



Mineral Formation & Classification

High School

Duration

2 -3 classes and Museum visit

Location

Classroom and
Gem & Mineral Hall

Supplies

- See individual lessons

Standards

Science 3.c; 9.a.

CCS ELA Grades 9-10:
Reading for Literacy in
Science and Technical
Subjects 10.2.4.7

CCS ELA Grades 9-10:
Writing for Literacy in
History/Social Studies,
Science and Technical
Subjects 7

Vocabulary

Intrusion
Igneous
Sedimentary
metamorphic
Ore
Deposit
Molten
Magma
Crystal
Transform
Pegmatite
Mantle



Module Overview

This module explores the process of mineral formation and how it contributes to its properties.

Module Purpose

In this lesson set, students use the Gem and Mineral Hall's collection to practice classifying minerals by observable characteristics and relating mineral properties to the environments in which they form. If time allows, students research California's gold deposits.

Module Outline

1. In one class before visiting, students become familiar with vocabulary and are introduced to (or review) the rock cycle and mineral classification. The depth of this phase varies with student needs.
2. During a visit to the Museum students practice classifying rocks and minerals by their observable properties and relate these properties to environments in which they formed.
3. In one to two post-visit sessions, students share findings with each other and research additional minerals and their formation environments, as well as California gold.

Assessment Opportunities

Lesson/Phase	Before and During the Lesson		End of Lesson
	Uncovers Student Ideas	Checks for New Understanding	Evaluates Learning
Pre-Visit	STIP	Building Scientific Vocabulary	
Museum		Gem & Mineral Hall Worksheet	
Post-Visit			Mineral Research

References & Resources

"Rocks and Minerals." Teachers' Domain. 5 Oct. 2011. Web. 22 May. 2012.
<http://www.teachersdomain.org/resource/idptv11.sci.ess.earthsys.d4krom/>.

Fossweb Rock Database:

http://www.fossweb.com/modulesMS/kit_multimedia/EarthHistory/media/rocksand_db_rock_limestone.htm



Building Vocabulary

Pre-Visit

Duration

1 class (and/or homework)

Location

Classroom

Supplies

- Worksheet
- Pencils
- Examples of igneous, metamorphic, and sedimentary rocks and minerals
- Pictures of igneous, metamorphic, and sedimentary rocks and minerals
- Computers

Purpose

Before visiting the Museum, this phase assesses and develops student background knowledge and vocabulary skills. Students learn about the basic types of rocks and minerals and the environments in which they are formed, as well as practice recognizing igneous, sedimentary, and metamorphic minerals based on their properties.

Objectives

- Students will become familiar with the following roots, prefixes and suffixes (see next page).
- Students will describe the processes that produce igneous, metamorphic, and sedimentary rocks.
- Students will relate the properties of igneous, metamorphic, and sedimentary rocks to the processes that produce them.

Outline

1. Have students complete the Scientific Terminology Inventory Probe (STIP) This probe reveals students' familiarity with the scientific terminology they will encounter during this lesson.
2. Introduce vocabulary activity to build literacy skills and vocabulary, and show that the meaning of many words can be inferred if one knows key roots, prefixes, and suffixes.
 - a. Give students the definitions for each prefix, suffix and root (see table on next page) and have them draw their own pictures representing them.
 - b. Have students brainstorm related words—words that are made with the prefix. You may need to model some words, for example, ign is related to both ignite and ignition. You may have students work in small groups or as a class for this, but they should have at least one related word for each word. Of course the more the better!.

- c. Finally, make sure students include the key vocabulary words in their related word lists, and have them copy the related sentences.
3. Show students the differences between igneous, metamorphic, and sedimentary rocks, briefly describing the processes that produce them.
 - a. Depending upon the amount of time and materials you have available, you may consider implementing this as a 5E lesson cycle, where students first sort the rocks into categories without direct instruction, recording their observations of the rocks and minerals. You would then provide the students with the scientific explanation of the different rock/mineral types and characteristics, showing them pictures. Students would then have time to resort their rocks using this new knowledge. Finally, you would give them the correct categorization for their rocks, and students would reflect on their experience.
 - b. If you have less time, you may want to consider introducing the rock/mineral classification system using direct instruction, showing students plenty of visuals and, if possible, allowing them to observe actual examples of these rocks and minerals.
 4. Have students summarize their findings in a table that they will take with them to the Museum.
 5. Go over academic and behavioral expectations for your trip to the Museum and explain the activities students will be completing while there.

Vocabulary

"Word"	Definition	Related words	Possible Sentence
Ign	Fire	Ignite, igneous, ignition	Igneous rocks are "born of fire " in volcanoes or the depth of the Earth
-ion	Process	Inclusion, erosion, conservation, pollution, decomposition	Erosion is a process in which soil and rock are worn away.
-ite	ore, rock, crystal	pegmatite, bauxite, bentonite, granite, graphite	Bauxite is an aluminum ore
Meta	Between, change	Metamorphic, metastable	Metamorphic rock has undergone change as a result of heat, pressure, and time
morph	form	metamorphic, morphology, isomorph	Metamorphic rock has changed form .
-ous, -us	Characterized by	Aqueous, igneous, carboniferous.	Aqueous solutions are characterized by water.
pegma	something fastened together	pegmatite	Pegmatite is composed of crystals tightly fastened together in an interlocking structure
pos	put, placed	deposit, position, expose, composite, opposite	Alluvial deposits have been laid down over time.
Sed, sid	Sit, settle	Sediment, subside, residue, sedimentary	Sedimentary rock forms from mineral and organic particles that settled on the surface of the earth.
trans	across	transform, transmit, transparent, translucent, transmission,	Radio transmitters send messages across long distances
-trud, -trus	To push	Intrude, extrusion, extrude, protrude, protrusion	Intrusions are formed when magma slowly pushes up from deep within the earth into any cracks or spaces it can find.

3 Mineral Formation & Classification



Mineral Formation Environments

STIP

<p style="text-align: center;">Intrusion</p> <ul style="list-style-type: none">◇ I have never heard of this◇ I have heard of this but I'm not sure what it means◇ I have some idea what it means◇ I clearly know what it means and can describe it:	<p style="text-align: center;">Ore</p> <ul style="list-style-type: none">◇ I have never heard of this◇ I have heard of this but I'm not sure what it means◇ I have some idea what it means◇ I clearly know what it means and can describe it:	<p style="text-align: center;">Pegmatite</p> <ul style="list-style-type: none">◇ I have never heard of this◇ I have heard of this but I'm not sure what it means◇ I have some idea what it means◇ I clearly know what it means and can describe it:
<p style="text-align: center;">Metamorphic</p> <ul style="list-style-type: none">◇ I have never heard of this◇ I have heard of this but I'm not sure what it means◇ I have some idea what it means◇ I clearly know what it means and can describe it:	<p style="text-align: center;">Igneous</p> <ul style="list-style-type: none">◇ I have never heard of this◇ I have heard of this but I'm not sure what it means◇ I have some idea what it means◇ I clearly know what it means and can describe it:	<p style="text-align: center;">Sedimentary</p> <ul style="list-style-type: none">◇ I have never heard of this◇ I have heard of this but I'm not sure what it means◇ I have some idea what it means◇ I clearly know what it means and can describe it:



Mineral Formation Environments

STIP

<p style="text-align: center;">Molten</p> <ul style="list-style-type: none">◇ I have never heard of this◇ I have heard of this but I'm not sure what it means◇ I have some idea what it means◇ I clearly know what it means and can describe it:	<p style="text-align: center;">Magma</p> <ul style="list-style-type: none">◇ I have never heard of this◇ I have heard of this but I'm not sure what it means◇ I have some idea what it means◇ I clearly know what it means and can describe it:	<p style="text-align: center;">Mantle</p> <ul style="list-style-type: none">◇ I have never heard of this◇ I have heard of this but I'm not sure what it means◇ I have some idea what it means◇ I clearly know what it means and can describe it:
<p style="text-align: center;">Deposit</p> <ul style="list-style-type: none">◇ I have never heard of this◇ I have heard of this but I'm not sure what it means◇ I have some idea what it means◇ I clearly know what it means and can describe it:	<p style="text-align: center;">Transform</p> <ul style="list-style-type: none">◇ I have never heard of this◇ I have heard of this but I'm not sure what it means◇ I have some idea what it means◇ I clearly know what it means and can describe it:	<p style="text-align: center;">Crystal</p> <ul style="list-style-type: none">◇ I have never heard of this◇ I have heard of this but I'm not sure what it means◇ I have some idea what it means◇ I clearly know what it means and can describe it:



Putting the Pieces Together

Using the prefix's, suffixes or roots in the oval, fill in the information in the tables below.

Definition:	Related Words:	ign
Picture:	Sentence:	

Definition:	Related Words:	-ion
Picture:	Sentence:	

Definition:	Related Words:	ite
Picture:	Sentence:	

Definition:	Related Words:	meta
Picture:	Sentence:	



Building Vocabulary

Definition:	Related Words:	morph
Picture:	Sentence:	

Definition:	Related Words:	-OUS, -US
Picture:	Sentence:	

Definition:	Related Words:	pegma
Picture:	Sentence:	

Definition:	Related Words:	pos
Picture:	Sentence:	



Building Vocabulary

Definition:	Related Words:	sed, sid
Picture:	Sentence:	

Definition:	Related Words:	trans
Picture:	Sentence:	

Definition:	Related Words:	trud, trus
Picture:	Sentence:	

Look back at the words on your STIP. Are there any that you couldn't define before that you think you can now? Which ones? What do you think they mean?



Classifying Minerals

Rock Types

Use the table below to record your notes about how different kinds of minerals are formed.

Rock Type	Formation Process	Properties	Examples
Sedimentary			
Igneous			
Metamorphic			



Observation

Museum Visit

Duration

40-60 minutes

Location

Gem & Mineral Hall

Supplies

- Worksheet
- Clipboards with LED or similar lights (optional: it is quite dark in the Mineral Hall)
- Magnifying glasses
- Pencils

Purpose

The Museum visit allows students to apply knowledge and practice observing and classifying rocks and minerals and provides concrete experiences to which students may practice new terminology. Students also practice using some of their scientific inquiry skills such as observation and classification.

Objectives

- Students will classify minerals in the Gem and Mineral Hall as igneous, metamorphic, or sedimentary,
- Students will support their choices using evidence.
- Students will read and take notes on various environments that form different minerals and the Native Gold display.

Outline

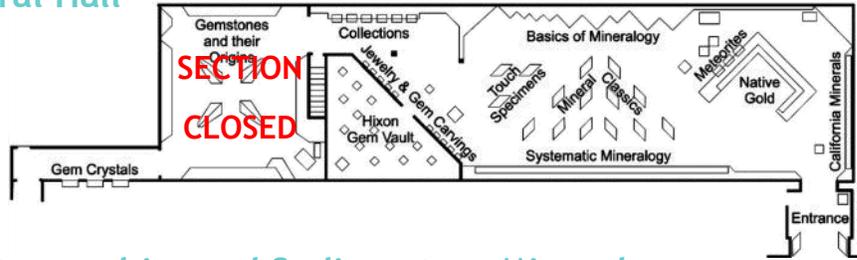
1. Verbally call on students before entering the hall and ask: What are the expectations for our visit?
2. Assign students to groups of 2-3 before arriving at the Museum.
3. **Whole Group:** Gather students in front of the hall, pointing out the general layout of the hall. You will want to assign student groups to different parts of the hall for the mineral classification activity:
 - about 2 groups: California Minerals
 - about 1 group: Touch Specimens
 - about 1 group: Collections
 - about 2 groups: Systematic Mineralogy
 - 1-2 groups: Mineral Classics
4. Make sure each group knows where they will be completing the classification activity, when and where the class will meet up again. (5-10 min)

5. You will also want to assign student groups to different Gemstone formation environments:
 - 2 groups: Water (Surface water, hydrothermal vents)
 - 2 groups: Magma Bodies (pegmatite, molten rock)
 - 2 groups: Metamorphic Bodies (high-temperature regional metamorphism, high-pressure metamorphism)
 - 2 groups: Earth's Mantle
5. **Whole Group:** Bring students to the Basics of Mineralogy, to the wall explaining Igneous, Metamorphic, and Sedimentary minerals. Review the definitions of these minerals with students, and have students observe the exemplar minerals of each type that are on the wall. They may want to fill in their "Classifying Minerals" table from the Pre-visit assignment with more information. Once students are done, they split into small groups to complete the remaining activities.
6. **Small Group:** Students work in groups to complete the assignment, observing the exhibits as they go. (30 min)
7. **Whole Group:** Once it is time for your class to move on to the next part of the museum, gather the class back at the entrance to the exhibit.
8. **Small Group:** Either on the bus or back in class, allow students time to share their results with another group or two.



Gem & Mineral Observation

Gem & Mineral Hall



Igneous, Metamorphic, and Sedimentary Minerals

Carefully observe the minerals within the section of the exhibit to which you have been assigned. Classify them as igneous, sedimentary, or metamorphic, citing *evidence* to support your classification.

Mineral	Observation	Classification



Gem & Mineral Observation

Mineral	Observation	Classification



Gem & Mineral Observation

Mineral Formation Environments

Read about the environments to which your group was assigned, summarizing the information in the appropriate section below.

Water

Type of minerals formed (circle one): igneous sedimentary metamorphic

Subenvironments	Picture of process	Mineral examples from environment



Gem & Mineral Observation

Magma Bodies

Type of minerals formed (circle one):

igneous sedimentary

metamorphic

Subenvironments	Picture of process	Mineral examples from environment

Metamorphic Bodies

Type of minerals formed (circle one):

igneous sedimentary

metamorphic

Subenvironments	Picture of process	Mineral examples from environment



Gem & Mineral Observation

Earth's Mantle

Type of minerals formed (circle one):

igneous sedimentary

metamorphic

Subenvironments	Picture of process	Mineral examples from environment

Native Gold

Carefully observe the display on gold, reading the facts and history of gold. What do you find most interesting in this display?



Review and Reflect

Post-Visit

Duration

30-60 minutes

Location

Classroom

(and/or Homework)

Supplies

- Worksheets
- Pencils

Purpose

Following the Museum visit, students evaluate each other's mineral classifications to learn from each other about the different environments in which gems form, and apply their learning to their study of California Gold.

Objectives

- Students will present possible answers to each other and listen critically to other students' explanations of their mineral classifications.
- Students will synthesize their knowledge of mineral formation environments and California's valuable ore deposits

Outline

1. Have students recombine into new groups, so that each group has a student that explored a different part of the museum.
2. Have students present their mineral classifications to their group, as well as the evidence they used to classify their minerals.
3. Have each group choose at least two minerals to research in more depth at home. They will specifically look for information about the mineral's formation.
4. Students should also share their notes on the Mineral Formation Bodies, so that every person in the group has a complete set of notes.
5. Students research California gold; looking up where it is found/ deposited, its properties, etc. Some useful websites include:
 - <http://www.nuggetshooter.com/articles/CRGeologyofcoarsegoldformation.html>
 - <http://www.minerals.net/mineral/gold.aspx>
 - <http://www.mindat.org/min-1720.html>

Group Members:

Mineral:	Appearance:
Proposed Formation Environment:	
Actual Formation Environment:	
Mineral:	Appearance:
Proposed Formation Environment:	
Actual Formation Environment:	
Mineral:	Appearance:
Proposed Formation Environment:	
Actual Formation Environment:	