Teacher Lesson Plan

LESSON 2.
Global Building Blocks

Limestone Rocks at Devil's Hall.
NPS picture (Bieri).

Overview
Rocks and minerals are the building blocks of the Earth Crust. Learning how to identify the main types of rocks and their minerals will help students understand the geology of the Guadalupes and how a beautiful reef can transform into a mountain.

Grades
9-12

Objectives
The student will:

- Learn about mineral composition and identification.
- Understand the rock cycle and identify some common rocks in each group.
- Apply this knowledge to geology in the Guadalupe Mountains region.

Duration
2 periods (1 hour each)

Vocabulary
Mineral, rock, crystal structure, chemical composition, hardness, luster, cleavage, carbonates, rock cycle, igneous rock, metamorphic rock, sediment, clast, sedimentary rock, metamorphism, magma, crystallization, cementation, evaporite, metallic, nonmetallic, striations, transparent, translucent, physical weathering, chemical weathering, erosion, rock cycle, basalt, granite, trona, limestone, conglomerate, sandstone, shale, coquina, coal, gneiss, schist, marble, slate, foliated, crystalline, texture, vesicular, ooids, pebbles, sand, gravel, grain size, clay, organic material, ultraviolet light, hydrochloric acid, effervescence, streak, calcite, dolomite, gypsum, halite, sulfur, pyrite, muscovite mica, orthoclase feldspar, quartz

Materials

- Mineral kit including: quartz, calcite, muscovite mica, gypsum, dolomite, sulfur, halite, pyrite, orthoclase feldspar
- Mineral identification kit including: penny, glass plate, porcelain tile, weak HCl acid (10%), hand lens
- Mineral identification flow-chart (Slide #23)
- Venn Diagram (Slide #24)
- Rock cycle chart (Slide #25)
- Rock identification flow charts (Slide #26)
- Rock kit including: limestone (coquina and crystalline limestone), trona, conglomerate, sandstone, shale, coal, granite, basalt, gneiss, schist, and marble
- Carlsbad Caverns National Park geologic map (Slide #110)
- Carlsbad Caverns National Park geologic formation descriptions (Slide #111)

Background information

The Earth's building blocks are minerals and rocks. Minerals, of which rocks are composed, are defined by standard criteria: 1) specific chemical composition, 2) inorganic, 3) regular crystalline structure, 4) naturally occurring, and 5) solid. While it is tempting to use color to determine the type of mineral, many of the same minerals come in a variety of colors so other characteristics must be used. Diagnostic tests for identifying minerals use properties: hardness (on a scale from one being the softest mineral, talc, to ten, a diamond, the hardest mineral found), streak (the color of the mineral powder when you rub it on a porcelain plate), cleavage (the ways a mineral naturally breaks), effervescence (reaction of mineral to weak HCl, hydrochloric acid), magnetism (attracted to magnets or not), taste (however some minerals are toxic, so you don't want to lick them all) and fluorescence (fluorescence when exposed to an ultraviolet light or not). While there are many different minerals found throughout the world, some minerals specific to the Guadalupe Mountains, Delaware Basin, and Carlsbad Caverns are calcite, dolomite, gypsum, halite, sulfur, and pyrite. The majority of the Earth's surface is composed of quartz and feldspar, two other minerals that are not as common in this area of carbonates.

Rocks, in turn, are composed of minerals. There are three types of rocks: 1) igneous rocks where the interlocking minerals crystallize out of molten material, 2) sedimentary rocks composed of cemented physically-weathered sediments derived from other rocks or chemically precipitated from saturated solutions, and finally 3) metamorphic rocks, which are pressure and temperature "cooked" versions of any of these three types of rock. Fossils can be found in sedimentary rocks and, occasionally, in some metamorphic rocks too. The most common rock in the area is limestone, which is composed of the mineral calcite.

Identification of rocks and minerals allows geologists to produce geologic maps. This knowledge can aid in the understanding of the paleoenvironment and time period in which the rocks and minerals formed. This activity will introduce common rocks and minerals found in the Guadalupe Mountains and Carlsbad Cavern region as well as others that are common elsewhere. Identification of samples will also enhance students' observational and

classification skills. Once the students have identified the rocks and minerals, they will be able to understand a geologic map.

Preparation

Read the background information and select the most common minerals and rocks samples to identify them at the lab.

Procedure

The teacher will:

- Explain that the Earth is composed of rocks, which are composed of minerals. Define each.
- Define the properties of minerals and explain that these characteristics may be examined and tested on hand samples.
- Pass out the mineral samples to identify with the testing kits and the flow chart. Explain that these are just a few of the minerals that are represented in the Guadalupe Mountains—emphasize that there are many more in the area and the world!
- Let the students work together to identify the different minerals using the standard tests and have them record the names and some characteristics in their notebooks.
- After checking students' answers, have students complete a Venn diagram for common minerals in the region (i.e. calcite, dolomite, and gypsum).
- Explain the rock cycle and that rocks are composed of different minerals. While there are three different types of rocks, for the Guadalupe Mountains and Carlsbad Cavern story, we are mainly interested in sedimentary rocks so these will be the majority of the rocks the students will identify.
- Once the rock samples are passed out and the students are divided into groups, help the class separate the different rock types.
- Pass out the three different rock flow charts and have students use the charts to identify the different rock samples. They should write descriptions and identifications in their science notebooks. The students may also look for their minerals in the rocks, but keep the samples separate to avoid confusion.
- Using the Guadalupe Mountains and Carlsbad Caverns National Park geology maps and formation descriptions, have students link the geologic formations with their rock and mineral characterizations. Students should record these descriptions of each unit in their science notebooks.

Assessments

- Lab report
- Data table of identified minerals and rocks
- Venn Diagram of several local minerals
- Geologic map interpretation

Alternative Assessments or Extensions

- Have students draw a schematic diagram of the backreef, reef, and forereef area. Label the different units and minerals found in each environment (similar to the schematic cross-section used in Lesson 1).
- Students should list different environments where each type of sedimentary rock is found (i.e. sandstone may be formed in rivers, beaches, mountains, deltas, etc.) to show the complexity of paleoenvironmental reconstructions using only rock types.
- Have students identify minerals used in everyday products (i.e. drywall, toothpaste, lipstick, milkshakes, vitamins, etc.).

Bibliography

Beaubouef, R.T., Rossen, C, Zelt, F.B, Sullivan, M.D., Mohrig D.C. and D.C. Jeanette. 1999. "*Deep-Water Sandstones, Brushy Canyon Formation, West Texas*." AAPG Field Guide #40.

Marshak, S. 2001. *Earth Portrait of a Planet.* New York: W.W. Norton & Co.

USGS Learning Web, Rocks and minerals web page: *http://interactive2.usgs.gov/learningweb/explorer/topic_rocks.htm*

Additional reading and other resources:

Amethyst Galleries Inc. Mineral Gallery web page: *http://mineral.galleries.com/*

USGS Rocks and Minerals web page: ***http://geology.er.usgs.gov/eastern/rocks.html***

LESSON 2.
Global Building Rocks

Student Worksheet

Limestone Rocks at Devils´Hall.
NPS picture (Bieri).

The Earth's building blocks are minerals and rocks. Minerals, of which rocks are composed, are defined by standard criteria: 1) specific chemical composition, 2) inorganic, 3) regular crystalline structure, 4) naturally occurring, and 5) solid. While it is tempting to use color to determine the type of mineral, many of the same minerals come in a variety of colors so other characteristics must be used. Diagnostic tests for identifying minerals use properties: hardness (on a scale from one being the softest mineral, talc, to ten, a diamond, the hardest mineral found), streak (the color of the mineral powder when you rub it on a porcelain plate), cleavage (the ways a mineral naturally breaks), effervescence (reaction of mineral to weak HCl, hydrochloric acid), magnetism (attracted to magnets or not), taste (however some minerals are toxic, so you don't want to lick them all) and fluorescence (fluorescence when exposed to an ultraviolet light or not). While there are many different minerals found throughout the world, some minerals specific to the Guadalupe Mountains, Delaware Basin, and Carlsbad Caverns are calcite, dolomite, gypsum, halite, sulfur, and pyrite. The majority of the Earth's surface is composed of quartz and feldspar, two other minerals that are not as common in this area of carbonates.

Rocks, in turn, are composed of minerals. There are three types of rocks: 1) igneous rocks where the interlocking minerals crystallize out of molten material, 2) sedimentary rocks composed of cemented physically-weathered sediments derived from other rocks or chemically precipitated from saturated solutions, and finally 3) metamorphic rocks, which are pressure and temperature "cooked" versions of any of these three types of rock. Fossils can be found in sedimentary rocks and, occasionally, in some metamorphic rocks too. The most common rock in the area is limestone, which is composed of the mineral calcite.

Identification of rocks and minerals allows geologists to produce geologic maps. This knowledge can aid in the understanding of the paleoenvironment and time period in which the rocks and minerals formed. This activity will introduce common rocks and minerals found in the Guadalupe Mountains and Carlsbad Cavern region as well as others that are common elsewhere. Identification of samples will also enhance students' observational and classification skills. Once the students have identified the rocks and minerals, they will be able to understand a geologic map.

Vocabulary

Mineral, rock, crystal structure, chemical composition, hardness, luster, cleavage, carbonates, rock cycle, igneous rock, metamorphic rock, sediment, clast, sedimentary rock, metamorphism, magma, crystallization, cementation, evaporite, metallic, nonmetallic, striations, transparent, translucent, physical weathering, chemical weathering, erosion, rock cycle, basalt, granite, trona, limestone, conglomerate, sandstone, shale, coquina, coal, gneiss, schist, marble, slate, foliated, crystalline, texture, vesicular, ooids, pebbles, sand, gravel, grain size, clay, organic material, ultraviolet light, hydrochloric acid, effervescence, streak, calcite, dolomite, gypsum, halite, sulfur, pyrite, muscovite mica, orthoclase feldspar, quartz

Activity 1.1. Getting to know minerals

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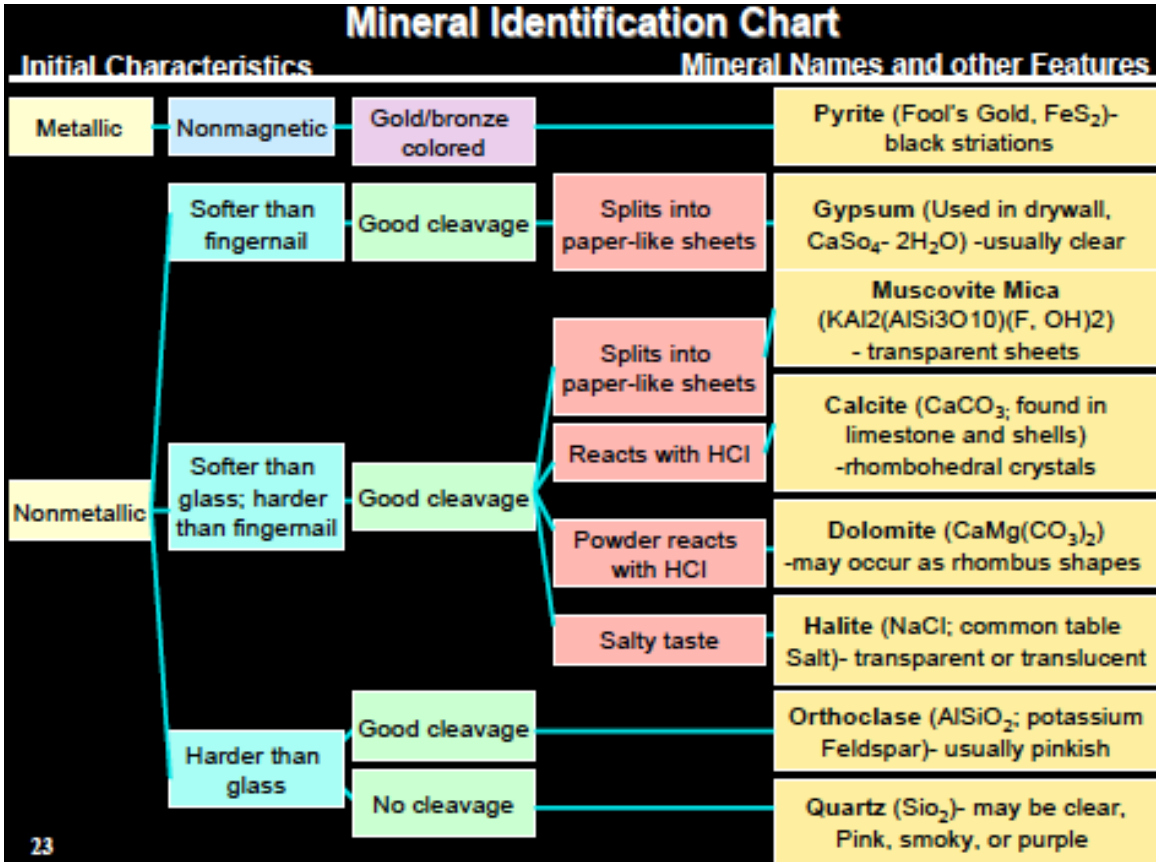
1. Using the dictionary or a textbook, define the following concepts:
   a) Mineral:
   b) Rock:
2. Is a rock made up of minerals or is a mineral made up of rocks?
3. Match elements from both columns:

Mineral properties	Definitions
a. Color	1. The way it reflects light
b. Luster	2. Mohs scale
c. Streak	3. It can vary
d. Hardness	4. The powder on a porcelain plate



Handout

MINERAL IDENTIFICATION LAB REPORT

QUESTION: What minerals can we find at the Guadalupe Mountains?

BACKGROUND RESEARCH: Find out the common minerals on a reef environment.

HYPOTHESIS: Form your own hypothesis based on your findings.

EXPERIMENT

- MATERIALS: mineral samples, hand lens, textbook, mineral guide, copper penny, steel knife blade, glass plate, porcelain tile, magnet, weak HCl acid (10%), safety goggles, gloves

- PROCEDURE:

1. Examine the mineral sample with the naked eye
2. Examine the mineral sample with a magnifying glass
3. Record the mineral properties (color, luster, streak and hardness)
    a. Color: it is determined by the presence of certain elements in the mineral. Some minerals always appear with same color, whereas others can have different colors.
    b. Luster: the way a mineral reflects the light. It can be **metallic** (it shines like a piece of metal) or **non-metallic** (it doesn't look like a metal at all). The non-metallic can be *vitreous* (as glass), *adamantine* (as diamonds), *pearly* (as pearls), *greasy* (as oil), *waxy* (as wax) or *dull* (no luster or earthy). It is a difficult characteristic so let your teacher help you out.
    c. Streak: the color of the mineral powder when you rub it on a porcelain plate.
    d. Hardness: the resistance of a mineral to be scratched by an object or other minerals. Use the Mohs scale.
    e. Other properties: effervescence, magnetism
4. Determine what type of mineral it is

Mohs scale

Hardness	Mineral	Test
1	Talc	Friable under a fingernail
2	Gypsum	Scratched by a fingernail
3	Calcite	Scratched by a coin
4	Fluorite	Easily scratched by a knife
5	Apatite	Scratched by a knife
6	Orthoclase	Scratched by a nailfile
7	Quartz	Scratched by a glass
8	Topaz	Scratched by tungsten tools
9	Corundum	Scratched by silicon carbide
10	Diamond	Scratched by an other diamond

RESULTS: Complete the data table with the mineral properties. And describe what you found out after carrying out the experiment.

CONCLUSION: Was your hypothesis supported by your results?

DATA TABLE:

MINERAL #	COLOR	LUSTER	STREAK	HARDNESS	OTHER PROPERTIES	MINERAL NAME
1						
2						
3						
4						
5						
6						
7						
8						

Activity 1.2. Building blocks: Rocks

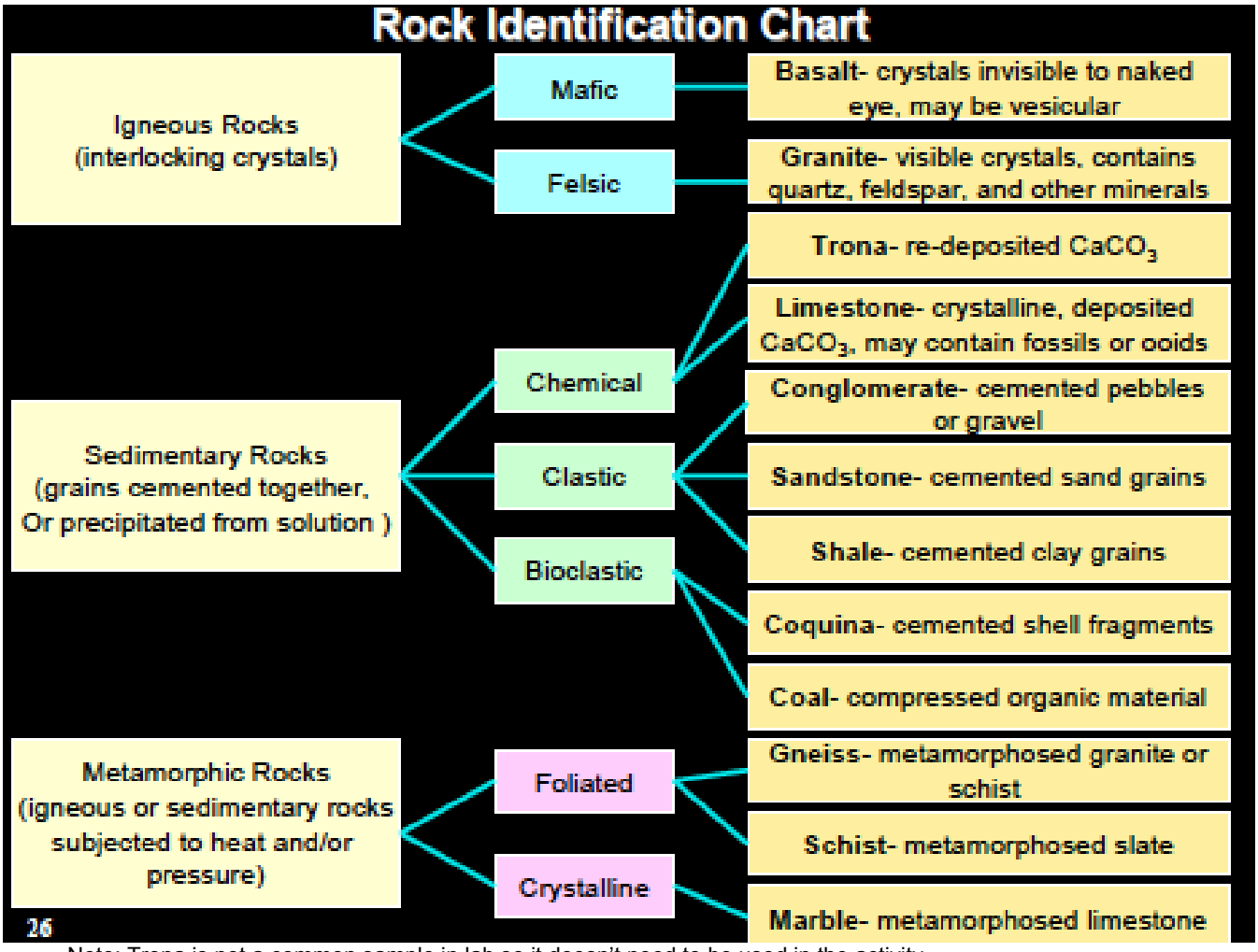
Answer the following questions:

a. Name the three types of rocks.

b. What kind of rocks form from cooling magma or volcanic lava?

c. What kind of rocks form from changes in heat and pressure?

d. What kind of rocks form from sediments?



Note: Trona is not a common sample in lab so it doesn't need to be used in the activity.

Handout

ROCK IDENTIFICATION LAB REPORT

QUESTION: What kind of rocks can we find at the Guadalupe Mountains?

BACKGROUND RESEARCH: Find out the common rocks on a reef environment.

HYPOTHESIS: Form your own hypothesis based on your findings.

EXPERIMENT

- MATERIALS: rock samples, hand lens, weak HCl acid (10%), safety goggles, gloves

- PROCEDURE:

1. Examine the rock sample with the naked eye.
2. Examine the rock sample with a magnifying glass.
3. Record the rock properties (color, texture and crystal size)

   Color: it is determined by the presence of certain elements in the minerals that contain the rock.

   Texture: it refers to its grain size. It can be coarse, medium, fine or glass (no grains).

   Crystal size: no crystals, small or big.

   Other properties: effervescence, magnetism

4. Determine what type of rock it is. Use the flow chart to help you out.

RESULTS: Complete the data table with the rock properties. And describe what you found out after carrying out the experiment.

CONCLUSION: Was your hypothesis supported by your results?

ROCK KEY

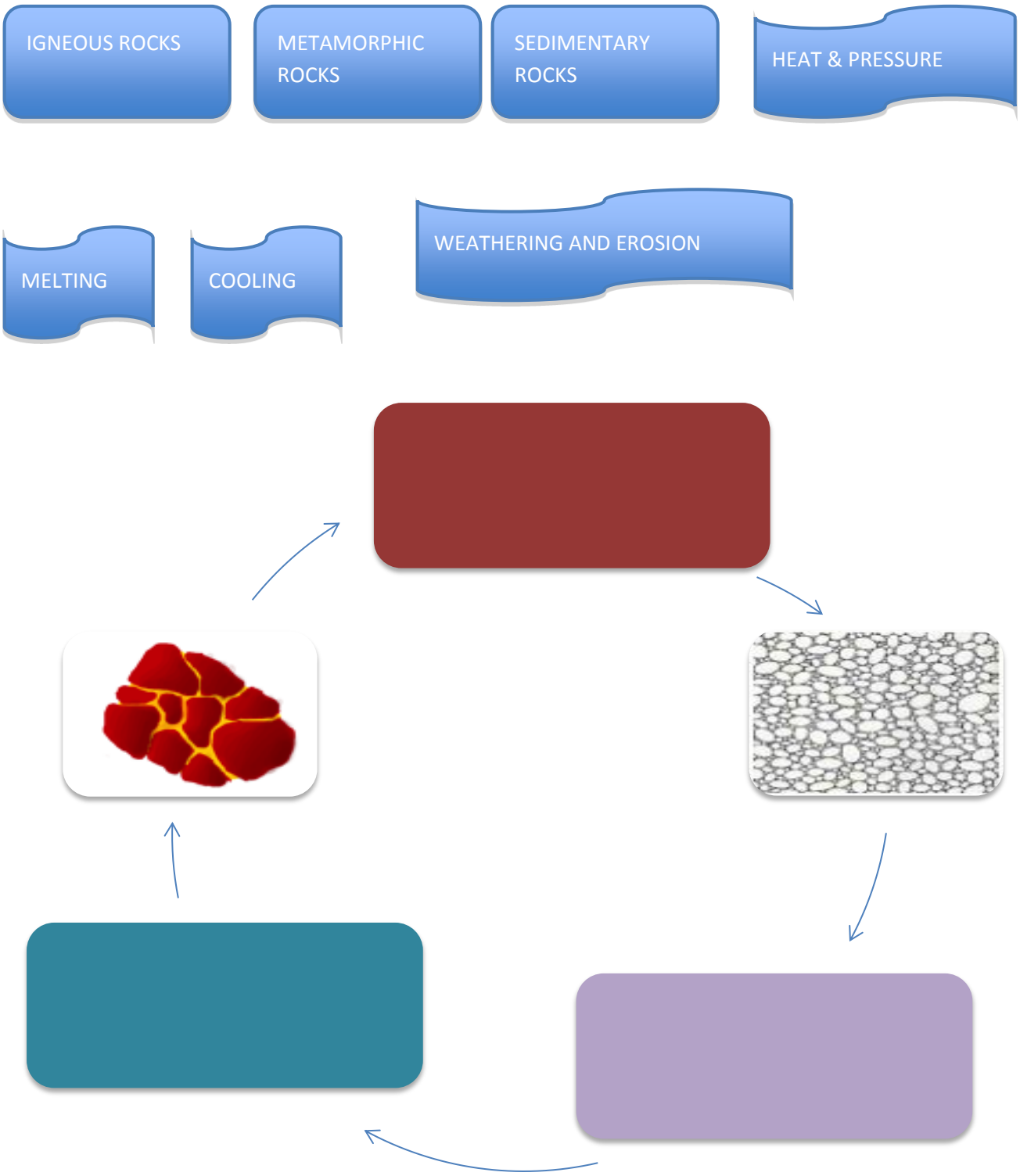
1. Does the rock have interlocking crystals?
   YES.- Go to 2
   NO.- Go to 3
2. Are the crystals invisible to naked eye?
   YES.- It is BASALT
   NO.- It is GRANITE
3. Does the rock have grains cemented together or precipitated from solution?
   YES.- Go to 4
   NO.- Go to 10
4. Is the rock made up of pieces of sediments?
   YES.- Go to 5
   NO.- Go to 10
5. Is the rock made up of cemented pebbles or gravel?
   YES.- It is CONGLOMERATE
   NO.- Go to 6
6. Is the rock made up of cemented sand grains?
   YES.- It is SANDSTONE
   NO.- Go to 7
7. Is the rock made up of cemented clay grains?
   YES.- It is SHALE
   NO.- Go to 8
8. Is the rock made up of cemented shell fragments?
   YES.- It is COQUINA
   NO.- Go to 9
9. Is the rock black and made up of compressed organic material?
   YES.- It is COAL
   NO.- It is LIMESTONE
10. Does the rock have a texture foliated or crystalline?
    YES.- Go to 11
    NO.- Go back to 4
11. Does the rock have a foliated texture (minerals aligned)?
    YES.- Go to 12
    No.- Go to 13
12. Does the rock have alternating darker and lighter bands?
    YES.- It is GNEISS
    NO.- It is SCHIST
13. Does the rock fizz with the HCl test?
    YES.- It is MARBLE
    NO.- Go back to 2

DATA TABLE:

ROCK #	COLOR	TEXTURE	CRYSTAL SIZE	OTHER PROPERTIES	ROCK NAME
1					
2					
3					
4					
5					
6					
7					
8					

Activity 1.3. Rock Cycle

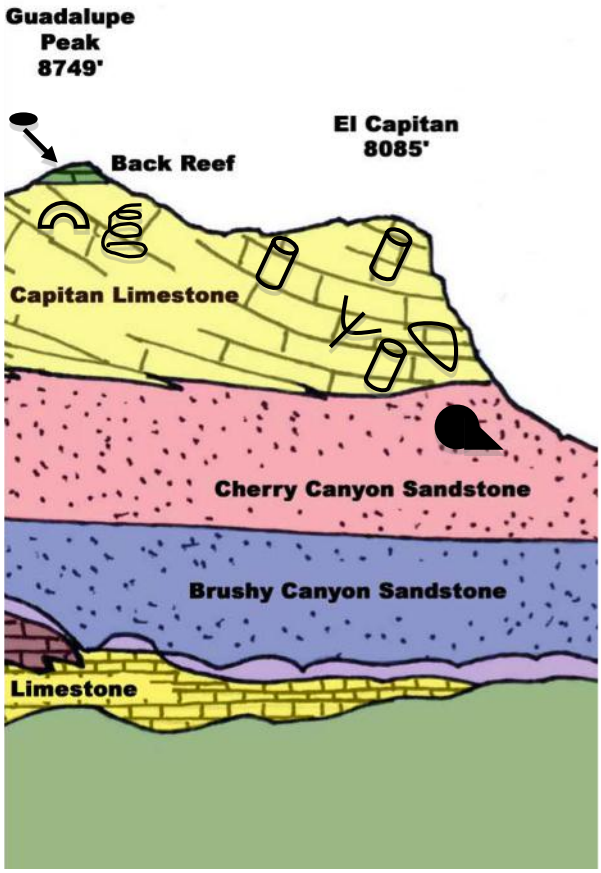
Complete the cycle chart with the three types of rocks and label the arrows with words from the boxes.



Activity 1.4. Geologic map

According to the U.S. Geological Survey, a geologic map "describe the rocks and soils at the surface, provide information about what rocks lie at depth, and describe the ages of rocks and soils, and show where features such as earthquake faults and landslides lie." Look at the following geological map of a section of the Guadalupe Mountains and answer the questions:

a. What are the two main rocks we can find in these mountains? What kind of rocks are they? Is this coherent with the knowledge you have about the geology of the area?
b. Based on the Law of Superposition (Steno), what is the most recent layer?
c. In which layer can we find fossils?
d. The fossils we can find are remnants of creatures that used to live in this area during the Permian period. In what kind of environment do you think they used to live?
e. Look at the geologic time chart and determine the approximate age (m.y.) of these fossils and rock strata based on the information on question d.



Fossil	Organism
	Algae
	Sponge
	Fusulinid
	Bryozoan
	Brachiopod
	Ammonoid
	Snail

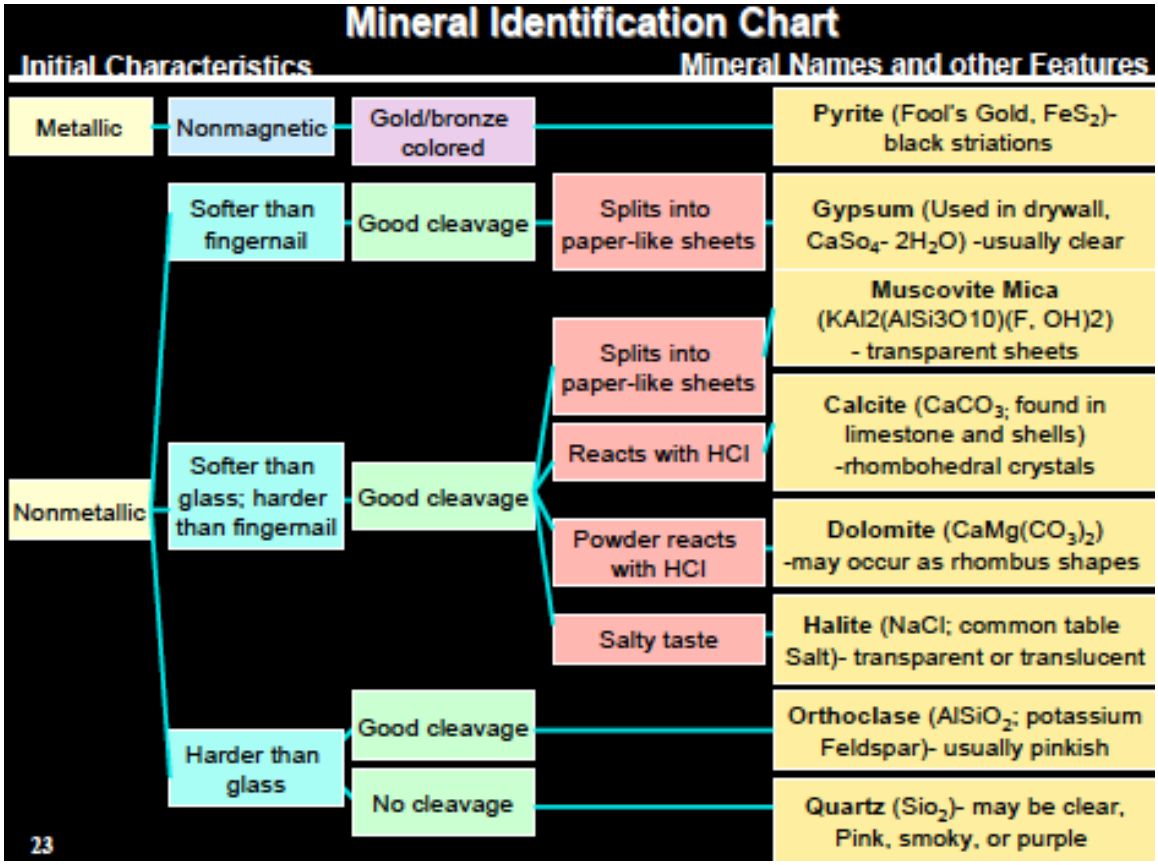
Answer Key

Activity 1.1. Getting to know minerals

1. Using the dictionary or a textbook, define the following concepts:
   a) Mineral: A naturally occurring, solid homogeneous inorganic solid substance having a definite chemical composition and characteristic crystalline structure, color, and hardness.
   b) Rock: naturally occurring solid aggregate of one or more minerals or mineraloids.
2. Is a rock made up of minerals or is a mineral made up of rocks?
   A rock is made up of minerals
3. Match elements from both columns:

Mineral properties	Definitions
a. Color	1. The way it reflects light
b. Luster	2. Mohs scale
c. Streak	3. It can vary
d. Hardness	4. The powder on a porcelain plate

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



MINERAL IDENTIFICATION LAB REPORT

Answers in the report sheet can vary depending on the student. The data table answers should be the following:

DATA TABLE:

MINERAL #	COLOR	LUSTER	STREAK	HARDNESS	OTHER PROPERTIES	MINERAL NAME
1	Gold, bronze	Metallic	Black or gold yellow	6.5	Non magnetic	PYRITE
2	White, colorless	Vitreous	White	2		GYPSUM
3	White to colorless	Vitreous, pearly	White	2.5		MUSCOVITE
4	White, yellow, red, …	Vitreous, pearly	White	3	HCl causes it to effervesce	CALCITE
5	White, grey to pink	Vitreous to pearly	White	3.5 to 4	May fluoresce under UV and effervesce with HCl	DOLOMITE
6	White, clear	Vitreous (glassy)	White	2.5	Fluorescent	HALITE
7	Colorless, green, pink, white	Vitreous (glassy)	White	6		ORTHOCLASE
8	Colorless, grey, red, white, blue, purple, …	Vitreous	White	7		QUARTZ

Activity 1.2. Building blocks: Rocks

Answer the following questions:

a. Name the three types of rocks. Igneous, sedimentary and metamorphic.
b. What kind of rocks form from cooling magma or volcanic lava? Igneous
c. What kind of rocks form from changes in heat and pressure? Metamorphic
d. What kind of rocks form from sediments? Sedimentary

ROCK IDENTIFICATION LAB REPORT

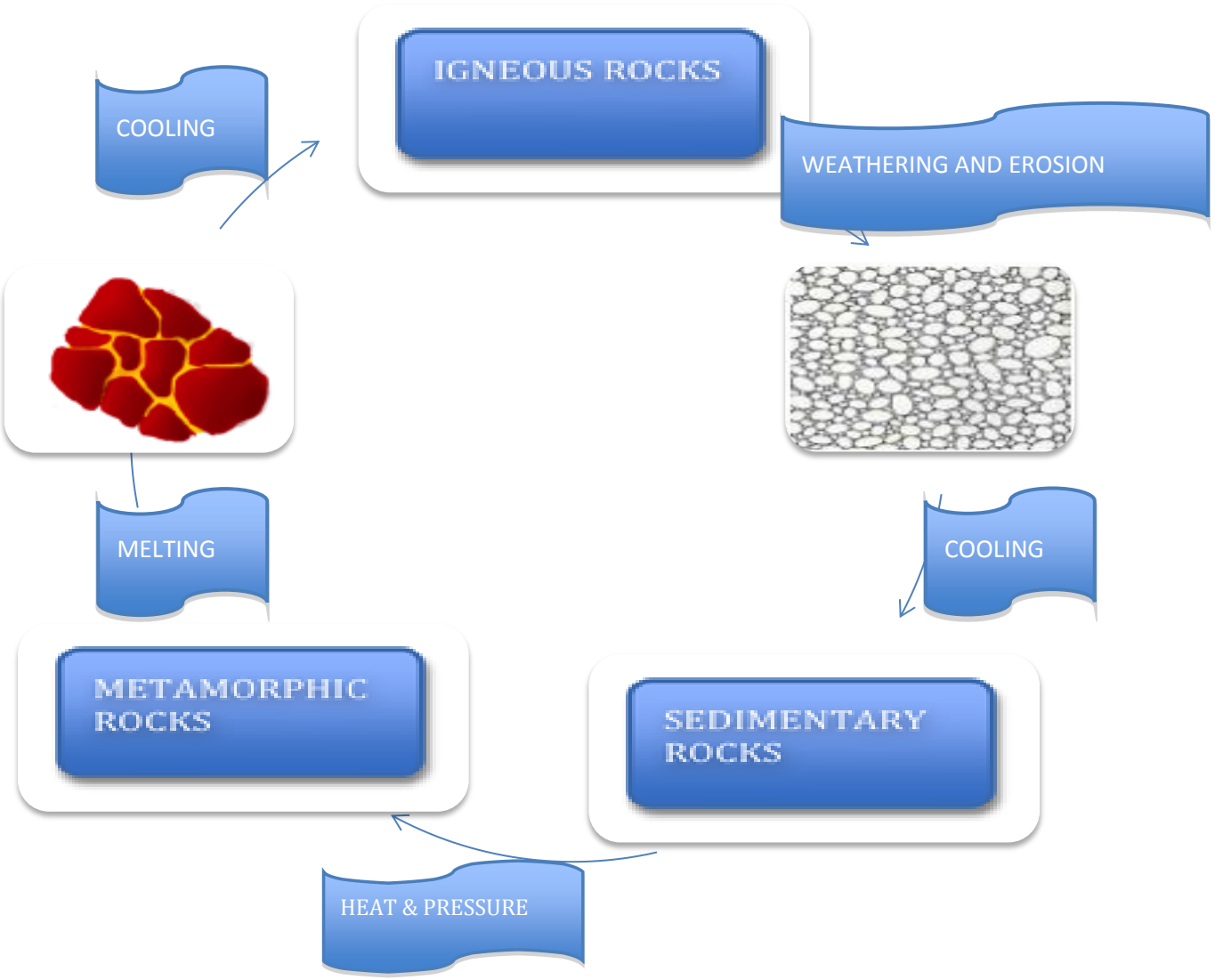
Answers in the report sheet can vary depending on the student. The data table answers should be the following:

DATA TABLE:

ROCK #	COLOR	TEXTURE	CRYSTAL SIZE	OTHER PROPERTIES	ROCK NAME
1	Black	Fine	Small	Heavy	BASALT
2	Grey, pink	Coarse	Big		GRANITE
3	Grey, white,	Medium	Medium	Effervescence	LIMESTONE
4	Brownish	Coarse	Big		CONGLOMERATE
5	Red, white	Fine	Small		SANDSTONE
6	black	Fine	Small		SHALE
7	white	Fine	Medium		COQUINA
8	black	Medium	Small		COAL
9	Grey, black with bands	Coarse	Medium		GNEISS
10		Coarse	Medium		SCHIST
11	White	Coarse	Medium	Effervescence	MARBLE

Activity 1.3. Rock Cycle

Complete the cycle chart with the three types of rocks and label the arrows with words from the boxes.



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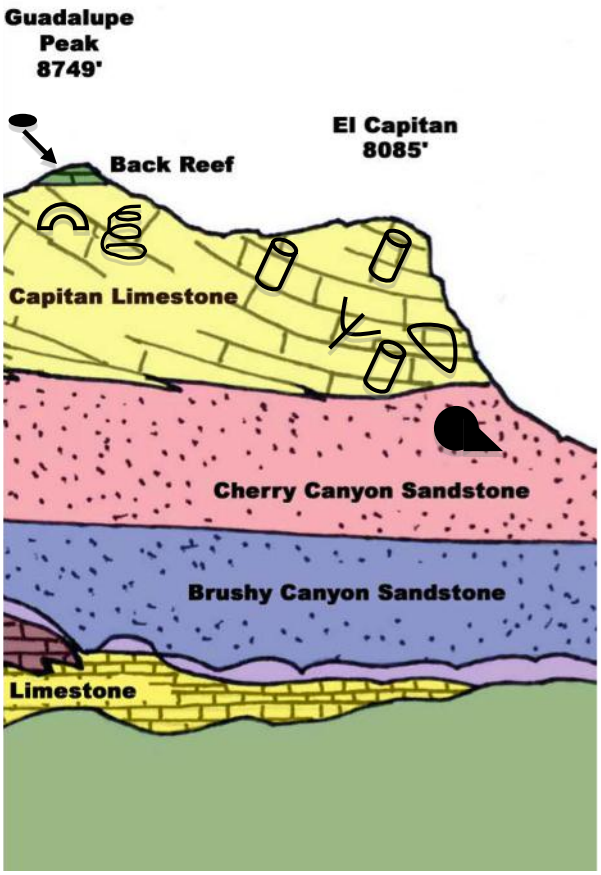
a. What are the two main rocks we can find in these mountains? What kind of rocks are they? Is this coherent with the knowledge you have about the geology of the area?
   Limestone and sandstone. Sedimentary rocks. Is this coherent with the knowledge you have about the geology of the area? Yes, because the there was a reef during the Permian period and sedimentary rocks are typical rocks from that kind of environment.
b. Based on the Law of Superposition (Steno), what is the most recent layer?
   The top one, the back reef layer
c. In which layer we can find fossils?
   Back reef, Capitan limestone and Cherry Canyon Sandstone
d. The fossils we can find are remnants of creatures that used to live in this area during the Permian period. In what kind of environment do you think they used to live?
   Ocean, sea or marine
e. Look at the geologic time chart and determine the approximate age (m.y.) of these fossils and rock strata based on the information on question d.
   Between 250 and 299 m.y.



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