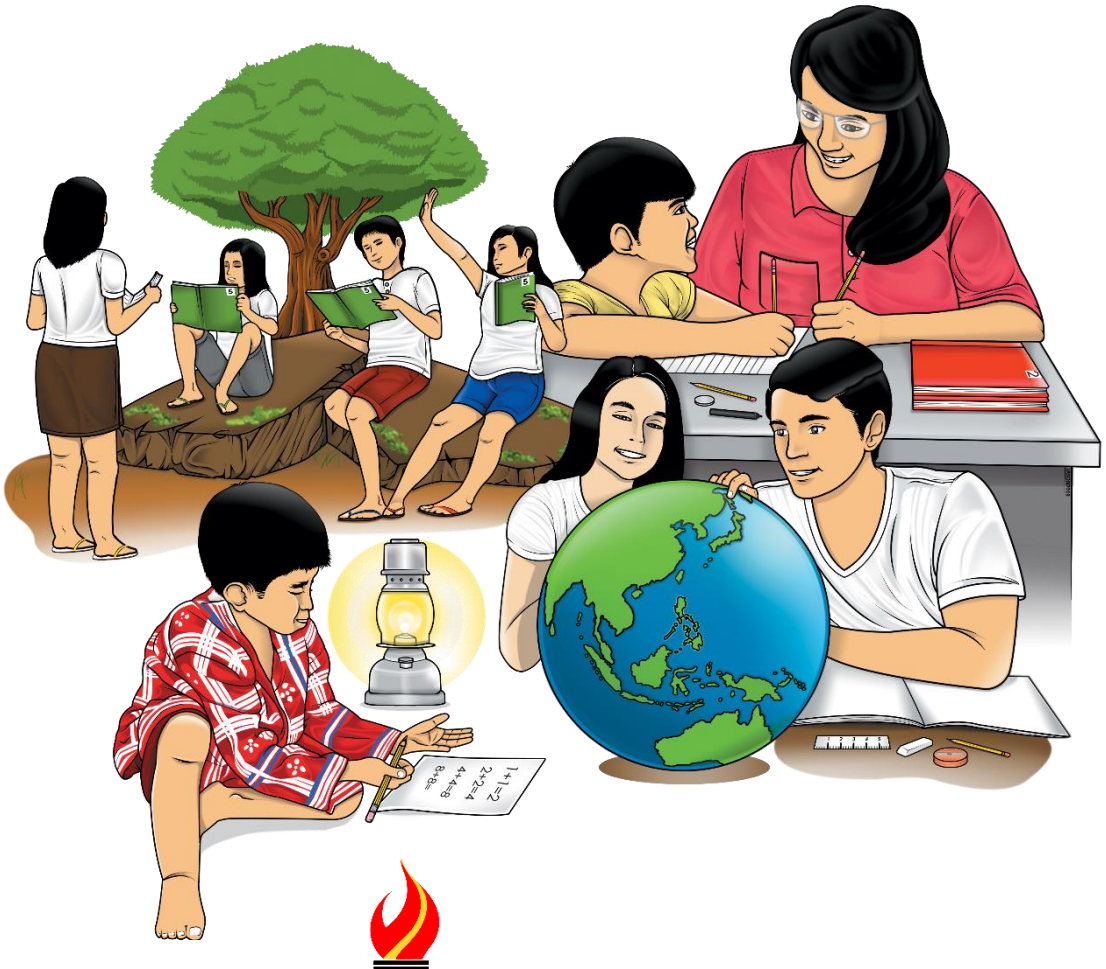
Senior High School

DepED
DEPARTMENT OF EDUCATION

Earth Science for STEM

Quarter 2 – Module 5:
Rock Behaviors Under Stress



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ADM

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Introductory Message

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

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

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

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

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

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

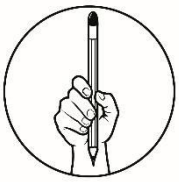
Thank you.

What I Need to Know

This module presents how rocks behave under different types of stress such as compressing, pulling apart, and shearing. This aims to provide an overview of three kinds of stress which cause rocks to undergo deformation. This includes pre-test, procedure/learning experience/learning activities, reflection, and posttest. Read the directions carefully before doing all the exercises and activities.

At the end of this module, the successful learner will be able to:

1. identify the different types of stress on rocks;
2. explain the behavior of the rocks under the different types of stress; and
3. describe the different geologic structures formed by rock stresses.



What I Know

Read and analyze the following questions. Write the letter of the correct answer in a separate sheet of paper.

1. Mountains are result of high-impact stress caused when two plates collided. What kind of stress caused it to form?
   A. compressional stress
   B. confining stress
   C. shear stress
   D. tensional stress

2. Rock undergoes changes when it is stressed. How does the rock behave when a tension stress acted on it?
   A. It is pulled apart or lengthen.
   B. It is compressed.
   C. It formed fold or fracture.
   D. It is deformed.

3. Which of the following type of stress is exerted in convergent plate boundaries?
   A. Compressional stress
   B. Direct stress
   C. Shear stress
   D. Tensional stress

4. Ava played a clay bar. She pushed the two sides of the clay bar using equal force from her hands on the same axis. What type of stress did she exert on the clay bar?
    A. Compressional stress
    B. Direct stress
    C. Shear stress
    D. Tensional stress

5. How will the clay bar behave after the application of stress in item no. 4?
    A. The clay bar will lengthen.
    B. The clay bar will break apart.
    C. The clay bar will fold.
    D. The clay bar will be pulled apart.

6. Stress between two plates may cause rocks to be compressed or pulled apart. In which plate boundary does shear stress commonly occur?
    A. Combine boundaries
    B. Convergent boundaries
    C. Divergent boundaries
    D. Transform boundaries

7. What happened to the rocks under shear stress?
    A. The rocks are squeezed.
    B. The rocks fold or fracture.
    C. The rocks are pulled apart.
    D. The rock walls slip to each other on opposite direction.

8. A compressive stress was exerted on the rock layers forming a simple fold or bend. What is the type of fold formed on the rock layers?
    A. Anticline
    B. Incline
    C. Monocline
    D. Syncline

9. What type of fold is formed when a compressive stress resulted to a landmass that arches upward?
    A. Anticline
    B. Incline
    C. Monocline
    D. Syncline

10. What type of fault is shown on the illustration below?
    A. Normal
    B. Reverse
    C. Strike Slip
    D. Transverse

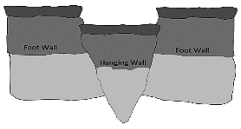


Figure. 1. Fault

11. Which of the following type of fault is found in divergent plate boundaries?
    A. Normal
    B. Reverse
    C. Strike Slip
    D. Transverse

12. Which of the following type of fault system creates the world's highest mountain ranges?
    A. Normal
    B. Reverse
    C. Strike Slip
    D. Transverse

13. Which of the following type of fault formed the San Andreas Fault?
    A. Normal
    B. Reverse
    C. Strike Slip
    D. Transverse

14. East African Rift is formed by stress on rocks that causes the hanging wall to drop down. Which among the type of fault does it belong?
    A. Normal
    B. Reverse
    C. Strike Slip
    D. Transverse

15. Reverse fault is formed through the stress that causes the hanging wall to move up. Which among the following is an example of this type of fault?
    A. Himalayas
    B. East African Rift
    C. San Andreas
    D. West Valley

Lesson 5 Rock Behaviors Under Stress

Rock is a naturally occurring substance that is an aggregate of different minerals that had been fused together. Each rock has a unique composition which make it distinct. Various types of rocks comprises large part of the earth which are involve in the formation of different land and rock formations. However, energy and forces on earth may cause deformation and breakage on rocks. These stress from forces may cause rocks to behave in a certain manner such as sliding in opposite direction, move away from each other or move towards each other. Thus, these may result to different geologic structure.

What's In

Do you still remember metamorphism? Critical reading will help you test how good your memory is. Read the passage below and answer the questions that follow. Write your answers in a separate sheet of paper.

Metamorphism

Metamorphism is the process wherein heat and pressure change the rock's physical and chemical makeup. Chemical changes happen during metamorphism when ions move and new minerals form. The new minerals which are the products of chemical change become more stable in the new environment. Foliation is the physical change that may occur during metamorphism.

Contact metamorphism and regional metamorphism are the two main types of metamorphism. What is the difference between the two?

When we say contact metamorphism, it is when magma contacts a rock and changes it by extreme heat while regional metamorphism is when great masses of rock are exposed to pressure.

Questions

1. What is metamorphism?
2. What are the changes that occur on rocks during the process of metamorphism? How do these changes occur?
3. Write the characteristics of contact metamorphism on the first circle and the characteristics of regional metamorphism on the second circle. In their intersection, write the characteristics which can be found on both types of metamorphism.

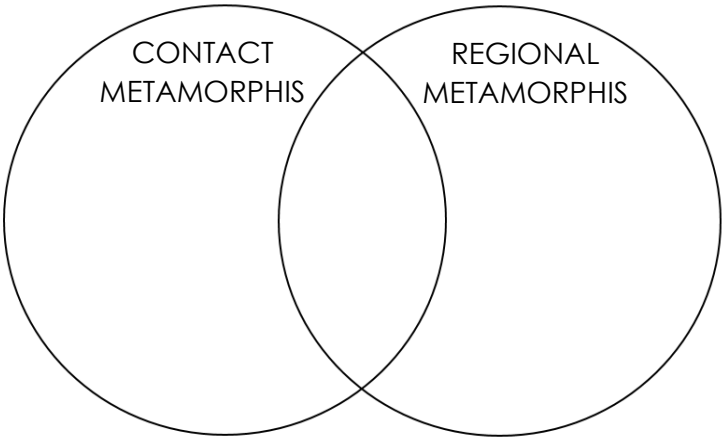


Figure 2. Comparison Between Contact and Regional Metamorphism

Notes to the Teacher

This module is a self-assisted module however your help is necessary in monitoring and evaluating students work. Give instructions carefully and monitor the students in performing every activity. Make sure that the students completely accomplish all the activities to ensure high quality transfer of learning in this module.

What's New

As a preliminary activity, perform the simple experiment below and answer the guide questions. Keep in mind the precautionary measures that you should follow in doing the activity. Write your answers briefly on your answer sheet.

Objectives of the Activity:

After the activity, students should be able to:

1. Describe stress as it relates to materials, such as rocks.
2. Identify and distinguish between the three types of stress.

Materials:

- Soil
- Water
- Alcohol
- Soap

Procedures:

Pre-Laboratory Activity

1. Prepare the materials needed.
2. Set the area so that it is clean and free from any hazardous or allergic materials.
3. Read articles and educational materials related to stress in rocks.

Laboratory Activity:

1. Gather some soil to any type of container. Make it sure that it is free from any hazardous objects or chemicals.
2. Add some water to the soil and compress it into a ball – shape. Make two balls of soil with the same size. Set it aside for few hours to let it dry. Once dried, you may begin doing the activity.

Figure 3. Ball of soil

3. Using ample force, pull the ball of soil for it to break into two large pieces. Make it sure that you will not bend or twist it. Refer to the figure below as your guide. Determine the type of stress present in this activity.

Figure 4. Pulling apart to break the ball of soil.

4. Hold both parts of the ball of soil using your left and right hand. Apply ample force to squeeze the material. Refer to the figure below as your guide. Determine the type of stress present in this activity.

Figure 5. The material is pressed using force.

5. Break the second ball by holding it with two hands at opposite sides and then slide or push the sides at opposite directions. Refer to the figure below as your guide. Determine the type of stress present in this activity.

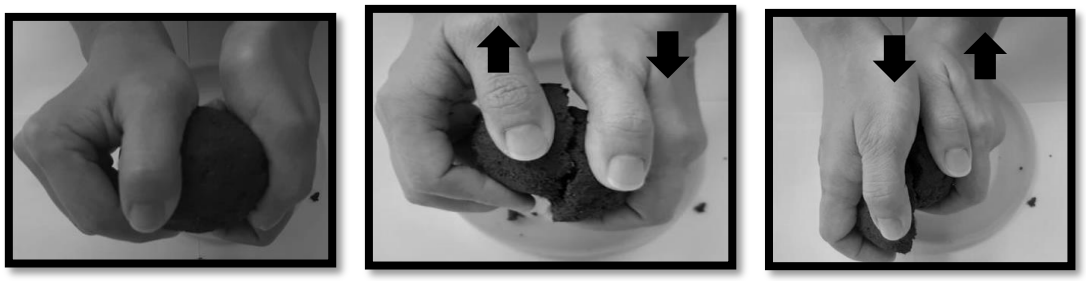


Figure 6. Pushing or sliding the sides of the mud ball parallel at opposite directions

Post - laboratory Activity:

1. Clean your place of work after performing the activity.
2. Wash your hands properly and apply alcohol or sanitizer to avoid any allergic reaction from the soil.

Guide Questions:

Read and analyze the given questions. Write your answers briefly on a separate sheet of paper.

1. In the experiment, which procedure manifested tension stress? Similarly, when tension stress is acted on rocks, how will the rocks behave?
   _____.

2. Which procedure, manifested compressional stress? Applying it to rocks, how will you describe effect or impact of compression stress on rocks?

   _____.

3. Which procedure manifested shear stress? What will happen to rock if it will undergo shearing?

   _____.

What is It

Rocks and large masses undergo deformation wherein it changes their shape, location, size, tilt or break due to squeezing or shearing. When the rocks or plates are pulled or pushed together, stress may occur. Not only human can experience stress, rocks also experienced different kinds of stress. In earth sciences and geology, stress is the force per unit area that is placed on a rock. There are three main types of stress, namely, tension, compression, and shear.

1. **Tensional stress** causes **rocks to be pulled apart** that result to lengthening and break apart. This type of stress can be found at **divergent plate boundaries**.
2. **Compressional stress** causes **rocks to fold or fracture**. It squeezes rocks together. Compression is the most common type of stress in **convergent plate boundaries**.
3. **Shear stress** happens **when forces slide pass each other in opposite direction** which results to slippage and translation. This is the most common stress found in **transform plate boundaries**.

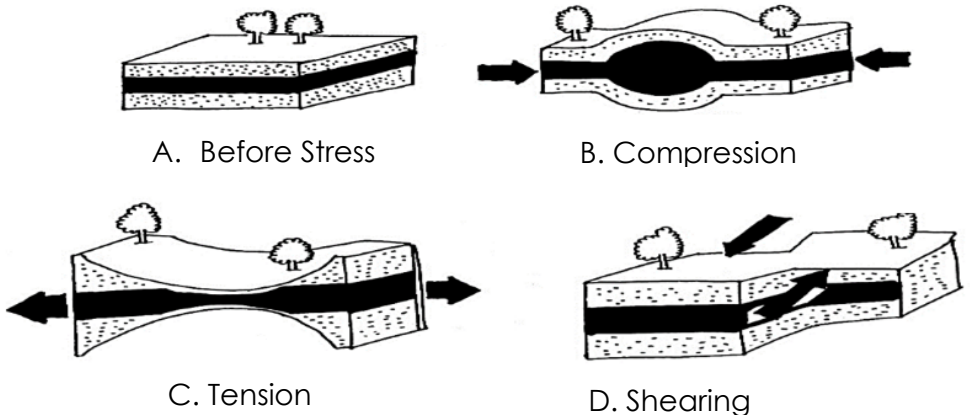


Figure 8. Stress on Rocks

Geologic Structures

1. **Folds** – are formed when rocks experienced compressive stress and deformed plastically. It causes bending of rocks. There are three types of folds: **monoclines, anticlines and synclines**. A **monocline** is a simple bend in the rock layers where the oldest rocks are at the bottom and the youngest are at the top. An **anticline** is a fold that arches upward where the oldest rocks are found at the center of an anticline. The youngest rocks are covered over them at the top of the structure. A **syncline** is a fold that bends downward which rocks are curved down to a center.

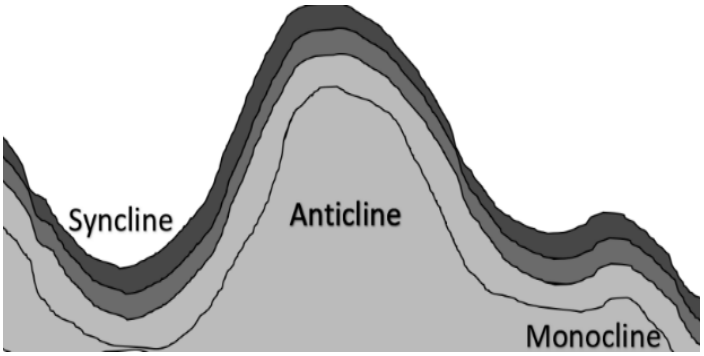


Figure 9. Folds

2. **Faults** – A rock under ample stress can crack, or fracture. The fracture is called a **joint** because there is a block of rock left standing on either side of a fracture line. The **footwall** is the rock that place on top the fault, while the **hanging wall** is below the fault.

   Faults can be classified into:

   a. **Normal faults**–are the most common faults at **divergent boundaries**. In relation to the footwall, it develops as the hanging wall drops down. **East African Rift** is one of the examples of this type of fault.

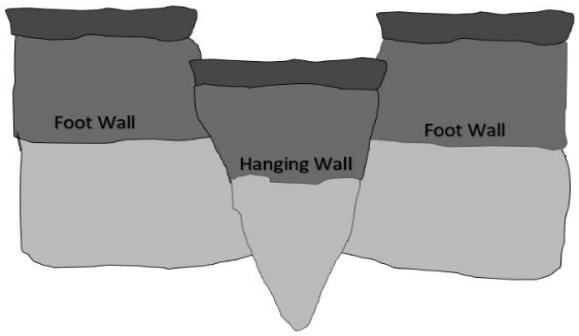


Figure 10. Normal Fault

   b. **Reverse faults** – This type of fault is most common at the **convergent boundaries**. It forms when the hanging wall moves up. It creates the world's highest mountain ranges such as **Himalayas Mountains and Rocky Mountains**.

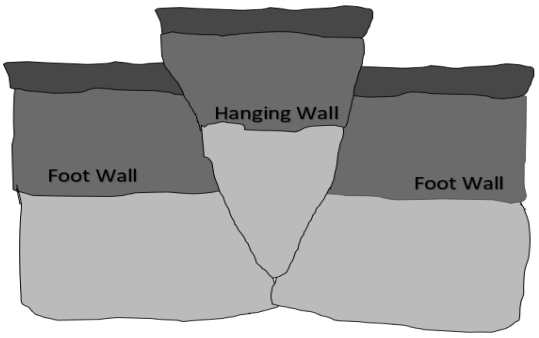


Figure 11. Reverse Fault

c. **Strike-slip faults** – This type of faults formed when the walls move sideways. It can be either right lateral or left lateral. It is mostly common on **transform plate boundaries**. The most popular example of this type is **San Andreas Fault**.

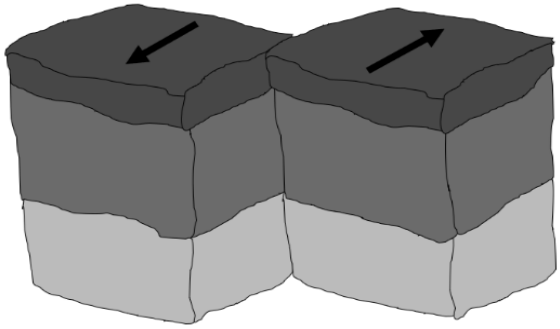


Figure 12. Strike-Slip fault

What's More

A. On each of the space below, arrange the scrambled letters to form the correct term based on the given description. Write your answers in a sheet of paper.

_____ 1. A simple bend on the rock layers
ONESCLIMON

_____ 2. Formed when rocks experienced compressive stress and deformed plastically
DOLF

_____ 3. A bend that arches upward
ESCLITINAN

_____ 4. A rock fracture or cracks due to stress
SLATFU

_____ 5. The most common faults at divergent plate boundaries
ORMLAN LATUSF

_____ 6. This fault type can be found on convergent boundaries.
EVESRER FULATS

_____ 7. It formed when the walls move sideways.
KESRIT LIPS ULFATS

_____ 8. An example of mountain range
MHAYALASI

_____ 9. The type of fault common on transform plate boundaries
RISTKE SIPL FATSUL

_____ 10. An example of fault at divergent plate boundaries
SEAT RICANAF TRIF

B. Identify the following types of stress on the following statements. Write ***T*** if it pertains to tensional stress, ***C*** for compressional stress, and ***S*** for shear stress. Write your answers in a separate sheet of paper.

_____ 1. It causes rocks to fold or fracture.

_____ 2. It causes rocks to be pulled apart.

_____ 3. The common type of stress found on divergent plate boundaries.

_____ 4. This stress on rocks results to slippage and translation of walls.

_____ 5. It occurs on convergent plate boundaries.

_____ 6. It causes rocks to lengthen and break apart.

_____ 7. This type of stress squeezes rocks together.

_____ 8. It commonly occurs in transform plate boundaries.

_____ 9. It happens when the dominant force is directed away from each other.

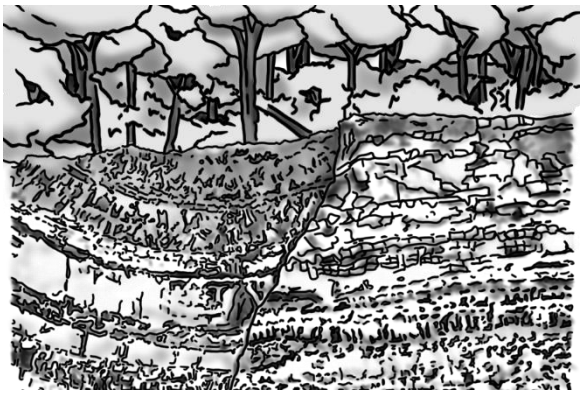
_____ 10. It develops when the forces are directed towards each other but not along the same axis.

C. Copy the table below on a sheet of paper. Draw and identify the type of stress, and its effects on rocks.

Illustration of type of stress	**Type of Stress**	**Effects on Rocks**

What I Have Learned

Analyze the given illustrations then complete the thought of the organizer below. Write your answers in a separate sheet of paper.



What I know
I think _____
_____
_____
_____.

What I heard
According to _____
_____
_____
_____.

What I Read
Based from _____
_____
_____
_____.

What I know
I think _____
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_____
_____.

What I heard
According to _____
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_____.

What I Read
Based from _____
_____
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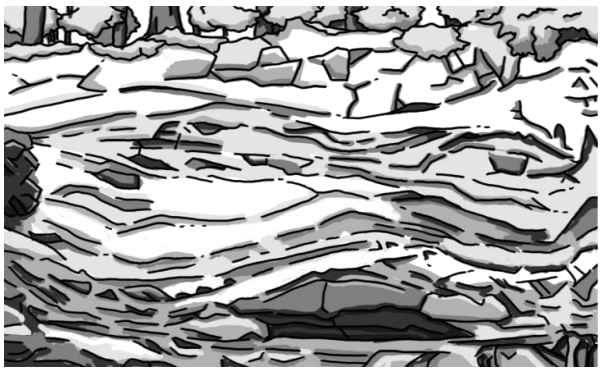
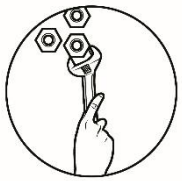
_____.



What I know
*I think*_____
_____
_____
_____.

What I heard
*According to*_____
_____
_____
_____.

What I Read
*Based from*_____
_____
_____
_____.



What I Can Do

Read the statements below. In not more than 50 words, answer the questions that follow. Write your answer in a sheet of paper.

Movement of tectonic plates generates enough energy that causes earthquakes which are released along the faults. As a STEM student, why do you think is it necessary to study the characteristics of fault system? If you are residing on an area where active fault is present, what will you do to educate your neighbors about it?

_____
_____
_____.

Rubric

Category	5	4	3	2	1
Content	There is one clear, well-focused topic. Main ideas are clear and are well supported by detailed and accurate information and examples. The questions were clearly and vividly answered.	There is one clear, well-focused topic. Main ideas are clear and are well supported by detailed and accurate information. Only one question was answered.	There is one clear, well-focused topic. Main ideas are clear and are well supported by detailed and accurate information. The questions were not directly answered.	There is no clear, well-focused topic. Main ideas are not clear and are well supported by detailed and accurate information.	The essay does not respond to what is needed in the task.

Organization of ideas	The ideas and concepts are precisely organized in a logical format and easy to follow.	Some ideas and concepts are vague but in a logical format and easy to follow.	Few ideas and concepts are vague and unorganized but not misleading.	Few ideas and concepts are incoherent and misleading.	All ideas and concepts are incoherent and misleading.
Pertinent words	50 pertinent words were used.	40 pertinent words were used.	30 pertinent words were used.	20 pertinent words were used.	10 pertinent words were used.
			Total Score:		

Assessment

Read the following question carefully. Write your answers in a separate sheet of paper.

1. Ava plays a clay bar. She pushed the two sides of the clay bar using equal force from her hands on the same axis. What type of stress did she exert on the clay bar?
    a. Compressional stress
    b. Direct stress
    c. Shear stress
    d. Tensional stress
2. How will the bar of clay behave after the application of stress in item no. 1?
    a. The clay bar will lengthen.
    b. The clay bar will break apart.
    c. The clay bar will fold.
    d. The clay bar will be pulled apart.
3. Mountains are result of high-impact stress caused when two plates collided. What kind of stress caused it to form?
    a. compressional stress
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    c. shear stress
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4. Which of the following type of stress is exerted in convergent plate boundaries?
    a. Compressional stress
    b. Direct stress
    c. Shear stress
    d. Tensional stress
5. Which of the following plate boundaries do rocks slide past each other?
    a. Combine plate boundaries
    b. Convergent plate boundaries
    c. Divergent plate boundaries
    d. Transform plate boundaries
6. What happened to the rocks under shear stress?
    a. The rocks are squeezed.
    b. The rocks fold or fracture.

c. The rocks are pulled apart.
d. The rock walls slip to each other on opposite direction.

7. Which of the following type of fault is found in divergent plate boundaries?
   a. Normal
   b. Reverse
   c. Strike Slip
   d. Transverse

8. East African Rift is formed by stress that causes the hanging wall to drop down. Which among the type of fault does it belong?
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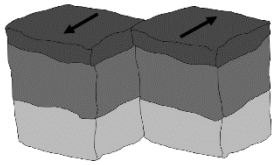
   b. Reverse
   c. Strike Slip
   d. Transverse

9. A compressive stress was exerted on the rock layers forming a simple fold or bend. What is the type of fold formed on the rock layers?
   a. Anticline
   b. Incline
   c. Monocline
   d. Syncline

10. Rock undergoes changes when it is stressed. How does the rock behave when a tension stress acted on it?
    a. It is pulled apart or lengthen.
    b. It is compressed.
    c. It formed fold or fracture.
    d. It is deformed.

11. What type of fold is formed when a compressive stress resulted to a landmass that arches upward?
    a. Anticline
    b. Incline
    c. Monocline
    d. Syncline

12. What type of fault is shown on the illustration below?
    a. Normal
    b. Reverse
    c. Strike Slip
    d. Transverse



13. Reverse fault is formed through the stress that causes the hanging wall to move up. Which among the following is the result of this type of fault?
    a. Himalayas
    b. East African Rift
    c. Marikina Fault
    d. West Valley

14. Which of the following type of fault system creates the world's highest mountain ranges?
    a. Normal
    b. Reverse
    c. Strike Slip
    d. Transverse

15. Which of the following type of fault formed the San Andreas Fault?
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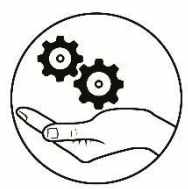
    b. Reverse
    c. Strike Slip
    d. Transverse



Additional Activities

Analyze the given pictures. In not more than 50 words, write an essay related to the land formation in the given picture. Refer to the rubrics below as your guide in writing your answers. Write on a separate sheet of paper.

Source: This photo was taken by
Ms. Niña Katherina A. Blanca
at Talahib Pandayan, Batangas City.

Rubric

Category	5	4	3	2	1
Content	It shows an understanding of the topic's concepts and principles and uses appropriate terminology and notations, Five examples were given with complete descriptions.	It has some mistakes in terminology or shows a few misunderstandings of concepts. Four examples were given with complete descriptions.	It has many mistakes in terminology and shows a lack of understanding of many concepts. Three examples were given with complete descriptions.	It has many mistakes in terminology and shows a lack of understanding of many concepts. Two examples were given with complete descriptions.	It does not show understanding of the topic's concepts and principles. One example was given with complete descriptions.

Organization of ideas	The ideas and concepts are precisely organized in a logical format and easy to follow.	Some ideas and concepts are vague but in a logical format but easy to follow.	Few ideas and concepts are vague and unorganized but not misleading.	Few ideas and concepts are incoherent and misleading.	All ideas and concepts are incoherent and misleading
Focus and details	There is one clear, well-focused topic and content. Main ideas are clear and are well supported by detailed and accurate information.	There is one clear, well-focused topic and content. Main ideas are clear but are not well supported by detailed information.	There is one topic and content. Main ideas are somewhat clear.	There is more than one focus of topic and content. Main ideas are vague and not detailed.	The topic and main ideas are not clear.
			Total Score:		

Answer Key

Type of Stress	Effects on rocks	Place Where Can be Found	Illustration
1. Tension	Lengthening and breaking apart	Divergent plate boundaries	
2. Compression	Formation of fold or fracture	Convergent plate boundaries	
3. Shear	Slippage and translation	Transform plate boundaries	

Assessment

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

What's More

A.

1. MONOCLINES
2. FOLD
3. ANTICLINES
4. FAULTS
5. NORMAL FAULTS
6. REVERSE FAULTS
7. STRIKE SLIP FAULTS
8. HIMALAYAS
9. STRIKE SLIP FAULTS
10. EAST AFRICAN RIFT

B.

1. C
2. T
3. T
4. S
5. C
6. T
7. C
8. S
9. T
10. S

What I Know

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

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