that will show the interaction of humans and the coastal environment using the coastal terms listed below. Then, describe your illustration in not less than 3-sentences.

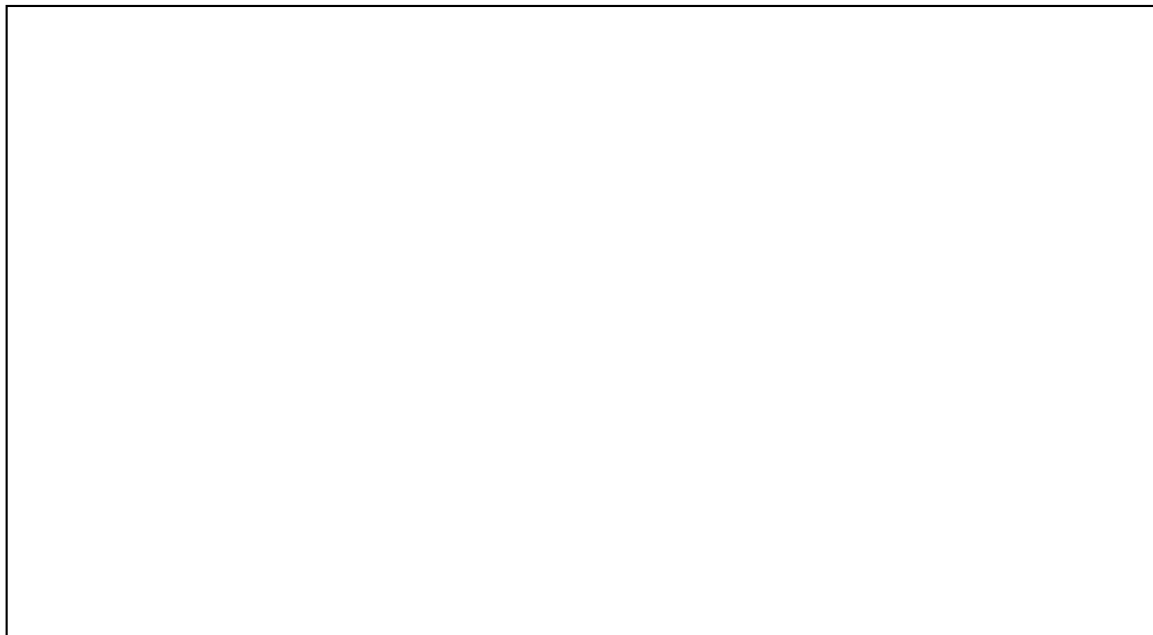
Humans

Beach

Coastal forest/trees

Estuary/river

Waves



What's New

Revisiting Marine and Coastal Processes

What have you noticed about the terms used in the previous activity? Actually, they are all marine and coastal processes. The scientific field dealing with these processes happening in our major oceans and seas is called **oceanography**. It is an interdisciplinary field of science that integrates the different fields such as physics, chemistry, biology, geology, meteorology, mathematics and even the social sciences to understand the link between humans and oceans. **Coastal processes** are activities or events happening in the marine environment. These are driven by the different environmental factors such as atmospheric pressure, temperature, movement of the Earth, moon and other dynamic changes in the ocean.

Now, let us talk about the different coastal processes in details.

Coastal processes include waves, tides, sea level change, crustal movement and storm surge. **Waves** are caused by the movement of the air masses in the coastal environment. **Tides** refer to the gravitational pull between the Earth and the moon. **Sea level change** is a result of the rise of ocean water which can be attributed to the melting of glaciers or iceberg in the polar regions. **Storm surge** refers to the rising of seawater due to changes in pressure and wind associated with a storm. **Crustal movement** is caused by the motion of the oceanic and continental crust of the Earth.

Effects of Marine and Coastal Processes

The different coastal processes described above may result to coastal hazards. **Coastal hazards** are physical phenomena that expose the marine environment to risk of property damage, loss of life and ecological degradation (Figure 2).

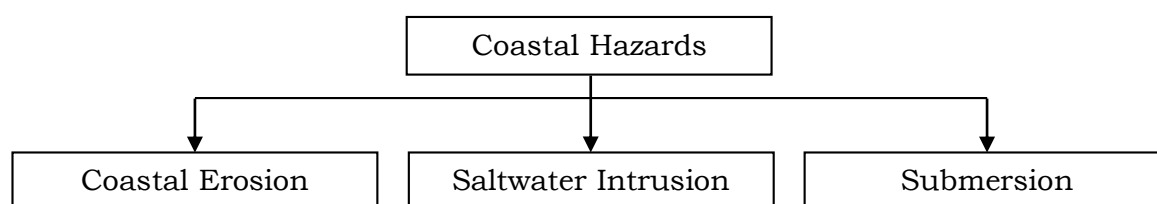


Figure 2. Concept map of coastal hazards

Coastal Erosion

It is the loss or displacement of land along the coastline due to the action of waves, currents, tides, wind-driven water or other impacts of storms. Coastal erosion is a type of coastal hazard which is brought about by the different coastal processes.



Figure 3. Coastal Erosion

Saltwater Intrusion

It is a major concern commonly found in coastal aquifers around the world. An **aquifer** is an underground layer of permeable rock, gravel, sand or silt. Groundwater from an aquifer is usually extracted by a water well. Once an aquifer becomes contaminated it becomes unusable anywhere from 2 weeks to 10,000 years. Saltwater intrusion is the induced flow of seawater into freshwater aquifers primarily caused by groundwater development near the coast.

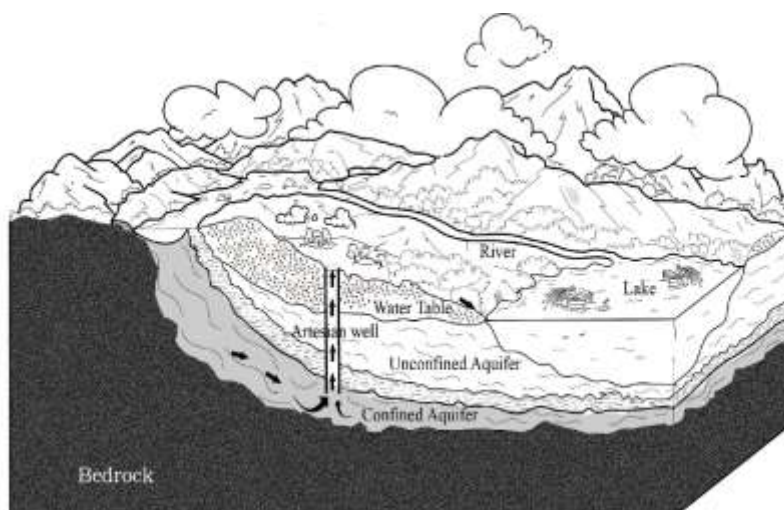


Figure 4. Aquifer

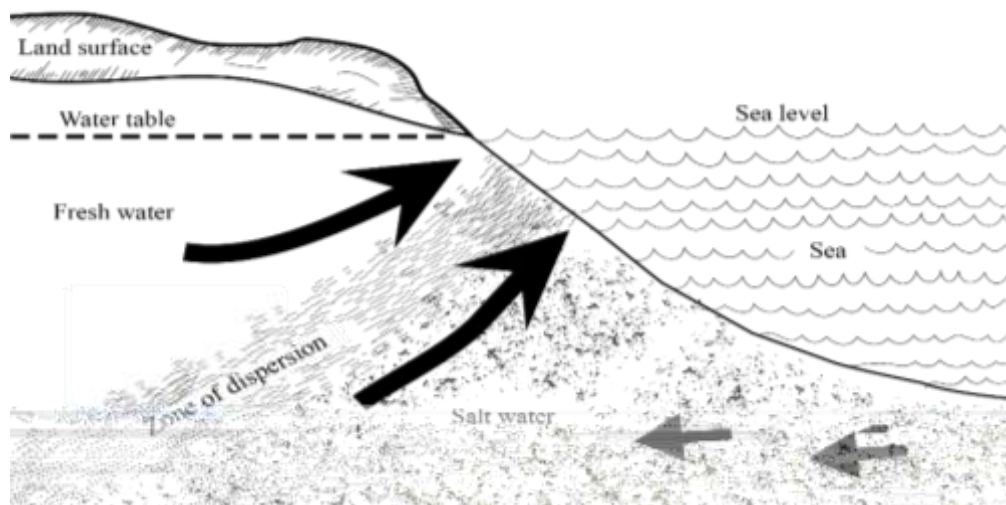


Figure 5. Saltwater intrusion

Submersion

It refers to the movement of coastal sediments from the visible portion of a beach to the submerged nearshore region of the coast.

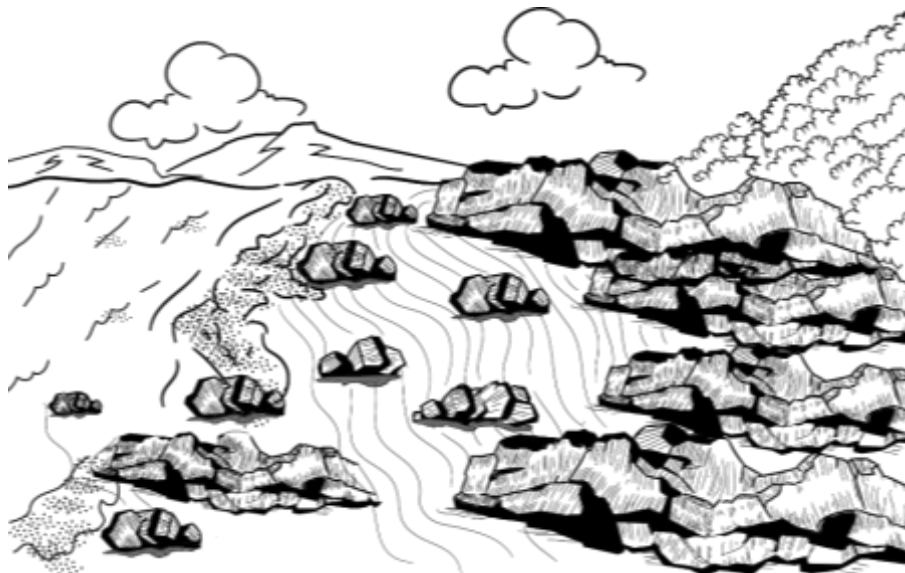


Figure 6. Submersion

What is It

The figure below shows the link between marine and coastal processes and coastal hazards. These processes could lead to hazards in the coastline that can be mitigated through different coastal management techniques which you will study in the next module.

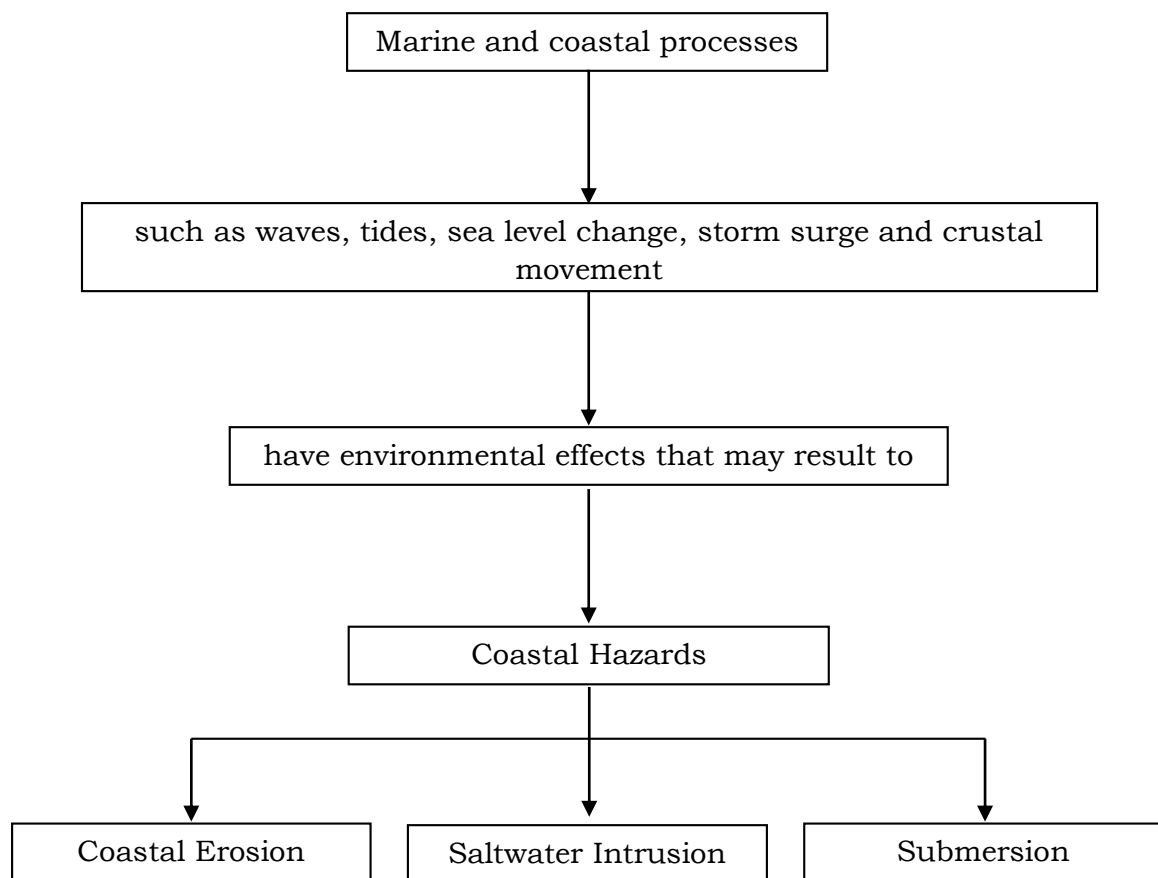


Figure 7. Concept map of the relationship between marine and coastal processes and coastal hazards

What's More

Activity 3. Picture Analysis

Directions. Take a look at the pictures presented below. Describe how prone or vulnerable the places are to coastal hazards. Discussions must be at least 2 sentences.



Figure 8. Calatagan coastline (*Photo taken during fieldwork of M. Cudiamat*)



Figure 9. Part of a river leading to mangrove forest in Mogpog, Marinduque
(*Photo taken during fieldwork of M. Cudiamat*)



Figure 10. Exposed beach front during low tide in Bali, Indonesia
(Photo taken by M. Cudiamat)

Activity 4. Poster Making

Directions. Prepare a poster with the theme: “*Coastal Processes and their Impacts to Society*”. Scoring criteria are as follows:

Relevance to the theme	4 points
Creativity	3 points
Originality	3 points
TOTAL	10 points

Post your draft here

What I Have Learned

Let us take a look at the main points of this module.

1. Ocean is a dynamic part of the planet Earth.
2. Marine systems are referred to as the world's oceans.
3. Coastal systems refer to the interface between oceans and land strongly influenced by the marine system.
4. Marine and coastal processes include waves, tides, sea level change, storm surge and crustal movement which affect the coastal systems.
5. Coastal hazards are physical phenomena that expose the marine environment to risk of property damage, loss of life and ecological degradation.
6. Some of the coastal hazards include coastal erosion, submersion and saltwater intrusion.
7. Coastal erosion is a process where land or sediment attached to coastline is displaced due to the action of waves, currents, tides, and other weather disturbances such as typhoon.
8. Submersion refers to the movement of coastal sediments from the visible portion of a beach to the submerged nearshore region of the coast.
9. Saltwater intrusion pertains to an induced flow of seawater into freshwater aquifers primarily caused by groundwater development near the coast

What I Can Do

Directions: As a Senior High School student, how can you help the local government to mitigate the harmful effects of coastal and marine processes such as coastal erosion, submersion and saltwater intrusion assuming that your community is prone to these coastal hazards.

Assessment

Directions. Read the following questions and choose the letter of the best answer. Write the chosen letter on a separate sheet of paper.

1. Which of the following is NOT a coastal process?
A. waves
B. storm surge
C. tides
D. landslides
2. Which of the following is caused by the gravitational pull of the moon and Earth?
A. tides
B. storm surge
C. sea level rise
D. tsunami
3. Which of the following is attributed to the rising of sea level in the polar region?
A. snow
B. continents
C. glaciers
D. crust
4. What refers to the rising of seawater due to pressure and wind associated with a storm?
A. tides
B. crustal movement
C. storm surge
D. waves
5. Which of the following statements is NOT TRUE about coastal processes?
A. Beach is prone to erosion.
B. Erosion only occurs in the upland areas.
C. Wind is a contributory factor to storm surge.
D. Ocean waves cause water to move in the seashore.
6. Which of the following is NOT a coastal hazard?
A. landslide
B. submersion
C. coastal erosion
D. saltwater intrusion
7. What is described as an induced flow of seawater into freshwater aquifers primarily caused by groundwater development near the coast?
A. submersion
B. storm surge
C. coastal erosion
D. saltwater intrusion
8. Which of the following is NOT an agent of coastal erosion?
A. land pollution
B. tides

- C. storms
 - D. ocean waves
9. What do you call the movement of sediments from the visible portion of a beach to the nearshore region of the coast?
- A. tides
 - B. submersion
 - C. coastal erosion
 - D. saltwater intrusion
10. Which of the following coastal processes may cause hazards in the marine environment?
- A. tides
 - B. waves
 - C. crustal movement
 - D. all of the above
11. What do you call the scientific study of the chemical, biological and physical properties of ocean water?
- A. Biology
 - B. Chemistry
 - C. Physics
 - D. Oceanography
12. Where can we usually find aquifers?
- A. underground
 - B. on the top of the mountain
 - C. top surface of the rivers
 - D. in the ocean waves
13. What two ions compose mainly the seawater?
- A. hydrogen and potassium
 - B. hydrogen and oxygen
 - C. sodium and chlorine
 - D. nitrogen and phosphorus
14. Which system is broader?
- A. marine system
 - B. coastal system
 - C. both A and B
 - D. neither A nor B
15. As a student, what ways can you do to help adapt and mitigate coastal hazards?
- A. Educate yourself.
 - B. Participate in local disaster preparedness program.
 - C. Promote the programs of the community.
 - D. All of the above

Additional Activities

Directions. Read the article below from the Philippine Star in relation to the effects of marine and coastal processes.

A. Coastal Erosion

MGB: Coastal erosion caused Zambales beach collapse

by Rhodina Villanueva (The Philippine Star) - July 2, 2013 - 12:00am

MANILA, Philippines - The Mines and Geosciences Bureau (MGB) yesterday said that the collapse of the coastline of a beach resort in Candelaria, Zambales does not constitute a sinkhole phenomenon but was a result of coastal erosion. MGB Director Leo Jasareno said they are recommending that the area be declared permanently as a no swimming and danger zone as well.

Jasareno said with the use of ground penetrating radar (GPR) equipment, a team of geologists who conducted an investigation found no voids or cavities, or even a sinkhole in the affected area. What was identified were alternating layers of loose and fine to coarse sand 18.5 meters below the surface, he said. The equipment functions like an X-ray that can check land sinking up to 100 meters or 300 feet below.

The beach slump is not due to sinkhole but is a result of coastal erosion caused by wave and tidal currents. Waves undercut the base of the shoreface, which happened during the interface of low tide and high tide, with the prevailing southwest monsoon, the MGB report said. Jasareno noted that the area is underlain by unconsolidated beach sand that is unstable and easily reworked by waves.

The coastal sedimentation dynamics is indicated by the advance and retreat of the shoreline, and that the area is also prone to storm surge hazard, he said. He said coastal erosion is a natural phenomenon leading to the formation of a cliff 100 meters from the shoreline. The depth of the cliff or the steep slope from the shoreline is about 25 to 30 meters. The MGB recommended continuous monitoring of the area for large-scale erosion and storm surge, particularly when there is an incoming weather disturbance. A danger zone should be declared as the area is highly prone to coastal erosion, he added. The MGB estimated the danger zone to be 100 kilometers long and the width to be 20 to 30 meters.

Answer the following questions based on the article you have read.

1. What is the article all about?
2. How did the MGB define coastal erosion?
3. What is the recommendation of the MGB about the issue?

B. Saltwater Intrusion

Saltwater Intrusion Threatening Potable Water Supplies in Philippines

21 Jun 2010 - 20:58 by OOSKAnews Correspondent

MANILA, PHILIPPINES

Some 19 areas within the Philippines are facing contamination due to saltwater intrusion, as many continue to extract water from the nation's aquifers, according to the Philippine Sanitation Alliance (PSA) Elisea Gozun, former Environment Secretary and current president of PSA and member of Earth Day Network Philippines, presented the findings based on government data on June 17.

"This is an irreversible process," Business Mirror quoted Gozun as saying. More than half, or some 58 percent, of groundwater that is to be used for potable supplies "is contaminated and needs treatment," she added. Also, saltwater intrusion is affecting one of the nation's last remaining potable water supply sources: rivers. Forty-nine percent of the river systems classified for drinking water do not meet pollution standards.

The PSA expected Pasig-Laguna, Pampanga, Agno, Bicol, Cagayan, Western Visayas and Cebu to be adversely affected by 2025. The economic costs of the pollution is thought to exceed \$ 1.7 billion USD each year, with health costs from improper sanitation making up the lion's share at \$1.2 billion USD, followed by water costs like domestic use and fish production at \$391 million USD.

Gozun stressed that the loss of life was even more costly. She said 55 Filipinos die every day from diseases related to poor sanitation and more than 11,338 Filipinos die each year from diarrhea.

"Improving sanitation is the key to achieving most of the Millennium Development Goals," Gozun said.

The PSA made both large-scale and small-scale suggestions for elevating the profile of the problem, including investment in wastewater management, rainwater harvesting, water reuse, repairing leaky household systems and using a cup of water to brush one's teeth. Meanwhile, Senator Edgardo J. Angara urged increased investment in water management and wastewater treatment.

"Climate change, urbanization and the need to feed a growing population have put a strain on our finite water resources, and there is an urgent need to address the dangers they pose to the health of our people and the sustainability of our environment. More often than not, water sanitation and sewerage systems in the country is overlooked and neglected. We need to pour more resources into it," the Philippine Information Agency quoted Angara as saying.

"The acute seasonal problem of lack of access to potable water has large economic costs, as well as profound impact on the quality of life. Poor water quality affects our citizens' health, lost agricultural production, threatens food security, and a host of other damaging consequences," he added.

Answer the following questions based on the article you have read.

1. What is the article all about?
2. How will you relate coastal hazards to water crisis in the Philippines?

Answer Key

What I Know 1. D 2. A 3. C 4. C 5. B 6. A 7. D 8. A 9. B 10. D 11. D 12. A 13. C 14. A 15. D	What's In 1. Tides 2. Waves 3. Sea level rise 4. Crustal movement 5. Storm surge What's More There are varied answers.	Assessment 1. D 2. C 3. D 4. C 5. D 6. C 7. A 8. C 9. C 10. B 11. C 12. C 13. C 14. B 15. B
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Earth and Life Science

Mitigation to Coastal Processes and Hazards

Earth and Life Science – Senior High School
Mitigation to Coastal Processes and Hazards
First Edition, 2020

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What I Need to Know

This module was designed and written with you in mind. It is here to help you master the nature of Earth and Life Science. 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 covers:

- Lesson 1 – Mitigation to Coastal Processes and Hazards

After going through this module, you are expected to:

1. identify the different impacts of human activities to coastal processes;
2. define mitigation to coastal hazards development; and
3. enumerate different ways to prevent or mitigate the impact of land, waste disposal and construction of structures on coastal processes.

What I Know

Directions. Read the following questions and choose the letter of the correct answer. Write the chosen letter on a separate sheet of paper.

1. Which of the following is NOT a reason for human population to choose coastal zones as settling grounds?
 - A. fertile agricultural land
 - B. abundant marine resources
 - C. peaceful and safe residential area
 - D. great possibility for trade and transport
2. What refers to the action taken to eliminate or reduce the long-term risks and hazards in the coastal area?
 - A. alteration
 - B. mitigation
 - C. renovation
 - D. restoration

3. What are the two processes interacting in a highly dynamic natural systems of coastlines?
 - A. chemical and physical processes
 - B. endogenic and exogenic processes
 - C. oceanic and continental processes
 - D. atmospheric and geologic processes
4. Which of the following activities in coastal areas DOES NOT trigger hazard to the natural balance of coastal system?
 - A. allowed number of tourists
 - B. construction of houses
 - C. development of hotels
 - D. prohibition of mining
5. Which of the following is NOT a result of a geologically active zone on Earth coastal system?
 - A. erosion
 - B. salt intrusion
 - C. sea-level change
 - D. water nourishment
6. What refers to a climate change phenomenon through which ocean water volume increases, ice sheets and glaciers melt, and thermal expansion occurs?
 - A. erosion
 - B. salt intrusion
 - C. sea-level change
 - D. water nourishment
7. What do you call the movement of saline water to fresh water aquifers which can lead to the degradation or contamination of ground water including drinking water resources?
 - A. erosion
 - B. salt intrusion
 - C. sea-level change
 - D. dewatering of beach
8. Which of the following is an impact of mining activities to coastal processes?
 - A. deposition
 - B. ice melting
 - C. reforestation
 - D. surface run-off

9. Which of the following is the BEST method to avoid erosion?
- A. break water construction
 - B. controlling land development
 - C. improving waste management
 - D. maintaining plant cover or vegetation
10. Which of the following processes is described as pumping out water from the shores to prevent erosion?
- A. beach dewatering
 - B. beach nourishment
 - C. breakwater construction
 - D. installation of sand bags
11. Which method are you going to use when there is a need to add a large amount of sand to the coast?
- A. beach dewatering
 - B. beach nourishment
 - C. breakwater construction
 - D. installation of sand bags
12. What will you construct to prevent the further advancement of saltwater if already present in the coastal areas?
- A. sand bags
 - B. breakwater
 - C. beach hotels
 - D. beach houses
13. Which of the following DOES NOT ensure effective management of saltwater intrusion cases?
- A. construction of seawalls
 - B. monitoring of coastal activities
 - C. assessment of coastal areas regularly
 - D. regulation of human activities along coastal zone
14. One of your classmates is living in a coastal area of the community. You found out that this coastal area is already polluted. What activity can you suggest to mitigate the said problem?
- A. acoustic concert
 - B. coastal clean-up drive
 - C. population control campaign
 - D. recollection and reflection among the community

15. Your school is located in a coastal area. You notice that waves are already damaging the shore near the fence of the school especially during high tide and monsoon seasons. What can be constructed to mitigate the said problem of the school?
- A. sand bag barriers
 - B. beach dewatering
 - C. breakwater
 - D. sea wall

Lesson 1 Mitigation to Coastal Processes and Hazards

Coastal areas have been attractive settling grounds for human population as they provide abundant marine resources, fertile agricultural land and possibilities for trade and transport. This has led to high population densities and high levels of development in many coastal areas and this trend is continuing into the 21st century. At present, about 1.2 billion people live in coastal areas globally, and this number is predicted to increase to 1.8–5.2 billion by the 2080s due to a combination of population growth and coastal migration. Along with this increase follows major investments in infrastructure and the build environment.

The characteristics of coastal environments, however, pose some great challenges to human habitation. Coastlines are highly dynamic natural systems that interact with terrestrial, marine and atmospheric processes and undergo continuous change in response to these processes. Over the years, human society has often failed to recognize the hazards related to these dynamics and this has led to major disasters and societal disruption to various degrees. Even today, coastal development is often taking place with little regard to the hazards present in these environments, although climate change is likely to increase the general hazard levels. Societal activities in coastal areas can also pose a hazard to the natural balance of coastal systems, thereby disrupting e.g. sensitive ecosystems and subsequently human livelihood.

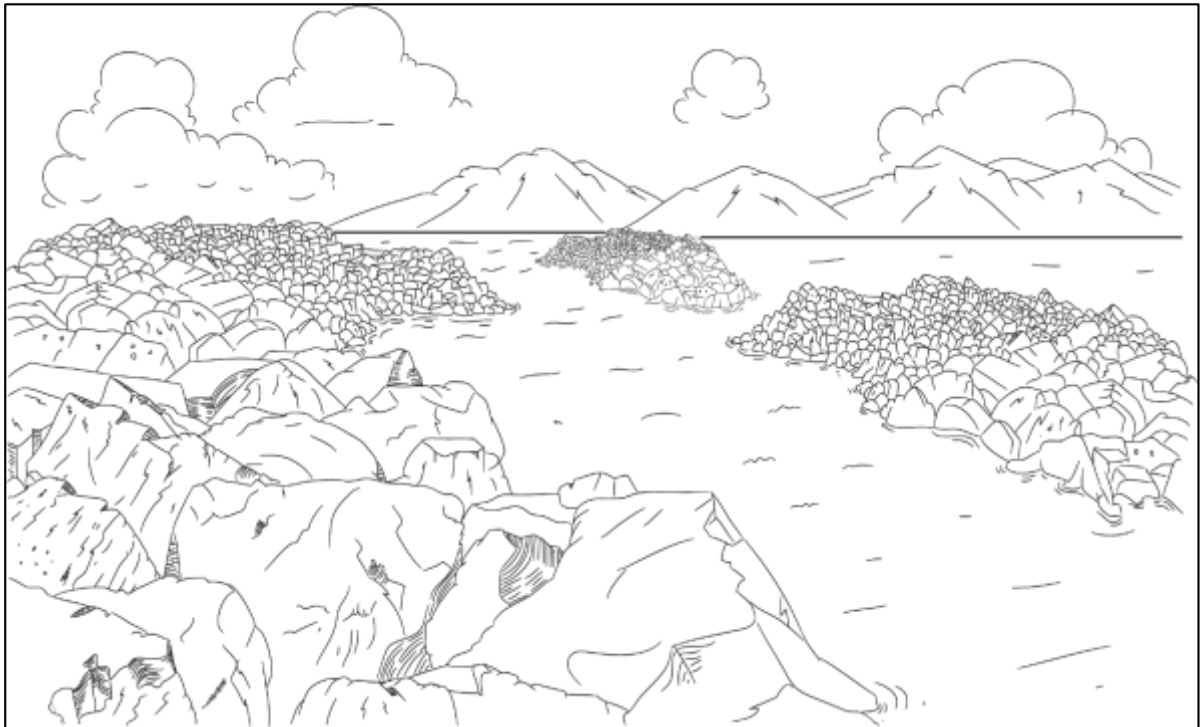


Figure 1. Breakwaters

What's In

Activity 1: Read to Fill-out!

Directions. Read the article about coastal processes. Then, fill in the given table below with the corresponding information needed.

According to the Department of Environment and Natural Resources, coastal ecosystems of the Philippines are very productive and represent the huge amount of natural resources. It provides food and livelihood to many people. However, it is also the most geologically active zone on Earth. Coastal processes in this zone may result to erosion, submersion and saltwater intrusion. These effects could lead to different hazards such as:

1. Barrier islands movement.

Barrier islands are formed due to deposition of sand brought by waves protecting the mainland from damage due to large waves. It also provides habitat for the aquatic wildlife. It can be destroyed or moved by erosion on the contrary.

2. Flooding

It also destroys habitat and may lead to great erosion. The main cause of this hazard is the submersion or sea level rise, a climate change

phenomenon through which ocean water volume increases, ice sheets and glaciers melt, and occurrence of thermal expansion.

3. Fresh water contamination

Intrusion or movement of saline water to fresh water aquifers can lead to the degradation or contamination of ground water including drinking water resources. Intrusion is aided by hydraulic action but triggered by human activities.

Table 1. Coastal processes, causes and effects of different hazards

HAZARD	RESPONSIBLE COASTAL PROCESSES	CAUSES	EFFECTS
Barrier island movement	Waves		Loss of Wildlife Habitat
Flooding		Climate Change	
Fresh water contamination	Sea level change	Salt water intrusion	

What's New

Activity 2: Break it Out!

Directions. Take a look at the given pictures. Then, answer the guide questions.



Figure 2. Sea walls

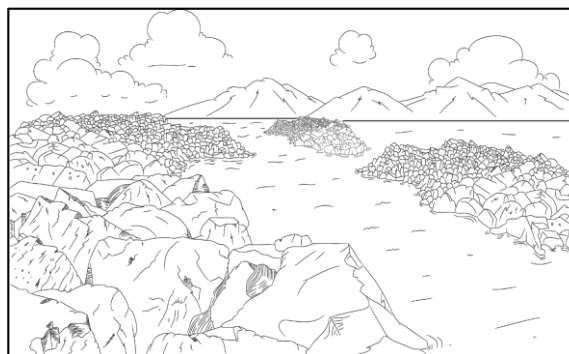


Figure 3. Breakwaters

Guide Questions:

1. What can you say about the pictures?

2. Explain how these ways help in preventing coastal hazards?

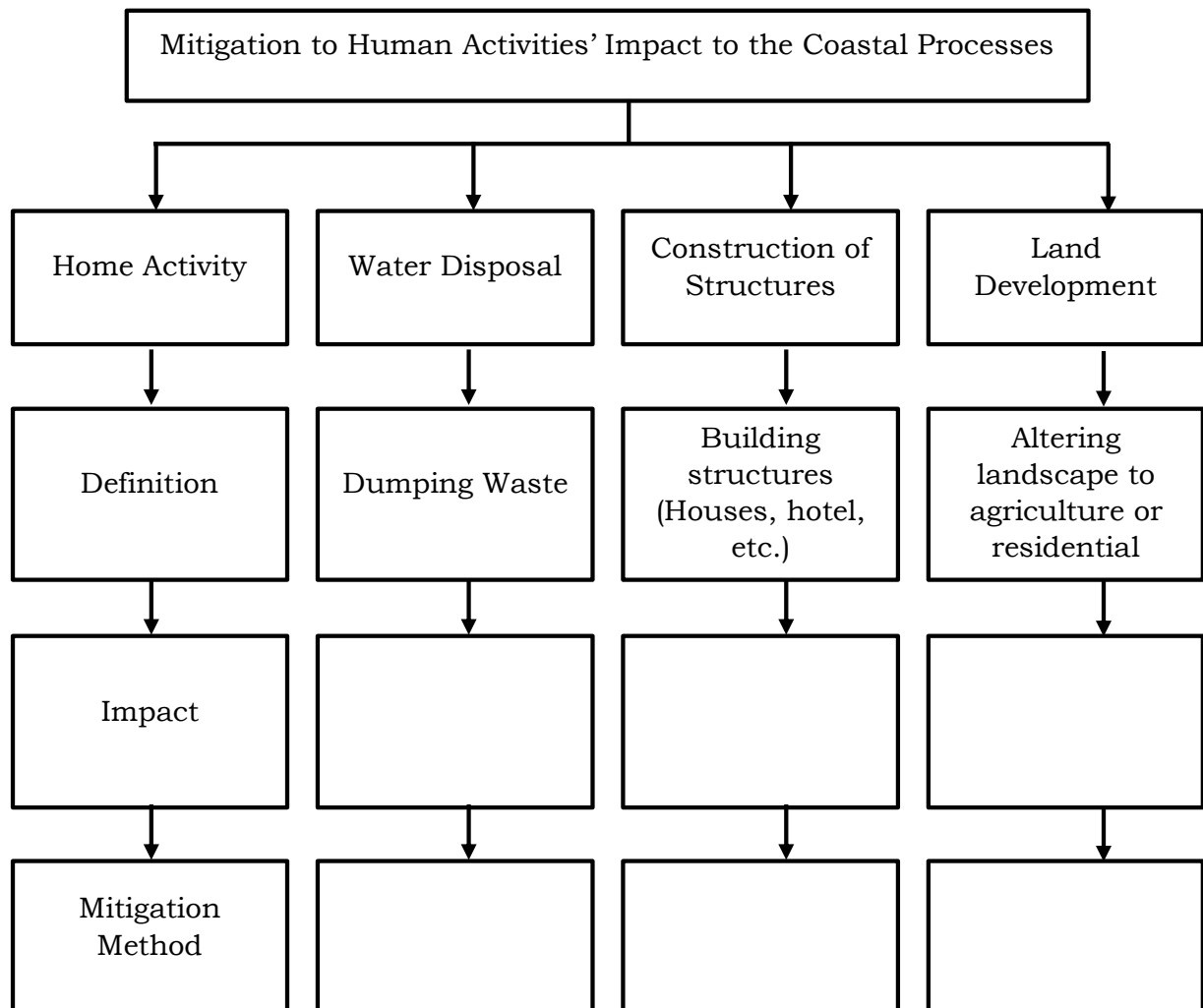
What is It

Activity 3: Root Mapping

Coastal hazard-prone areas in the Philippine local government units in areas that are ranked extremely high in susceptibility to landslide and flooding are advised to immediately relocate the residents of these zones to safer areas. Especially during typhoons that can cause coastal hazards. Though naturally occurring, there are human activities that can affect coastal processes that may lead to hazards.

With this, mitigation methods in the coastal zones for protection are enhanced in these areas. Mitigation refers to action taken to eliminate or reduce the long-term risks and hazards,

Directions. Complete the following concept map by identifying the impacts and mitigation method appropriate in the given human activities.



Options for Impacts:

- Increased erosion
- Increased sediments run-off
- Sea level rise
- Change natural drainage patterns
- Enhanced salt intrusion

Options for Mitigation Methods:

- Maintaining plant cover – This can result to improved vegetation
- Monitoring and assessment - It ensures effective management of saltwater intrusion cases.
- Regulation of Laws
- Artificial recharge – It pumps freshwater to the reservoir to prevent saltwater from intruding through the coasts
- Engineering structures.
- Jetties – It prevent coastal erosion by promoting beach build-up as they trap sand
- Prepare and emergency survival kit
- Create an evacuation plan.
- Know where the evacuation center is and how to get there.
- Listen to news from any means.

Options for Mitigation Methods:

- Seawalls - These are used to counteract waves that hit the shores. These are offshore structures that protect coasts from parallel waves.
- Groins / Stone barriers – It intercepts the steady flow of sand keeps the particular sand from eroding.
- Breakwaters – It can be constructed along coasts to prevent further advancement of saltwater if already present
- Beach nourishment – It is a method where a large amount of sand is added to the coasts.
- Installation of small walls or sandbags – These are used to counteract waves that hit the shores.
- Beach dewatering – It involves pumping out water from the shores to prevent erosion.
- Construction of buildings in a safe distance from the water
- Ban of mining activities – This can cause decrease in pollutants

According to the Department of Environment and Natural Resources, coastal ecosystems of the Philippines are very productive and represent the huge amount of natural resources. It provides food and livelihood to many people. It is also the most famous tourist destinations in the archipelago. Thus, there are many business men who made expeditious development in coastal zones. Along with these are the land development and number of construction sites near the zone. However, it is also the most geologically active zone on Earth. Coastal processes in this zone may result to erosion, submersion and saltwater intrusion.

Erosion as discussed from the previous module is brought by processes like waves and tides. During intense storms and tidal waves, most coastal erosion occurs. It may cause damages on properties, and affect human habitation and tourist activities. They put structures like seawalls to avoid that. These are used to counteract waves that hit the shores. These are offshore

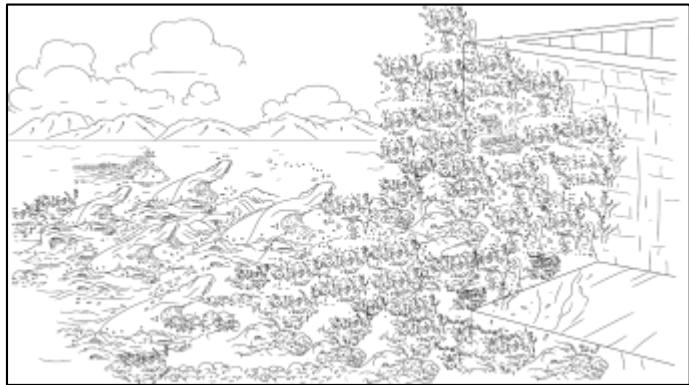


Figure 4. Sea walls

structures that protect coasts from parallel waves. Groins / Stone barriers that intercepts the steady flow of sand are also built to keep sands from eroding. Breakwaters can also be constructed along coasts to prevent further advancement of saltwater if already present. Though these structures avoid erosion it has disadvantages, too. It prevents natural deposition of sands. They absorb wave energy but permanently destroy sand grasses and dunes. Eventually, it will destroy marine habitat.

Aside from concrete structures, there are also practices that can disturb and totally destroy the natural coastal process.

Beach nourishment is commonly done by adding sand to the shore to extend their houses, hotels and other structures. Likely, beach dewatering is another

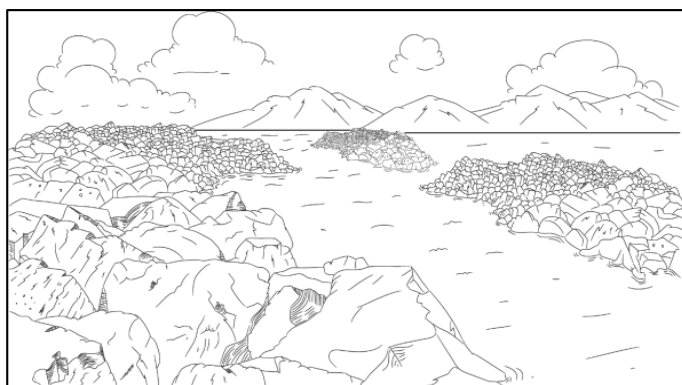


Figure 5. Breakwaters

method to avoid erosion. It involves pumping out water from the shores. However, these practices may lead to saltwater intrusion or movement of saline water into freshwater aquifers. It will result to groundwater quality degradation. Groundwater includes drinking water.

Global Warming and Coastal processes

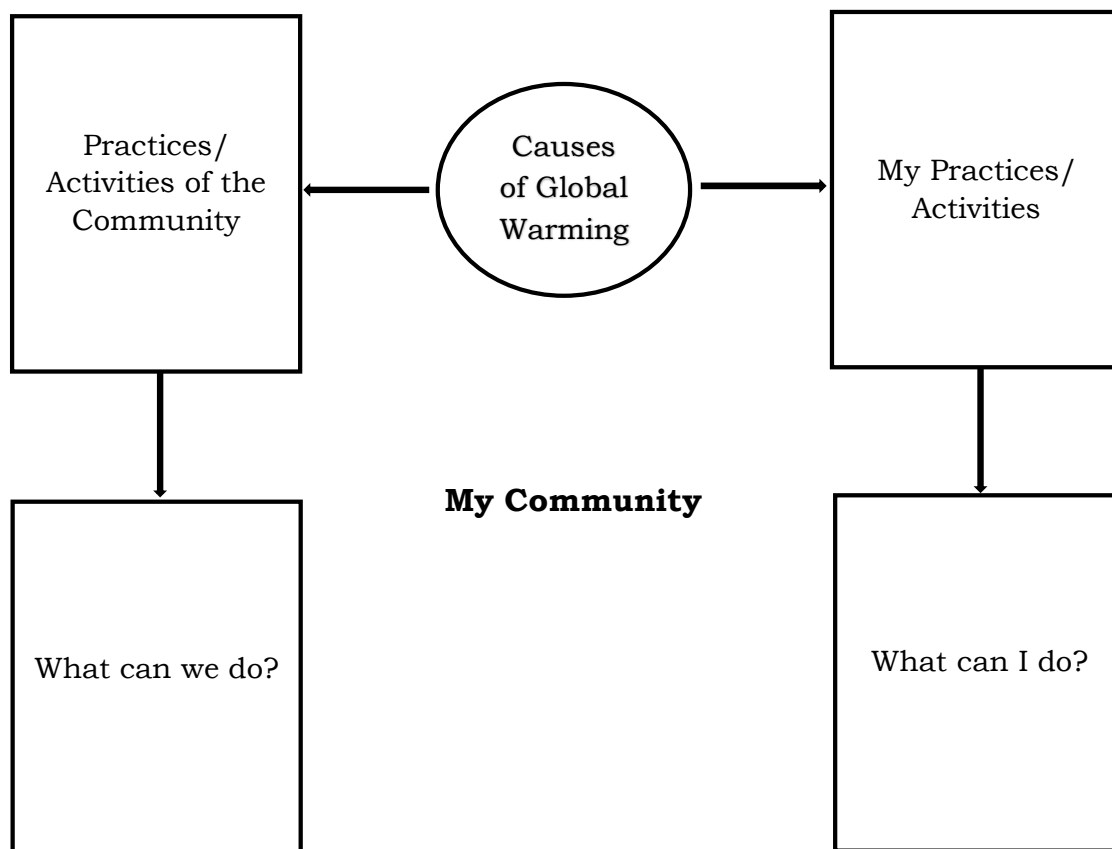
Crustal movements and sea level change are coastal processes and its interactions affect the climate. They are part of tight interconnected Earth system that affects both global and regional climates. On the other hand, climate change also affects these processes.

We are very familiar with the enhanced global warming. It gives a lot of consequences even if it is just a few degrees increased than the usual average temperature. Global warming results to intense storms, flooding, droughts and extreme storm. High temperature resulted to ice melting. Consequently, sea level rises affecting the people throughout the world.

What are the different causes of climate change?

Activity 4: We Can!

Directions. Observe your community. Identify the different practices and activities that cause and triggers global warming.



What's More

Activity 5: Making an Action Plan

Directions. Suppose you are the coordinator of the Municipal Disaster Risk Reduction Management of your town. You are tasked to make an action plan to mitigate the effects of coastal processes in risk zone. The action plan template is already given below. Remember that the environmental and people health are your priorities. Then, kindly answer the guide questions.

Table 2. Action plan for mitigation of coastal processes and hazards

<i>Project</i>	<i>Activity</i>	<i>Objectives</i>	<i>Resources Needed</i>	<i>Persons Involved</i>	<i>Duration</i>	<i>Action Taken</i>	<i>Remarks</i>
<i>Project READY!</i> Resilience Enhancement Amidst Disaster -Youth Empowerment	<i>Conduct of Symposia and Awareness Campaign</i>	<i>To inform and empower residents on coastal hazards and mitigation</i>	<i>Resource Speaker</i> <i>Venue</i> <i>Sound System</i> <i>Projector</i> <i>Learning kits</i>	<i>Residents</i> <i>Barangay Officials</i> <i>Committee</i>	<i>2 months</i>	<i>Preparation of action plans, and emergency response teams</i>	<i>The participants gained knowledge and skills on coastal mitigation through action plans</i>

Guide Questions:

1. What are the factors did you consider to make projects and activities?

2. Are all your objectives measurable and attainable? Justify your answer.

3. What are the difficulties/problem did you encounter in making the action plan?

4. How did you cope up with the problem encountered in making the action plan?

What I Have Learned

Directions: Read the following statements and fill in the blanks with the correct answer. Choose from the pool of words given below.

1. _____ have been attractive settling grounds for human population as they provide abundant marine resources, fertile agricultural land and possibilities for trade and transport.
2. _____ refers to action taken to eliminate or reduce the long-term risks and hazards in the coastal area.
3. Coastlines are highly dynamic natural systems that interact with _____, _____, and _____ processes and undergo continuous change in response to these processes.
4. _____ activities in coastal areas can also trigger hazard to the natural balance of coastal systems, thus disrupting e.g. sensitive ecosystems and subsequently human livelihood.
5. As the most geologically active zone on Earth coastal processes zone may result to _____, _____, and _____.
6. _____ is a climate change phenomenon through which ocean water volume increases, ice sheets and glaciers melt, and thermal expansion occurs.
7. _____ movement of saline water to fresh water aquifers which can lead to the degradation or contamination of ground water including drinking water resources.
8. _____ is a mitigation method where a large amount of sand is added to the coasts
9. _____ involves pumping out water from the shores to prevent erosion.
10. _____ or total prohibition of mining activities avoid pollution and sediments run-off.

WORD POOL

coastal area	salt intrusion	erosion
mitigation	beach nourishment	adaptation
submersion	atmospheric	sea-level rise
terrestrial	putting sand bag	marine
beach dewatering	human	ban of mining

What I Can Do

Activity 6: Researcher's Problem

Directions. Suppose you are one of the leading researchers in your coastal community. A land developer wants to build a mall that is 20 feet off the edge of the coast. He presented that his mall will not be affected by coastal processes because there were no records of any major damages done in your community. As a researcher, what are the problems that the land developer might encounter if he would continue to build his mall? Answer the question in the form of a letter.

Assessment

Directions. Read the following questions and choose the letter of the correct answer. Write the chosen letter on a separate sheet of paper.

1. Which of the following activities in coastal areas can trigger hazard to the natural balance of coastal system?
 - A. allowed number of tourists
 - B. construction of breakwater
 - C. enhancing vegetation
 - D. prohibition of mining
2. Which of the following is/are natural result/s of a geologically active zone on Earth coastal system?
 - A. breakwater
 - B. sand erosion
 - C. sandbags and stone barriers
 - D. seawalls and island barriers
3. What refers to a climate change phenomenon through which ocean water volume increases, ice sheets and glaciers melt, and thermal expansion occurs?
 - A. erosion
 - B. salt intrusion
 - C. sea-level change
 - D. water nourishment
4. Which of the following is the BEST reason for human population to choose coastal zones as settling grounds?
 - A. abundant marine resources
 - B. peaceful and safe residential area
 - C. small possibility for trade and transport
 - D. unfertile agricultural land
5. What refers to the action taken to eliminate or reduce the long-term risks and hazards in the coastal area?
 - A. alteration
 - B. mitigation
 - C. renovation
 - D. restoration

6. Salt intrusion is the movement of saline water to fresh water aquifers which can lead to the following EXCEPT
- A. loss of vegetation
 - B. erosion to low land area
 - C. contamination of ground water
 - D. shortage in drinking water supply
7. What are the two processes interacting in a highly dynamic natural systems of coastlines?
- A. chemical and physical
 - B. endogenic and exogenic
 - C. oceanic and continental
 - D. atmospheric and biosphere
8. The following activities promote erosion EXCEPT
- A. break water construction
 - B. land development
 - C. mining activities
 - D. waste disposal
9. Which of the following is NOT an impact of mining activities to coastal processes?
- A. enhanced erosional activities
 - B. improved biodiversity
 - C. loss of vegetation
 - D. surface run-off
10. Which of the following structures are built to counteract waves that hit the shores?
- A. barrier
 - B. groins
 - C. jetties
 - D. seawalls
11. Which of the following DOES NOT ensure effective management of saltwater intrusion cases?
- A. construction of seawalls
 - B. monitoring of coastal activities
 - C. assessment of coastal areas regularly.
 - D. regulation of human activities along coastal zone.

12. Which method are you going to use when there is a need to add a large amount of sand to the coast?
- A. beach promotion
 - B. beach nourishment
 - C. sand bag installation
 - D. seawalls construction
13. One of your classmates is living in a coastal area of the community. You found out that this coastal area is already polluted. What activity can you suggest to mitigate the said problem?
- A. acoustic concert
 - B. coastal clean-up drive
 - C. population control campaign
 - D. recollection and reflection among the community
14. Your house is located in a coastal area. You notice that waves are already damaging the shore near the fence of the house especially during high tide and monsoon seasons. What can be constructed to mitigate the said problem of your house?
- A. artificial water recharge
 - B. beach dewatering
 - C. breakwater
 - D. sea wall
15. What will you construct to prevent the further advancement of saltwater if already present in the coastal areas?
- A. beach nourishment
 - B. beach dewatering
 - C. breakwaters
 - D. sand bags

Additional Activities

Directions. Choose one from the given the activities. Do the tasks given adhering to the theme: *“Benefits and Costs of Coastal Sustainable Development.”*

1. Write a 1000-word essay.
2. Make a poster-collage using recyclable materials.
3. Create a jingle.
4. Create a two-minute infomercial.

Table 3. Rubrics for the activities

<i>Activity</i>	<i>Content</i>	<i>Grammar/ Creativity</i>	<i>Timeliness</i>	<i>Points</i>
Essay	Accurate and well-organized	Exemplar grammar	Submitted on or before the deadline	10
	Organized with minimal error	With 1-5 grammatical errors	Submitted one-two days after the deadline	7
	Not organize and with errors	With five or more grammatical errors	Submitted a week after the deadline	5 and below
Poster-collage Jingle Infomercial	Accurate and well-organized	Exemplar creativity and resourcefulness	Submitted on or before the deadline	10
	Organized with minimal error	With creativity within the standard	Submitted one-two days after the deadline	7
	Not organize and with errors	Lacking of creativity and resourcefulness	Submitted a week after the deadline	5 and below

Answer Key

What Can I Do Activity 5 Answer may vary Assessment 1. A 2. B 3. C 4. A 5. B 6. B 7. C 8. A 9. B 10. D 11. A 12. B 13. B 14. D 15. C	What is It Activity 3 Impact 1. Sea level rise 2. Erosion, Intrusion, changed in drainage 3. Changed in drainage pattern 4. Erosion, patterns, increased 5. Mitigation 6. Coastal area 7. Terrestrial, marine, atmospheric 8. Human 9. Erosion, submersion, salt water intrusion 10. Submersion 11. Salt water intrusion 12. Sand bag barriers 13. Beach dewatering 14. Ban What I have Learn? Answers may vary	What I Know 1. C 2. B 3. C 4. D 5. D 6. C 7. B 8. D 9. D 10. A 11. B 12. B 13. A 14. B 15. D What's in Activity 1 Answers may vary What's New Activity 2 Answer may vary
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