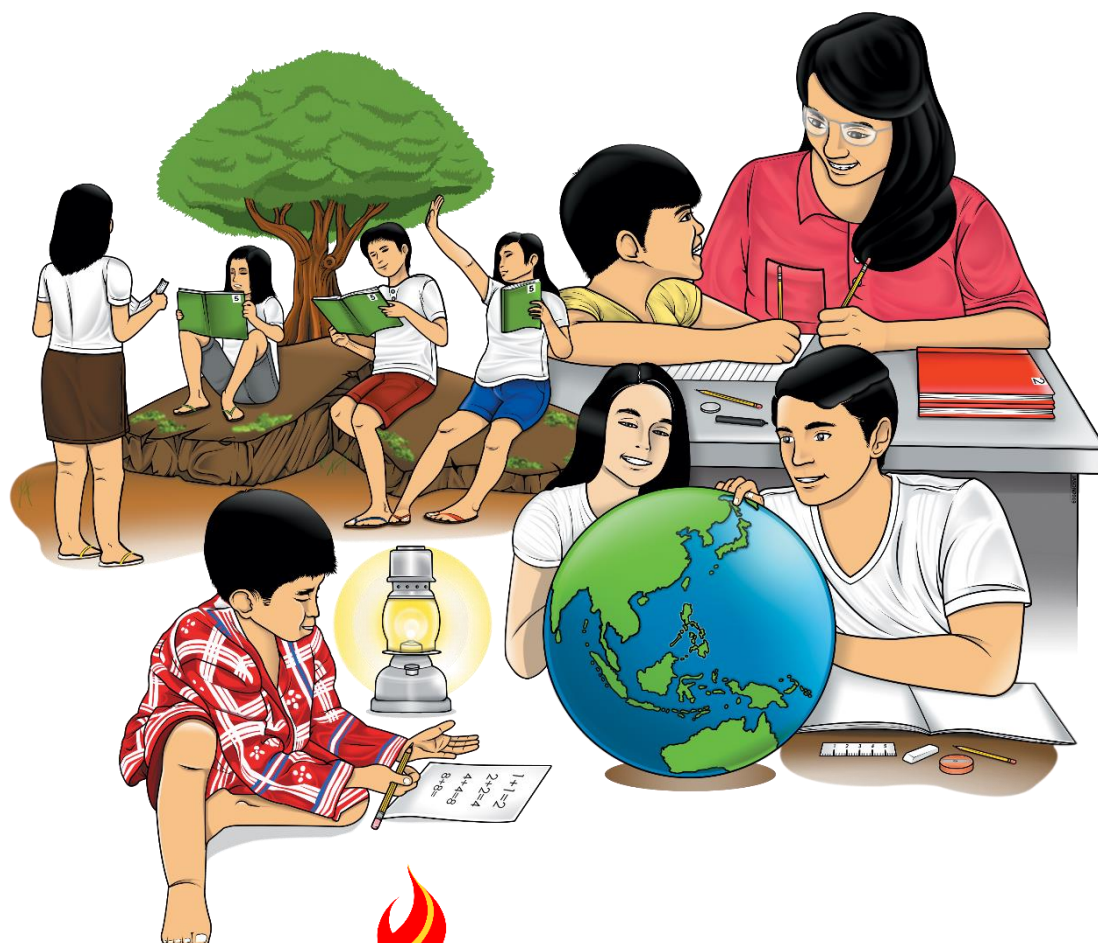


Earth and Life Science

Quarter 1 – Module 9:

Igneous Rocks: How Are They Formed?



Earth and Life Science

Alternative Delivery Mode

Quarter 1 – Module 9: Igneous Rocks: How Are They Formed?

First Edition, 2021

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Earth and Life Science

Quarter 1 – Module 9:

Igneous Rocks:

How Are They Formed?

Introductory Message

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

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

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

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

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

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

Thank you.



What I Need to Know

This module was designed and written with you in mind. It is here to help you master the 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 – Igneous Rocks: How Are They Formed?

After going through this module, you are expected to:

1. compare 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. describe the different textures of igneous rocks.



What I Know

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. recrystallization
 - B. sedimentation
 - 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 examples 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. from magma or lava
 - B. coarse or fine grains
 - C. large or small crystals
 - D. plutonic and volcanic
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? Are they the same? Do they have different colors? Are there crystals? Do they undergo the 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.

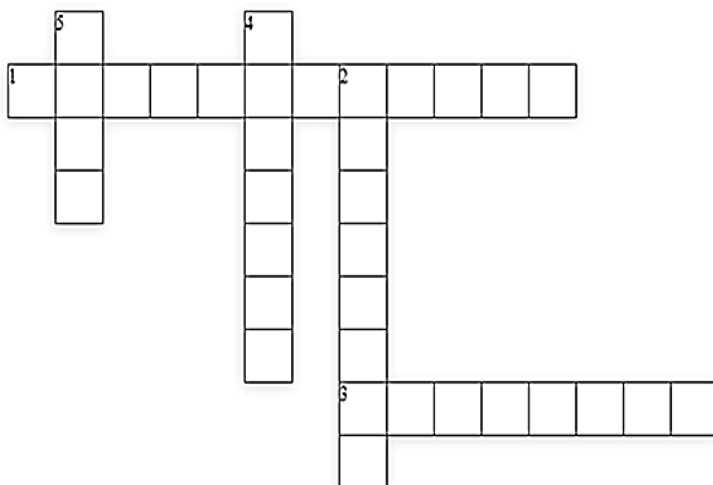


What's In

Activity 1. Crossword Puzzle

In the previous lesson, you have learned about metamorphism of rocks. Let us take a review before we proceed to the next topic.

Fill-in the crossword puzzle with the words being described. Match the number of the sentences with the boxes 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.



Notes to the Teacher

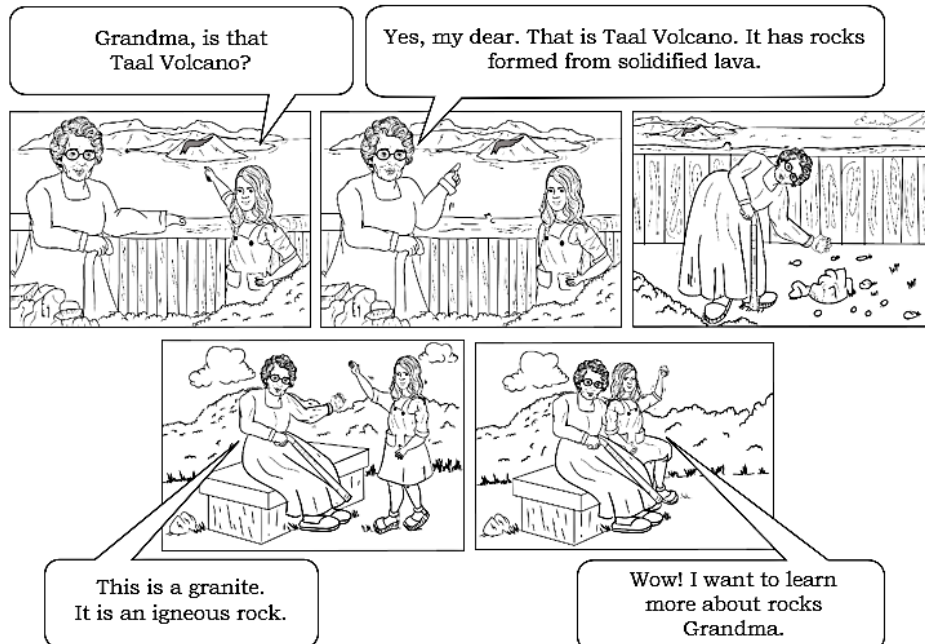
This module will help you to understand the concepts about the formation of igneous rocks. All parts consist of activities. Be guided with the instruction on how you will answer each. Expectedly, you will meet the target at the end of the module.



What's New

Activity 2. Comic Strip Analysis

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.

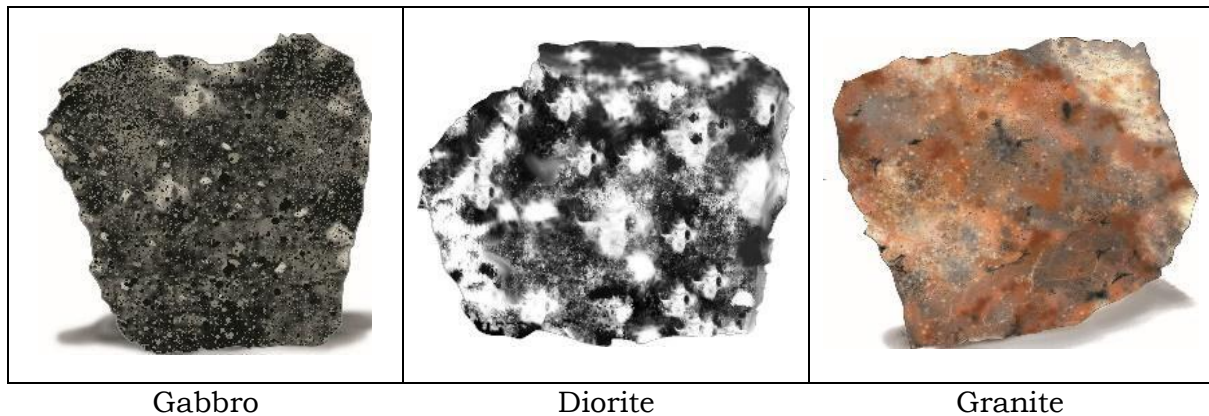


Figure 1. Examples of Intrusive Rocks

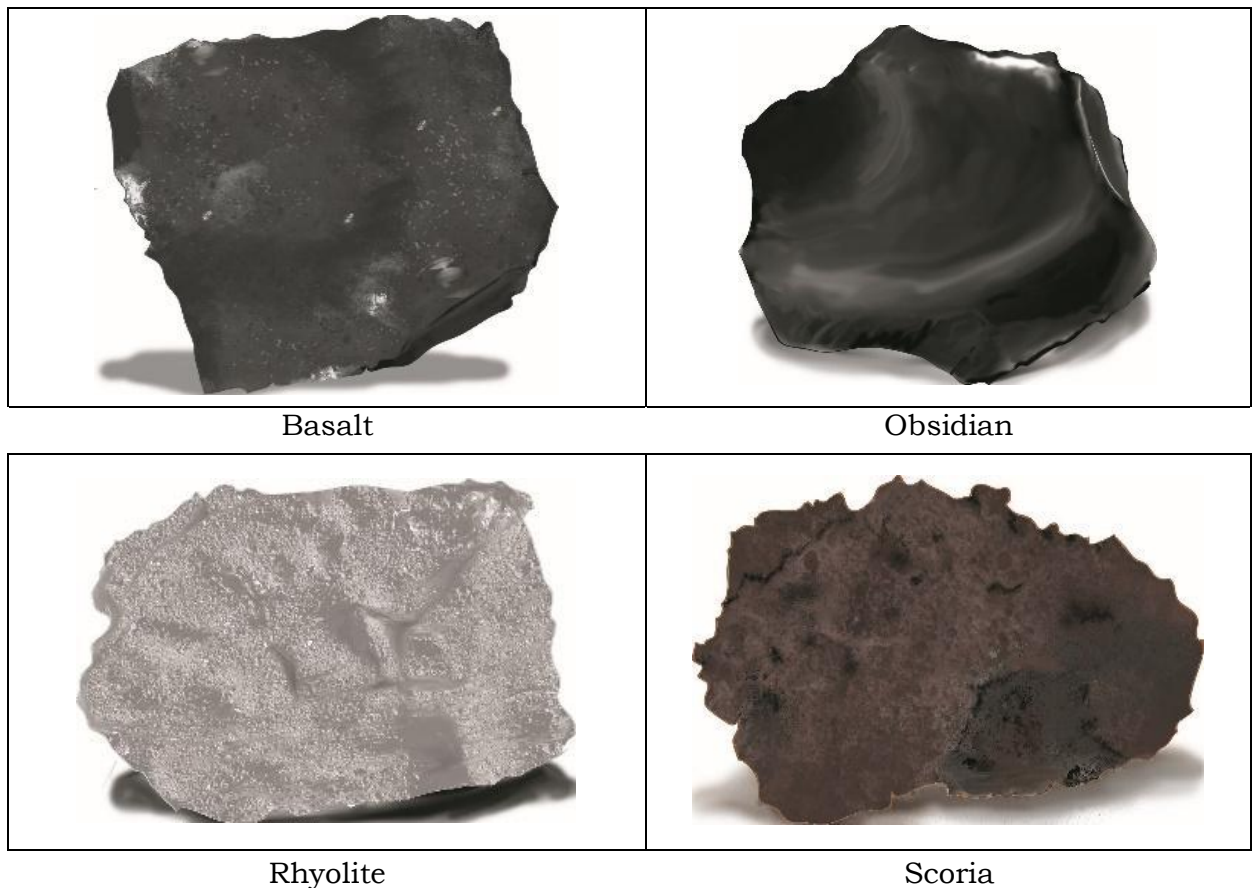


Figure 2. Examples of Extrusive Rocks

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.

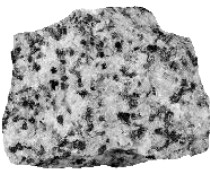
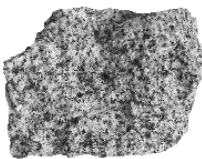







Rock Types	Granite	Diorite	Gabbro	Peridotite
				
Composition	FELSIC	INTERMEDIATE	MAFIC	ULTRAMAFIC
Color	Light  Dark			
				
SiO ₂	70%	60%	50%	40%
MgO	0.95%	2.5%	15%	48%
Major mineral content	Quartz Alkali Feldspar	Biotite Alkali Feldspar Quartz	Pyroxene Plagioclase Feldspar	Pyroxene Olivine

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, the amount of silica affects the color of the rocks.

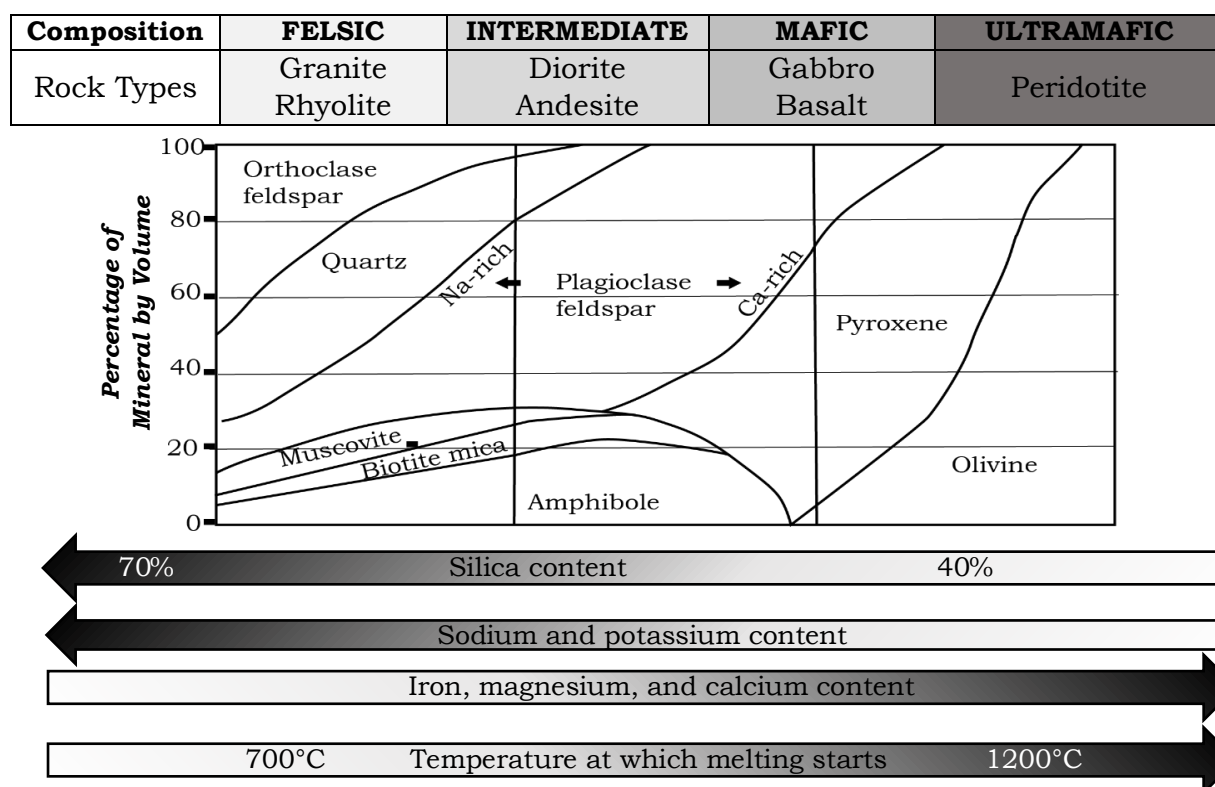


Figure 4. Differences of Igneous Rocks based on Composition in Relation to Silica Content and Temperature

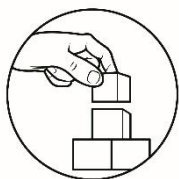
This is another illustration showing the differences of ultramafic, mafic, intermediate, and felsic igneous rocks; rock types, kind, and percentage of minerals; percentage of silica content; and ranges of temperature.

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. The 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!

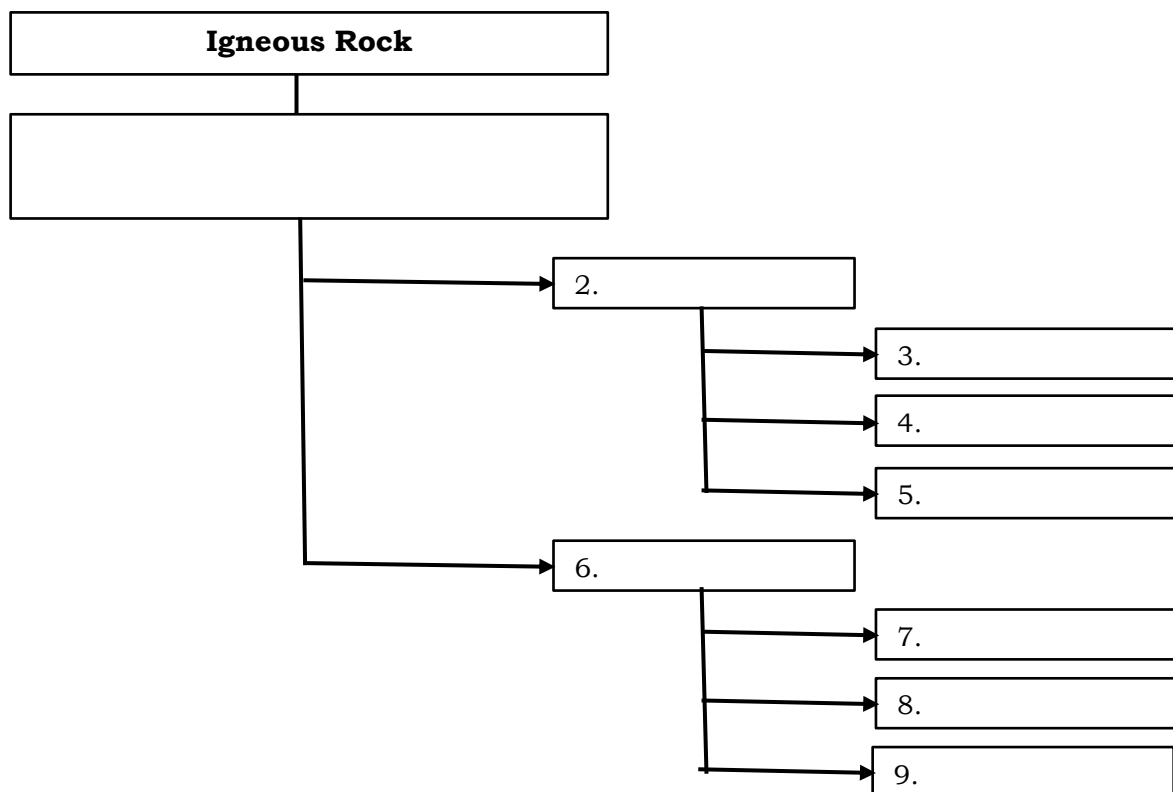
Different examples of igneous rocks are given below. Supply the missing information to complete the table below.

Rock	Type of Igneous Rock (intrusive or extrusive)	Formed from (magma or lava)	Cooling rate (fast or slow)	Crystal size (small, large or no crystal)
 Rhyolite	extrusive	1.	2.	small
 Gabbro	3.	4.	slow	large

Rock	Type of Igneous Rock <i>(intrusive or extrusive)</i>	Formed from <i>(magma or lava)</i>	Cooling rate <i>(fast or slow)</i>	Crystal size <i>(small, large or no crystal)</i>
 Granite	intrusive	5.	slow	6.
 Scoria	7.	lava	8.	No crystals
 Obsidian	9.	lava	fast	10.

Activity 4. Concept Map

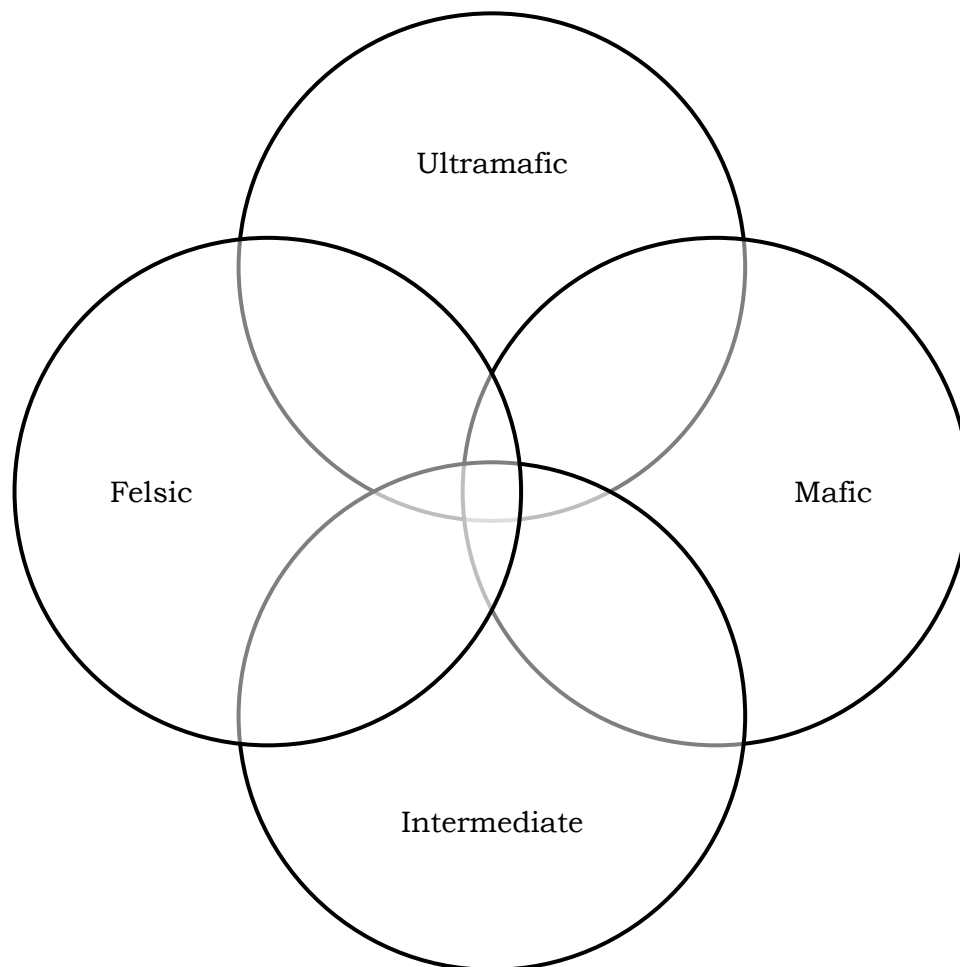
Complete the blank concept map by supplying the needed information using the given terms and phrases related to igneous rocks.



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

Compare the four classifications of igneous rocks based on composition.



Activity 6. Apply It!

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 on the next page.

Rocks (Drawing)	Type of Igneous Rock and its Characteristics
1.	
2.	
3.	



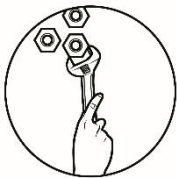
What I Have Learned

Activity 7. Complete Me!

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!

Read the given statement and justify your answer.

Quarrying is the process of removal of rocks, sand, gravel, or other minerals from the ground to produce materials for construction and others. Last December 2020, the Department of Environment and Natural Resources (DENR) launched an investigation into quarry operations in Rizal after heavy flooding hit the province and Marikina City. Torrential rains due to Ulysses pushed the water level in the Marikina River to swell over 22 meters –higher than what it reached in 2009 because of Typhoon Ondoy, inundating Marikina City.

Based on this event, what is your stand about this? Justify your answers.



Assessment

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

1. Which type of igneous rock forms when magma hardens beneath Earth's surface?
 - A. clastic
 - B. extrusive
 - C. intrusive
 - D. non-clastic
2. What type of igneous rock texture has large minerals?
 - A. aphanitic
 - B. glassy
 - C. phaneritic
 - D. vesicular
3. 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
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. Which of the following is/are the process/es of igneous rocks?
 - A. recrystallization
 - B. sedimentation
 - C. solidification and crystallization
 - D. solidification and recrystallization
6. Which of the following is NOT an extrusive igneous rock?
 - A. basalt
 - B. granite
 - C. obsidian
 - D. rhyolite
7. 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.

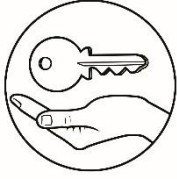
8. Which type of igneous rock forms from lava on Earth's surface?
- A. clastic
 - B. extrusive
 - C. intrusive
 - D. non-clastic
9. What Latin word was the term "igneous" derived from?
- A. *ignus*
 - B. *lithos*
 - C. *meta*
 - D. *sedere*
10. Which of the following is NOT an intrusive igneous rock?
- A. diorite
 - B. gabbro
 - C. granite
 - D. obsidian
11. 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
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. 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 examples of these rocks.
14. How are igneous rocks classified based on their origin?
- A. from magma or lava
 - B. coarse or fine grains
 - C. large or small crystals
 - D. plutonic and volcanic
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.



Additional Activities

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

Criteria	4	3	2	1
Creativity	All of the pictures used in the collage reflect a degree of student creativity in their display.	Most of the pictures used in the collage reflect student creativity in their display.	Only a few pictures reflect student creativity, but the ideas were typical rather than creative.	None of the pictures reflects student creativity.
Design	Pictures are cut to an appropriate size, shape and are arranged neatly.	1-2 Pictures are lacking in design or placement. There may be a few smudges or glue marks.	3-4 Pictures are lacking in design or placement. Too much background is showing. There are noticeable smudges or glue marks.	Pictures are not an appropriate size shape.
Theme	The student gives a reasonable explanation of how every item in the collage is related to the assigned theme.	The student gives a reasonable explanation of how most items in the collage are related to the assigned theme.	The student gives a fairly reasonable explanation of how most items in the collage are related to the assigned theme.	The student's explanations are weak and illustrate difficulty understanding how to relate items to the assigned theme.



Answer Key

<p>Assessment</p> <p>1. C 2. C 3. A 4. C 5. C 6. B 7. B 8. B 9. A 10. D 11. A 12. B 13. C 14. A 15. D</p> <p>What I Can Do</p> <p>Activity 8</p> <p>Answers may vary</p> <p>Activity 7</p> <p>1. fire 2. surface, beneath 3. solidification, crystallization 4. temperature, pressure, cool, solidify, crystallize 5. intrusive, extrusive 6. magma, lava 7. slowly, quickly 8. large, small or no 9. gabbro, diorite, granite 10. basalt, obsidian, rhyolite, scoria 11. silica 12. oversaturation 13. undersaturation 14. ultramafic, mafic, intermediate, felsic 15. felsic, ultramafic</p>	<p>16. felsic, ultramafic 17. ultramafic, felsic 18. ultramafic, felsic 19. ultramafic, felsic 20. lighter, lower</p> <p>What's More</p> <p>Activity 3</p> <p>1. lava 2. fast 3. intrusive 4. magma 5. magma 6. large 7. extrusive 8. fast 9. extrusive 10. no crystals</p> <p>Activity 4</p> <p>1. form from cooling and solidification of lava and magma 2. intrusive 3. large crystal form 4. magma cools slowly 5. composed of magnesium and iron 6. extrusive 7. small or no crystal form 8. lava cools quickly 9. composed of aluminum</p> <p>Answers may vary</p> <p>Activity 5</p> <p>Answers may vary</p>	<p>Activity 6</p> <p>Answers may vary. Their color, density, grains, crystals, and location of the rocks</p> <p>What's in</p> <p>Activity 1</p> <p><i>Across</i></p> <p>1. metamorphism 3. regional</p> <p><i>Down</i></p> <p>2. pressure 4. contact 5. heat</p> <p>What I Know</p> <p>1. A 2. A 3. C 4. A 5. B 6. B 7. B 8. C 9. A 10. B 11. C 12. B 13. C 14. A 15. D</p> <p>What's New</p> <p>Activity 2</p> <p>1. grandmother and her granddaughter 2. place where Taal volcano can be seen 3. They are talking about rocks found in Taal volcano. 4. igneous rocks 5. granite</p>
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References

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