Senior High School

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Earth Science for STEM

Quarter 2 – Module 1:
Weathering

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Earth Science for STEM
Alternative Delivery Mode
Quarter 2 – Module 1: Weathering
First Edition, 2021

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Secretary: Leonor Magtolis Briones
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Development Team of the Module

Writer: Lorna B. Alvarez

Editors: Randie B. Atienza

Reviewers: Marionel U. Briz, Francia C. Silva, Christian Dick B. Cunag, Ryan B. Garcia, Cyrus T. Festijo, Rowena D. Cabanding

Illustrator: Patrick Lemuel V. Reyes

Layout Artist: Paulina S. Crescini, Leomar G. Paracha

Management Team: Francis Cesar B. Bringas
Job S. Zape Jr.
Ramonito O. Elumbaring
Reicon C. Condes
Elaine T. Balaogan
Fe M. Ong-ongowan
Sacoro R. Comia
Fe M. Fallurin
Marieta N. Perez

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Department of Education – Region IV-A CALABARZON

Office Address: Gate 2 Karangalan Village, Barangay San Isidro
Cainta, Rizal 1800
Telefax: 02-8682-5773/8684-4914/8647-7487
E-mail Address: region4a@deped.gov.ph

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Introductory Message

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

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

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

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

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

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

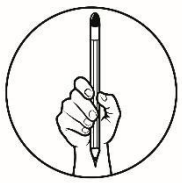
Thank you.

What I Need to Know

This module was designed and written with you in mind. It is here to help you master Weathering. 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.

After going through this module, you are expected to:

1. identify the different agents of weathering;
2. identify the different types of physical, chemical, and biological weathering;
3. describe physical, chemical, and biological weathering; and
4. explain how rocks undergo weathering



What I Know

Read and analyze the following questions. Select the letter of the best answer. Write your answers in a separate sheet of paper.

1. Which of the following best describes weathering?
   a. The process by which rocks are exposed to severe weather
   b. The process by which rocks are formed by heat and pressure
   c. The mechanical or chemical process by which rocks are broken down
   d. The process by which rocks are chemically strengthened due to exposure to heat and pressure

2. How does gravity contribute to weathering?
   a. by abrasion of the rocks
   b. by expansion of rocks
   c. by dissolving rocks' particles
   d. by creating holes in rocks

3. Which of the following is NOT an example of physical weathering?
   a. Freeze- thaw
   b. Wind blowing sand onto a rock
   c. Plant that grows on the cracks of the rocks
   d. Abrasion due to the movement of glaciers

4. What happens to pieces of rock as they are transported by a river?
   a. they get smaller and rounder
   b. much larger and rounder
   c. smaller and more jagged
   d. gets larger and more jagged

5. In hydration, water is an active agent of chemical weathering. What happens when water loosely combines with the minerals of the rock?
   a. cements them together
   b. converts the mineral into another kind
   c. transports the rock into a lower altitude
   d. weakens the molecular binding of the minerals

6. What are the two things that affect the rate of weathering?
   a. time and date
   b. type of rock and climate
   c. rain and ice
   d. size of rock and time of the year

7. Which of the following best describes chemical weathering?
   a. The process by which rocks are broken down by physical forces
   b. The process by which rocks are broken down by chemical means
   c. The process by which rocks are broken down by anthropogenic activities
   d. all of the above

8. Weak organic acids are produced by the action of the growing roots of lichens. These acids react with some minerals in rocks resulting in the decomposition of rocks. How will you classify this process?
    a. Physical weathering
    b. Chemical weathering
    c. Biological weathering through physical means
    d. Biological weathering through chemical compounds

9. Which of the following conditions promotes slow chemical weathering?
    a. fracturing
    b. thick soil
    c. high amount of rainfall
    d. cold temperature

10. Which type of rocks tends to weather more rapidly through hydrolysis process?
    a. Rocks that contain iron.
    b. Rocks that contain quartz.
    c. Rocks that are impermeable.
    d. Rocks that contain feldspar.

11. Which is an example of oxidation?
    a. Rust decomposes rocks completely with passage of time.
    b. Some of the minerals get dissolved in water.
    c. The joints enlarge in size and lime is removed in the solution.
    d. Due to the absorption of water by rocks, its volume increases.

12. Which of these statements is NOT true about mechanical weathering?
    a. breaks rock material into smaller pieces
    b. changes the chemical composition of rocks
    c. strong winds carrying sand blows on the rocks
    d. beach rock gets hot in daytime and cools in the evening thus creating fracture on the rock

13. Which of the following activities has resulted in an increased rate of chemical weathering through acidification?
    I. The production of SO2 and NO in the atmosphere that combine with rain to form acids.
    II. The release of too much carbon dioxide in the air that turn rain into weak acid.
    III. The disintegration of rocks during construction and mining
    IV. The growth of the plant roots on the rock crack.

    a. 1 only b. 2 only c. 1 and 2 d. 2 and 3

14. Which is NOT included in the group?
    a. carbonation b. abrasion c. acidification d. hydration

15. In which of the following climates will chemical weathering be most rapid?
    a. cold and dry
    b. cold and humid
    c. hot and dry
    d. hot and humid

Lesson 1 Weathering

The Earth is constantly changing or altered physically as we have observed. The changes driven by different forces of nature create new land forms. One of these forces is weathering. This process includes degradation or breaking down of rocks into smaller segments known as sediments. It occurs when mechanical force is applied on rocks or through chemical reactions happening on the surface or within the rocks.

In this lesson, you are going to describe how rocks undergo weathering and the different agents that cause weathering on rocks.

What's In

Read the paragraph about rocks and how it disintegrates or dissolves, then answer the questions below. Write your answer on your answer sheet.

Rocks are naturally occurring mass of different kinds of minerals. It can be classified into different kinds such as igneous, metamorphic and sedimentary rocks. These rocks are classified based on their composition and the process of its formation. Igneous are formed from volcanic materials, sedimentary rocks are result of the cementation of different sediments to form a new rock and metamorphic rocks are produced through exposure of parent rock which can be an igneous, sedimentary or another metamorphic rock to intense temperature and pressure. This scenario proves that rocks are made up of components that can be broken down overtime. Continuous exposure to external environmental forces can separate these components.

A rock disintegrates or even dissolves because a chemical reaction changes the composition of the rock. When certain types of rock come in contact with rainwater, a chemical reaction occurs, slowly transforming the rock into substances that dissolve in water. As these substances dissolve, they get washed away. How are these things carried on to our next lesson?

Guide Questions:

1. Are you familiar with these changes in rocks when in contact with the environment?
2. What particular place/s in your locality where such occurrence is observed?

Notes to the Teacher

Physical and chemical changes are strongly related to two types of weathering. Weathering just focuses on the breaking of rocks into its basic composition through physical and chemical means.

What's New

Activity: Rock Breaking Challenge

Perform the activity entitled "Rock Breaking Challenge". Put your observations on your answer sheet.

Materials: 3 rock sample, hammer, and a concrete surface

Ensure safety while performing the activity especially with using the different materials.

Procedure:

1. Get at least 3 rock samples found in your backyard.
2. Wrap the rock samples in a piece of cloth.
3. Put the wrapped rock samples on the concrete surface.
4. Using hammer, hit each rock sample. **(Wear eye protection in doing this activity).**
5. Observe what happened to the rock sample after series of hitting. Record your data in the table.

Sample	No. of Hits			
	1	2	3	4
	No. ofpieces	No. ofpieces	No. ofpieces	No. ofpieces
1				
2				
3				

Guide Questions:

1. What happened to the rock after a series of hitting?
2. How will you describe the particles from the broken rocks?
3. What can you infer in the process of breaking down rocks?

What is It

WEATHERING

Weathering is the process of breakdown of rocks at the Earth's surface, by the action of water, ice, acids, salts, plants, animals, gravity and changing temperatures. There are three types of weathering: physical weathering, chemical weathering, and biological weathering.

Agents of Weathering

1. Water

Either in liquid or solid form is one of the agents of mechanical weathering. In liquid form, it seeped into cracks and crevices of rocks and when the temperature dropped, it freezes and definitely will expand in the form of ice. The ice then works as a wedge which slowly widens the cracks and splits the rock. When the ice melts, the liquid water performs the act of erosion by carrying away the tiny rock fragments lost in the split.

2. Salt

In the process of haloclasty, salts served as an agent of weathering. Saltwater sometimes gets into the cracks and pores of rock. When it evaporates, salt crystals are left behind and grow in the cracks and pores which caused pressure on the rock and slowly break it apart.

3. Temperature

Temperature changes can also contribute to weathering through the process called thermal stress. During thermal stress, rock tend to expand with heat and contract with low temperature. As this happens repeatedly, the structure of the rock weakens and over time crumbles.

4. Plants

Plants also served as agents of weathering. Its contribution take place when the seed of a tree being spread in the environment sprout in soil that has collected in a cracked rock. As the roots grow, they widen the cracks, eventually breaking the rock into pieces. Over time, trees can break apart even large rocks. Even small plants, such as mosses, can enlarge tiny cracks as they grow.

5. Animals

Animals that tunnel underground, such as moles and prairie dogs, also work to break apart rock and soil. Other animals dig and trample rock aboveground, causing rock to slowly crumble.

Types of Weathering

A. Physical Weathering

Physical weathering is caused by the effects of changing temperatures on rocks, causing the rock to break apart. The process is sometimes assisted by water. It happens especially in places where there is little soil and few plants grow, such as in mountain regions and hot deserts. It occurs either through repeated melting and freezing of water (mountains and tundra) or through expansion and contraction of the surface layer of rocks that are baked by the sun (hot deserts). There are two main types of physical weathering:

Figure 1. Kapurpurawan Rock formation at Burgos, Ilocos Norte

1. **Abrasion.** It occurs when rocks surface is frequently exposed to water, wind and gravity.
2. **Freeze-thaw.** It occurs when water continually seeps into cracks, freezes and expands, eventually breaking the rock apart. It occurs in mountainous regions like the Alps or Snowdonia. It occurs through the following process:

Rainwater or snow- melt collects in cracks in the rocks→ at night the temperature drops and the water freezes and expands→ the increases in volume of the ice exerts pressure on the cracks in the rock, causing them to split further open→ during the day the ice melts and the water seeps deeper into the cracks → at night, the water freezes again.

3. **Exfoliation.** It can happen as cracks develop parallel to the land surface as a consequence of the reduction in pressure during uplift and erosion. It occurs typically in upland areas where there are exposures of uniform coarsely crystalline igneous rocks. The following are the process of exfoliation.

The rock mass at depth is under high pressure from underlying rocks. It tends to be uniform and lack fractures. → As progressive erosion occurs, the rock mass is subjected to progressively lower pressure of overlying rocks which leads to tension in directions at right angles to the land surface → this tension is relieved by formation of cracks which follow the land surface. They are relatively flat on plateaus but can be steep on the flanks of mountains which are called exfoliation domes → once the crack is developed; water enters and causes chemical weathering leading to the formation of new low- density minerals. This enhances the cracks and encourages slabs of rock to detach from the surface.

B. Chemical Weathering

Chemical weathering is caused by rainwater reacting with the mineral grains in rocks to form new minerals (clays) and soluble salts. These reactions occur particularly when the water is slightly acidic. These chemical processes need water, and occur more rapidly at higher temperature, so warm, damp climates are best. Chemical weathering (especially hydrolysis and oxidation) is the first stage in the production of soils.

Figure 2. Kapurpurawan Rock formation at Burgos, Ilocos Norte

There are different types of chemical weathering, the most important are:

1. **Carbonation** – carbon dioxide in the air dissolves in rainwater and becomes weakly acidic. This weak "carbonic acid" can dissolve limestone as it seeps into cracks and cavities. Over many years, solution of the rock can form spectacular cave systems.
2. **Hydrolysis –** the breakdown of rock by acidic water to produce clay and soluble salts. Hydrolysis takes place when acid rain reacts with rock-forming minerals such as feldspar to produce clay and salts that are removed in solution.

   The only common rock-forming mineral that is not affected is quartz, which is a chemically resistant mineral. Therefore, quartz and clay are the two of the most common minerals in sedimentary rocks.
3. **Hydration –** a type of chemical weathering where water reacts chemically with the rocks, modifying its chemical structure. Example: H2O (water) is added to CaSO4 (calcium sulfate) to create CaSO4 + 2H2O (calcium sulfate dihydrate). It changes from anhydrite to gypsum.
4. **Oxidation –** the breakdown of rock by oxygen and water, often giving iron- rich rocks a rusty-colored weathered surface.

C. Biological weathering

Belete tree (*Ficus sp.*) grows in a commercial building in Lemery, Batangas.

Biological weathering of rocks occurs when rocks are weakened by different biological agents like plants and animals. When plant roots grow through rocks, it creates fracture and cracks that result eventually to rock breakage. It can be classified into:

1. **Biological Weathering by Physical Means.** Burrowing animals like shrews, moles and earthworms create holes on the ground by excavation and move the rock fragments to the surface. These fragments become more exposed to other environmental factors that can further enhance their weathering. Furthermore, humans also indirectly contribute to biological weathering by different activities that cause rocks to break.
2. **Biological Weathering by Chemical Compounds.** Some plants and animals also produced acidic substances that react with the rock and cause its slow disintegration.

What's More

A. Write C if the statement is correct and I if the statement is incorrect. Write your answers in a separate sheet of paper.

_____ 1. Gravity is one of the agents of weathering.

_____ 2. Exfoliation occurs when water continually seeps into cracks, freezes and expands eventually breaking the rock apart.

_____ 3. Carbonation occurs when carbon dioxide dissolved in water makes acid and reacts with rocks.

_____ 4. Burrowing animals cannot contribute on weathering of rocks.

_____ 5. Hydrolysis takes place when acid rain reacts with rock-forming minerals such as feldspar to produce clay and salts that are removed in solution.

_____ 6. Animals produce acidic compounds that can cause rock disintegration.

_____ 7. Sulfur dioxide and nitrogen oxide when mix with water produces basic substance that can break down rocks' components.

_____ 8. Humans indirectly contribute on weathering.

_____ 9. Water alters chemical components of rocks that cause weathering.

_____ 10. Earthworms are physical weathering agent.

B. Group the following statements as to Physical, Chemical or Biological Weathering by writing them down on the table provided below. Do this on your answer sheet.

_____ 1. Balete tree grows at the wall of the building.

_____ 2. Construction workers use power tools to break the rocks.

_____ 3. Insects secrete acidic substance on rocks.

_____ 4. Glaciers carve its pathways.

_____ 5. Rainwater combined with iron on rocks produces rusts.

_____ 6. Carbon dioxide mix with water produces carbonic acid that reacts with rocks.

_____ 7. Water freezes in a large crack of a rock.

_____ 8. Strong winds blow small particles of the rocks.

_____ 9. Rocks form bubbles after the heavy pour of acid rain.

_____ 10. Rocks fall down from the mountain and break.

Physical Weathering	Chemical Weathering	Biological Weathering

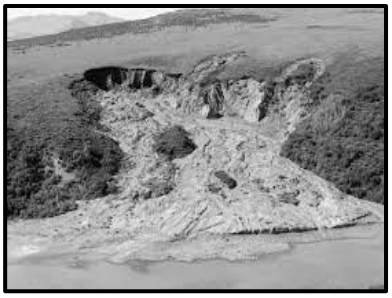
What I Have Learned

In a separate sheet of paper, identify what type or agent of weathering is shown in the picture. Support your answer.

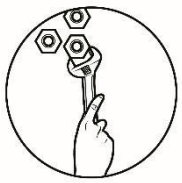
1. 

2. 

3. 

4. 

5. 



What I Can Do

From the concepts you have learned in this module, create a simple 3-minute documentary video or photographic documentation of weathering you will find in your locality/area.

In a separate sheet of paper, answer the following questions:

1. Cite what are the risk that you might encounter upon knowing those places are found in your locality?
2. How can you prevent or what precautions will you do to be safe if danger occur?

Rubrics for Documentary video/ photo documentation.

Rubrics

Trait	Criteria				Points
Content Did the presentation have valuable materials?	Presentation contained little to no valuable material.	Presentation had moments where material was present but as a whole content was lacking.	Presentation had a good amount of material and benefited the class.	Presentation had an exceptional amount of valuable material and was extremely beneficial to the class.	
Organization Was the presentation well organized and easy to follow?	The presentation lacked organization and had little evidence of preparation.	There were minimal signs of organization or preparation.	The presentation had organizing ideas but could have been much stronger with better preparation.	The presentation was well organized, well prepared and easy to follow.	
Presentation Did the presenters speak crealy? Is it neat and concise? Was it obvious that the material is credible?	Presenters were unconfident and demonstrated little evidence of planning prior to presentation.	Presenters were not consistent with the level of confidence/prep aredness they showed the class but had some strong moments.	Presenters were occasionally confident with their presentation however the presentation was not as engaging as it could have been for the class.	Presenters were all very confident in delivery and they did an excellent job of engaging the class. Preparation is very evident.	

Assessment

Read and analyze the following questions. Select the letter of the best answers. Write your answers in a separate sheet of paper.

1. Which of these statements are TRUE about mechanical weathering?
   I. breaks rock material into smaller pieces
   II. changes the chemical composition of rocks
   III. moss growing on the wall fence creates crack on the walls
   IV. beach rock gets hot in daytime and cools in the evening thus creating fracture on the rock

   a. I and II b. I and III c. I and IV d. II and III

2. Which of the following activities has resulted in an increased rate of chemical weathering through acidification?
   a. The growth of plant roots on the rock crack.
   b. The disintegration of rocks during construction and mining
   c. The release of too much carbon dioxide in the air that turn rain into weak acid
   d. The production of SO2 and NO in the atmosphere that combine with rain to form acids

3. Which is NOT included in the group?
   a. abrasion b. acidification c. carbonation d. hydration

4. In which of the following climates will chemical weathering be most rapid?
   a. hot and dry b. cold and dry c. hot and humid d. cold and humid

5. Which of the following DO NOT describe weathering?
   I. The process by which rocks are broken during severe weather
   II. The process by which rocks are formed by heat and pressure
   III. The mechanical or chemical process by which rocks are broken down
   IV. The process by which rocks are chemically strengthened due to exposure to heat and pressure

   a. I, II and III b. I, II and IV c. I, III and IV d. II, III and IV

6. How does gravity contribute to weathering?
   a. by expansion of rocks c. by creating holes in rocks
   b. by abrasion of the rocks d. by splitting rocks particles

7. Which of the following is an example of biological weathering?
   a. Freeze- thaw
   b. Wind blowing sand onto a rock
   c. Abrasion due to the movement of glaciers
   d. Plant that grows on the cracks of the rocks

8. What happens to pieces of rock as they are transported by a river?
   a. smaller and more jagged c. much larger and rounder
   b. gets larger and more jagged d. they get smaller and rounder

9. In hydration, water is an active agent of chemical weathering. What happens when water loosely combines with the minerals of the rock?
    a. cements minerals of the rock together
    b. converts the mineral into another kind
    c. transports the rock into a lower altitude
    d. breaks down the molecular binding of the minerals

10. Which type of rocks tends to weather more rapidly through the hydrolysis process?
    a. Rocks that contain iron.
    b. Rocks that contain quartz.
    c. Rocks that contain feldspar.
    d. Rocks that are impermeable.

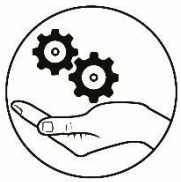
11. Which is an example of oxidation?
    a. Some of the minerals get dissolved in water.
    b. Rust decomposes rocks completely with passage of time.
    c. The joints enlarge in size and lime is removed in the solution.
    d. Due to the absorption of water by rocks, its volume increases.

12. What are the two things that affect the rate of weathering?
    a. rain and ice
    b. time and date
    c. type of rock and climate
    d. size of rock and time of the year

13. Which of the following best describes chemical weathering?
    a. The process by which rocks are broken down by physical forces
    b. The process by which rocks are broken down by chemical means
    c. The process by which rocks are broken down by anthropogenic activities
    d. all of these

14. Weak organic acids are produced by the action of the growing root of lichens. These acids react with some minerals in rocks resulting in the decomposition of rocks. How will you classify this process?
    a. Physical weathering
    b. Chemical weathering
    c. Biological weathering through physical means
    d. Biological weathering through chemical compounds

15. Which of the following conditions promotes slow chemical weathering?
    a. fracturing
    b. thick soil
    c. high rainfall
    d. cold temperatures



Additional Activities

Create a photo gallery of places showing the examples of weathering in your locality. Upload this on social media and put a #weathering # the type of weathering. Tag it with your teachers and classmates

Answer Key

What I Know

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

What's More

A.

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

B.

1. B
2. B
3. B
4. P
5. C
6. C
7. P
8. P
9. C
10. P

What I have Learned

1. Acidification
2. Carbonation
3. Sedimentation
4. Mass Wasting
5. Freeze thaw

What I have Learned

1. Acidification
2. Carbonation
3. Sedimentation
4. Mass Wasting
5. Freeze thaw

What I Can Do

Answers may vary based from rubrics

Additional Activities

Answers may vary based from rubrics

Assessment

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

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For inquiries or feedback, please write or call:

Department of Education - Bureau of Learning Resources (DepEd-BLR)

Ground Floor, Bonifacio Bldg., DepEd Complex
Meralco Avenue, Pasig City, Philippines 1600

Telefax: (632) 8634-1072; 8634-1054; 8631-4985

Email Address: blr.lrqad@deped.gov.ph *