



How Old is the Earth?

7th Grade

Duration

2 classes (depending on length of class) and a Museum visit

Location

Classroom and
Gem & Mineral Hall

Supplies

- See individual lessons

Standards

Science 4.a.c.d
CCS ELA Grades 6-12:
Language Standards 4.b
Reading Standards for
Literacy in Science and
Technical Subjects 2.7.9

Vocabulary

Intrusive
Inclusive
Igneous
Sedimentary
Metamorphic
Pressure
Rock Cycle

Module Purpose

This lesson best serves as an introduction into Earth's History—it could be used as the "engage and explore" phases of a 5E cycle.

Module Outline

1. In one class before visiting, students consider how we determine the age of an object if we can't actually measure it. They develop hypotheses and learn new vocabulary by becoming familiar with roots, prefixes and suffixes.
2. During a visit to the Museum students observe the rock cycle using their hypotheses as a framework for their research.
3. In 1 post-visit session, students find out how scientists use relative aging and begin to learn about deep time and Earth's history.

Assessment Opportunities

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

References & Resources

Aging Diamonds? (Video) Teachers' Domain. 18 Nov. 2008. Web. 18 May. 2012.
<http://www.teachersdomain.org/resource/nat08.earth.geol.min.aging>

Inclusion Conclusions. Teachers' Domain. 18 Nov. 2008. Web. 18 May. 2012.
<http://www.teachersdomain.org/resource/nat08.earth.geol.min.conclusion/>

Deep Time Teachers' Domain. 4 May. 2010. Web. 18 May. 2012.
<http://www.teachersdomain.org/resource/psu10sci.vid.deeptime/>

The Grand Canyon: Ancient Mountains. Teachers' Domain. 21 Oct. 2005. Web. 18 May. 2012.
<http://www.teachersdomain.org/resource/ess05.sci.ess.earthsys.vishnu/>



Building Vocabulary

Pre-Visit

Duration

30-60 minutes
(and/or homework)

Location

Classroom

Supplies

- Worksheet
- Pencils
- Computer with projector
- "Aging Diamonds?" (See *References and Resources*)
- Colored pencils, crayons or the like

Purpose

Before visiting the museum, this phase engages students in the lesson by posing a scientific quandary: How can we determine the age of an object without directly measuring it? This will activate thinking, provide a framework for future metacognition, and initiate scientific inquiry and exploration of ideas. This phase also begins the process of building vocabulary.

Objectives

- Students will become familiar with the words, metamorphic, igneous, and sedimentary, inclusion and intrusion, and roots, prefixes, and suffixes (see next page).
- Students will differentiate between metamorphic, igneous, and sedimentary rocks.
- Students will identify how scientists determine the age of most rocks and minerals.

Outline

1. Pass out the discussion questions; preview them without students answering them, telling them you want them to listen for the answers during the video. Show students the video "Aging Diamonds?"
2. Review discussion questions with students. Then ask, "If diamonds never get old, do you think it's possible to find out when they formed?, If so - how?" Ask students to write down their hypotheses.
3. Explain that when they go to the Museum, they will be looking for data to answer this question. Ask, "What kind of data might we want to look for?" Give students time to think about this in small groups.
4. Introduce the vocabulary grid activity. This activity is to build literacy skills and scientific vocabulary. It also shows students that they can infer the meaning of many words if they know the definition of a few key roots, prefixes, and suffixes.

5. Give students the definitions for each prefix, suffix and, root in table below, and give them time to draw their own pictures representing them.
6. Students will then brainstorm related words—words that are made with the prefix. You may need to get them started by modeling a few, for example, ign is related to both ignite and ignition. You may choose to have students work in small groups or as a class for this, but they should have at least one related word for each section. Of course, the more the better!.
7. As students work, ensure they include the key vocabulary words in their related word lists, and have them record the related sentences. Because intrusion and inclusion are easy to mix up, have students compare and contrast these words after you give them to full definitions.
8. Finally, go over behavioral and academic expectations for your trip to the Museum and explain the activities students will be completing while there. Remind them of the question they will be trying to answer!

Vocabulary

"Word"	Definition	Related words	Possible Sentence
Clud, clus	close	Inclusion, include, exclude, exclusive, inclusive, conclude	An inclusion is a solid, liquid, or gaseous foreign body enclosed in a mineral or rock.
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.
Meta	Between, change	Metamorphic, metastable	Metamorphic rock has undergone change as a result of heat, pressure, and time
-ous, -us	Characterized by	Aqueous, igneous, carboniferous.	Aqueous solutions are characterized by water.
Sed, sid	Sit, settle	Sediment, subside, residue, sedimentary	Sedimentary rock forms from mineral and organic particles that settled on the surface of the earth.
-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 How Old is the Earth?

Pre-Video

1. Have you ever heard the saying, "Diamonds are forever?" What do you think it means? Do you think it is true? Explain.

Video: Aging Diamonds

2. How do diamonds get to the surface of the earth?
3. Why are diamonds valuable to scientists?
4. How do scientists determine the age of rocks and minerals? Why is it that "a diamond never grows old"?
5. Do you think it is possible to determine the age of a diamond? What ideas do you have about how this could be done? (list as many as you can think of)
6. What kind of evidence would you look for to confirm or refute your ideas when we go to the museum?



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:	clud,clus
Picture:	Sentence:	

Definition:	Related Words:	ign
Picture:	Sentence:	

Definition:	Related Words:	-ion
Picture:	Sentence:	

Definition:	Related Words:	meta
Picture:	Sentence:	



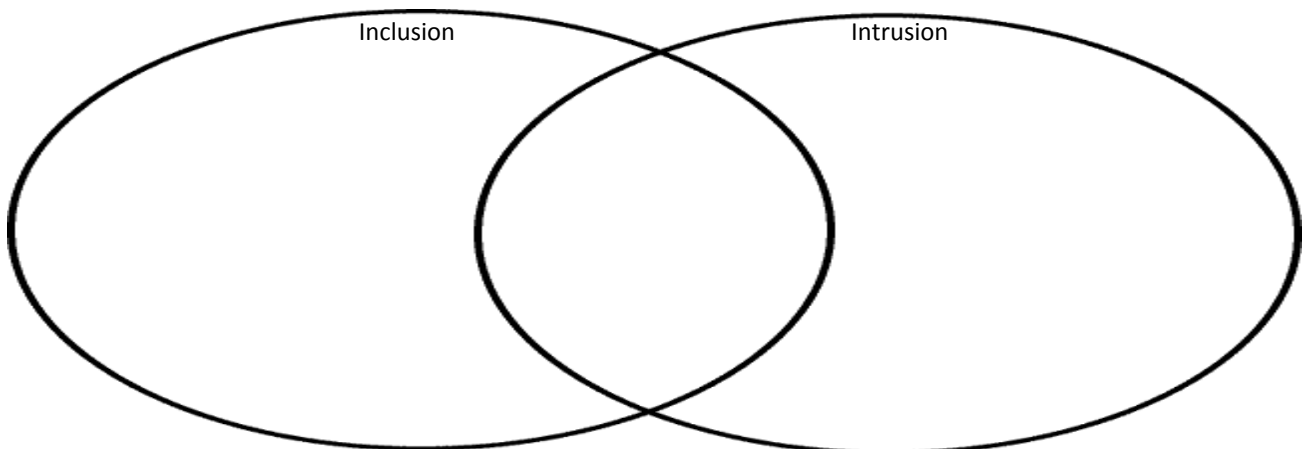
Building Vocabulary

Definition:	Related Words:	-ous, -us
Picture:	Sentence:	

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

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

Use the venn diagram below to compare the words *Inclusion* and *Intrusion*:





Observation and Inquiry

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)
- Pencils

Purpose

The Museum visit allows students to observe authentic rocks and minerals. It promotes transfer learning by providing concrete experiences to which students may practice applying new terminology. Students also practice using inquiry skills, specifically observation and classification.

Objectives

- Students will diagram the general layers of the earth.
- Students will collect evidence for methods by which scientists might be able to date the formation of diamond.
- Students will recognize that while some types of rocks take longer to form than others, all rocks take a minimum of millions of years to form.

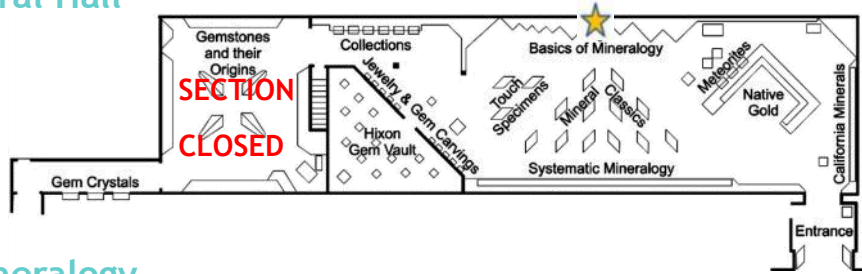
Outline

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 to point out the general layout of the hall. Assign each group to start in a different part of the hall to avoid clumping, though they will spend most of their time in 'Gemstones and their Origins.' (5-10 min)
4. **Small Group:** Students work in groups to complete the assignment, observing the exhibits as they go. (30 min)
5. **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.
6. **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



Basics of Mineralogy

1. Read the definition of igneous, sedimentary, and metamorphic rock. Do these definitions make sense based on what you know about the roots, prefixes, and suffixes of the words? Why or why not?
2. Look at the picture the definitions are on. Why do you think the Earth's crust looks like that?

Gemstones and their Origins

Observe the displays around the perimeter of this exhibit about how different minerals form. Pay special attention to diagrams and look for evidence about how much time it takes for minerals to form.

3. Without reading the labels, do you notice any patterns in the diagrams? Draw a picture representing the pattern:



Gem & Mineral Observation

4. Why do you think this pattern exists? Can you make any inferences about what this pattern tells us?

5. When you read something that mentions the length of time a process takes, make note of it using the table below.

Process	Amount of Time



Gem & Mineral Observation

Collecting Evidence

Use this space to write down any observations or evidence you think may help us figure out how we can determine when a diamond or other mineral formed, even if we can't measure its age. Look at rocks and minerals and read displays throughout the Gem and Mineral Hall to help you in your search. Draw pictures if you would like, including the *names* of the minerals so you know where you got your evidence.



Looking to the Future

Post-Visit

Duration

30-60 minutes

Location

Classroom

(and/or Homework)

Supplies

- Worksheets & Rubric
- How Light Interacts with a Gem: Rubric
- "Inclusion Conclusions" See Resources Section)
- "Deep Time" See Resources Section)
- "The Grand Canyon: Ancient Mountains" (See Resources Section)



Student Work

Purpose

Students are ready to work with more theoretical concepts. This phase introduces concepts, ideas, skills, relationships and explanations while verifying or validating students' ideas or challenging their alternative concepts.

Objectives

- Students will present possible answers to each other and listen critically to other students' explanations.
- Students will accurately apply their knowledge of the properties of light to scientifically explain the appearance of gems and minerals.
- Students will create a poster, using a rubric as a guide.

Outline

1. As a class or in groups, have students share their findings from the Museum. Students may recognize ideas of Hutton and Lyell (uniformitarianism, intrusive and cross-cutting relationships, inclusions and components, horizontality and superposition etc...). Write ideas on the board, asking them to cite evidence.
2. Show "Inclusion Conclusions." Emphasize the age of diamonds, ask: "What do you think can happen in A BILLION YEARS?" Have students Pair Share their answers.
3. Show "Deep Time." Go over the discussion questions in the worksheet.
4. If there is time, show "The Grand Canyon: Ancient Mountains." Point out the layers visible in the canyon, and go over the discussion questions. Students should be able to identify Vishnu Schist.
5. Use observations from the Museum in continued activities in your Earth's History unit.

Suggested Activities

- Develop a lab where students 'build' a sedimentary rock
- Look closely at historical readings about Hutton, Lyell, Darwin
- Create a Deep Time timeline mural



Video: Inclusion Conclusions

1. How hard are diamonds?
2. What is meant by the term “inclusion”?
3. What can scientists determine by studying diamonds and their inclusions?
4. How old are most diamonds?

Video: Deep Time

1. What is the notion of deep time?
2. Where have scientists found evidence of an ancient earth?
3. What branch of science supports Darwin’s theory of evolution?



Video: The Grand Canyon: Ancient Mountains

1. What pattern do you see in the Grand Canyon that you also saw at the Museum?
2. Which of the three major rock types is the 1.7-billion-year-old Vishnu Schist, described in the video as once "sandstone and shale, which have been cooked...?"
3. The video states there once was a mountain range as high as the Himalayas before the Vishnu Schist was formed. What evidence has led geologists to reach this conclusion?
4. What do you predict will happen in the Grand Canyon in the future?