7-2008

GSI: Geo Scene Investigation! On-site Programming, Support Materials (Grade 7)

Discover Mojave: Forever Earth

GRADE 7

GSI
Geo Scene Investigation!

ON-SITE PROGRAMMING ● SUPPORT MATERIALS

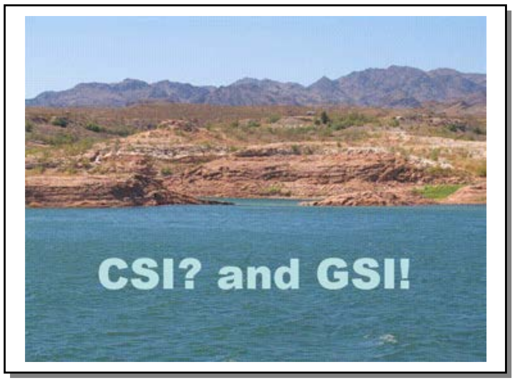
Demonstration:
INTERPRETING WHAT YOU SEE

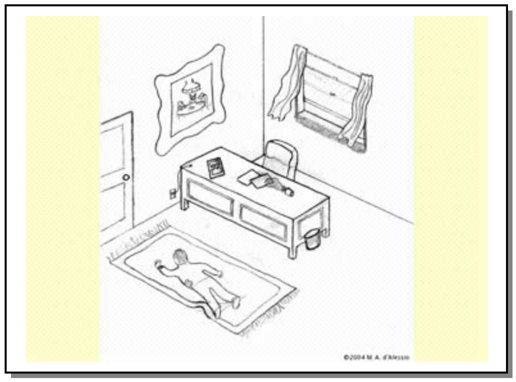
Interpreting what You See is a PowerPoint presentation developed by the U.S. Geological Survey as part of Lesson 3 (GeoSleuth) of its School Yard Geology program.

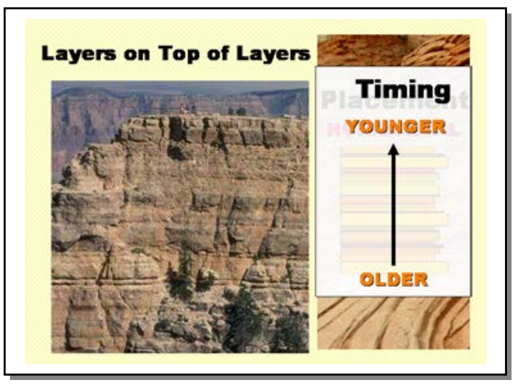
The power of this exercise is that it exposes students to geology within a context that they can understand. The process of examining a mystery scene highlights general observational skills, which are also essential in the study of geology. Geology is actually lot like detective work. One must use common sense along with fundamental principles. In this lesson, many geology principles are presented in a non-geologic context and then related to their geological application.

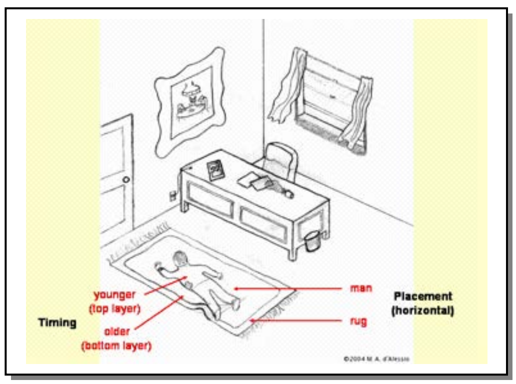
http://education.usgs.gov/schoolyard/

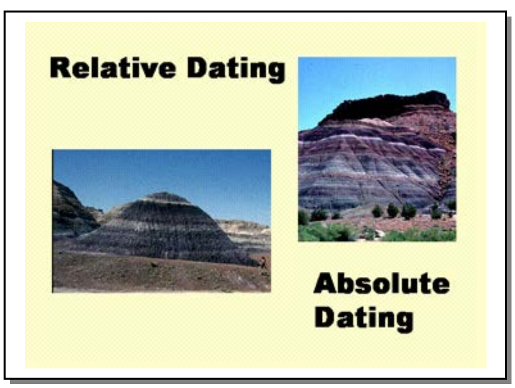
Note that the actual PowerPoint file includes animations.

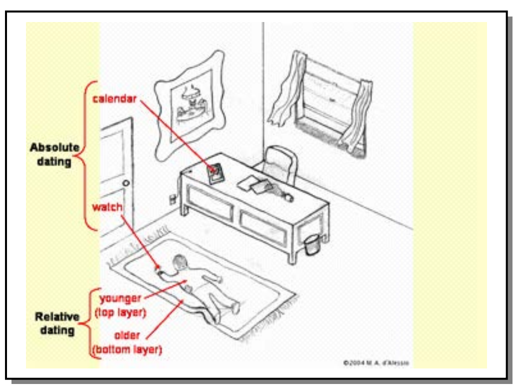


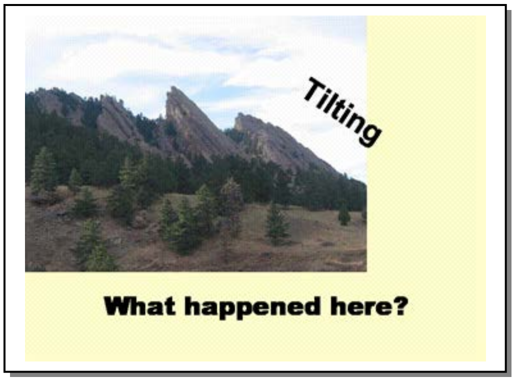


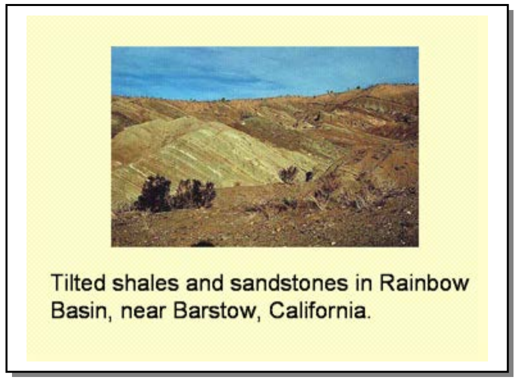


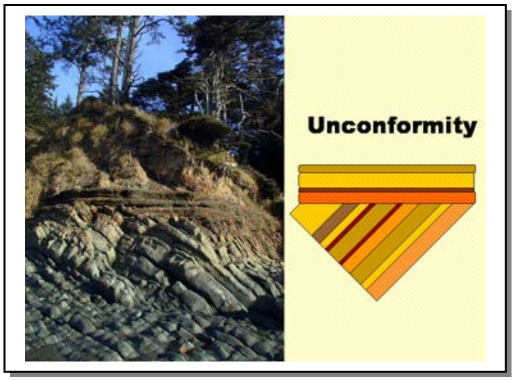


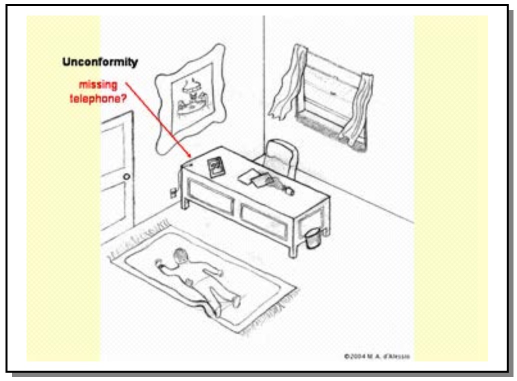


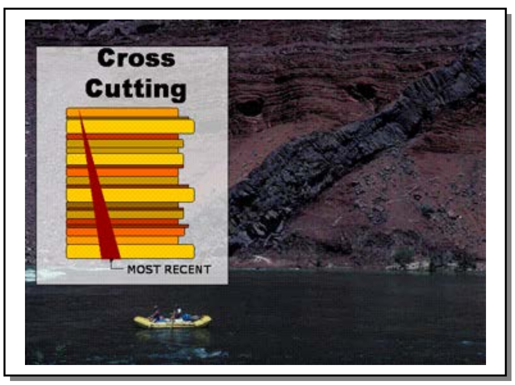


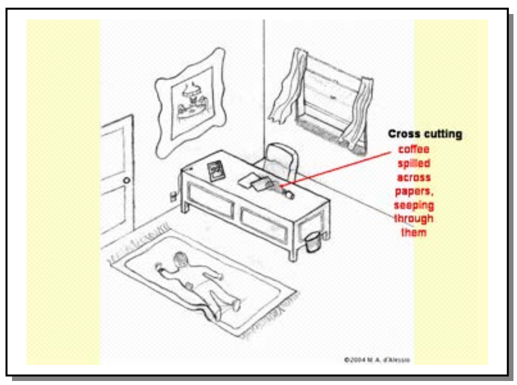

Tilting
What happened here?

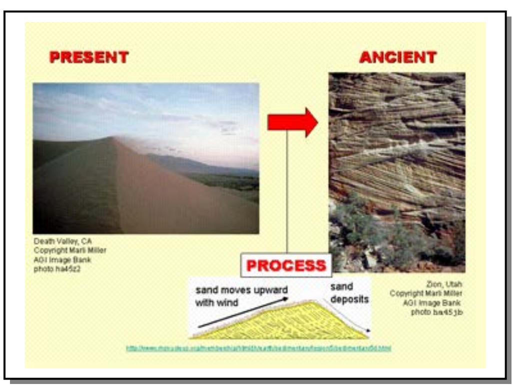

Tilted shales and sandstones in Rainbow Basin, near Barstow, California.

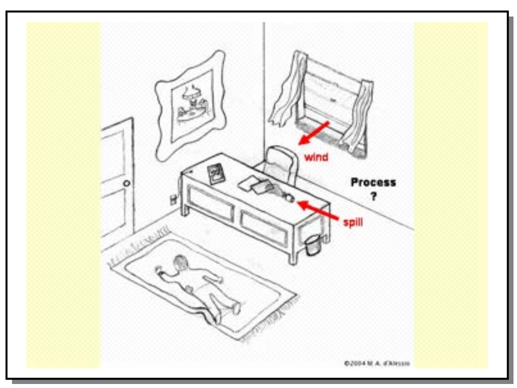

Unconformity


Unconformity
missing telephone?
©2004 M. A. d'Alessio


Cross Cutting
MOST RECENT


Cross cutting
coffee spilled across papers, seeping through them
©2004 M. A. d'Alessio


PRESENT
ANCIENT
Death Valley, CA
Copyright Marli Miller
AGI Image Bank
photo ha45z2
PROCESS
sand moves upward with wind
sand deposits
Zion, Utah
Copyright Marli Miller
AGI Image Bank
photo ha45jb


wind
Process ?
spill
©2004 M. A. d'Alessio

Facilitator Reference:
NOTES FOR INTERPRETING WHAT YOU SEE

Slide	*Graphic*	*Narrative*
1, 2	Title slide; Mystery Drawing	Now that we've learned how observation and interpretation are different, let's take a look at how the same detective skills that we used for this mystery can also be applied to geology.
3	Layers on Top of Layers, Timing	One of the basic principles or rules of geology is that when layers of rocks are deposited, they usually start out flat or horizontal. This is because they often form under water where individual grains of sediment settle down to the bottom of the ocean, lake, or stream. Settling leads to horizontal layers. We can also tell something about the sequence of events. The oldest layers are on the bottom, and younger, new layers get added on top of what is already there.
4	Mystery Drawing; Arrow Depictions	In our drawing, what examples can you find of horizontal layering and timing of events? Man and rug are placed horizontally. The man is on top of the rug, so he had to fall AFTER the rug was placed on the floor.
5	Relative Dating, Absolute Dating	Geologists are interested in how old things are and when things happened. They describe how something is in two ways. You can usually tell which rocks are older because the oldest rocks are on the bottom. This description describes the relationship between the ages and positions of different layers. This is called "relative dating." It's also possible to tell how old a rock layer is by measuring the decay of uranium or other radioactive elements found in rocks (it's similar to carbon-14 dating). This is called "absolute dating."
6	Mystery Drawing; Arrow Depictions	Can you find an example of relative dating in the drawing? Rug came first, then man on top of rug. Papers were on desk, then coffee spilled on papers. There are two examples of absolute dating in the drawing? Wrist watch on the man. Calendar open on the desk.
7	What happened here?	These are tilted layers. When we discover layers that are no longer horizontal, we know that something must have happened. They started out flat, or else they wouldn't form such nice layers. Then at a later time, they must been tilted. Again, we can discover the sequence of events from looking at the shapes and positions of layers. Which are the oldest rocks in the photo? The ones on the left side; the youngest rocks are on top of these, at the back right.
8	Tilted shales and sandstones	This is another example of tilted layers.
9	Unconformity	Sometimes layers give an indication of many events. First, there was a set of layers laid down flat. Then they got tilted like the previous photo. Over time, the tips of the layers got eroded down into a new, flat surface. Then

		another set of flat layers got deposited on top. This feature is called an “unconformity” because one set of layers does not fit in with tilting of the other set of layers (it doesn’t conform). In other words, something is missing.
10	Mystery Drawing; Arrow Depictions	What unconformity can you find in our mystery drawing? In other words, what is obviously missing? The cord extending from the wall to the desk indicates that something, maybe a telephone or a computer, might be missing.
11	Cross Cutting	Sometimes, layers get cut by something else. Here, the reddish-brown layers were deposited horizontally. Then the dark layer cut across all the other layers. We know the dark layer is younger because you can’t cut layers until they have been deposited. This dark layer was originally molten magma that was squeezed into the layers as it fought its way towards the surface and then eventually solidified.
12	Mystery Drawing; Arrow Depictions	What example of cross cutting can you find in the mystery drawing? Coffee spilled onto the papers. The papers were there before the coffee spilled.
13	Sand Dune Process	The sand dune on the left is being shaped by the wind today. Sand dunes are an example where you form layers that are not horizontal. The rocks with the wispy layers on the right are ancient sand dunes, and you see a bunch of different layers. We can use this knowledge of the process of sand dune growth to learn about ancient wind patterns. Because the layers on the right are in all different directions, we can learn that the wind direction must have changed over the years when these rocks were deposited.
14	Mystery Drawing; Arrow Depictions	Is there an indication of wind direction in the mystery drawing? The curtains tell us which way the wind is blowing. How about the cup? Did the wind blow it over? Probably not, because the cup would have fallen in a different direction.

Facilitator Reference:
OVERVIEW OF LAKE MEAD GEOLOGY

Events that date from the very beginning of the Earth set the stage for the birth of the Colorado River.

What happened geologically to produce the landscape we see today? What was the stage like that ultimately produced the Colorado River? What are the processes that are still at work today?

To begin exploring and discovering the answers to these questions, we can look at what's happened in the past and also examine the clues that are evident on today's landscape. Lake Mead's geologic past can be organized like acts in a play. These geologic "acts" represent the area's significant geologic events. The acts are not equal in terms of time (millions of years), nor is all geologic time accounted for during this "play."

ACT I

<u>Two Kinds of Seas: Sea of Water, Sea of Sand (185-560 mya)</u>

During this time, Lake Mead NRA would have been submerged below a sea. Lots of plants and animals accumulated along shoals and reefs. When they died, skeletons accumulated on the bottom in layers along with fine sediments, forming sedimentary rocks such as shale and limestone. Gypsum-rich silts were also deposited during this time.

The seas retreated and desert replaced the sea. Winds howled, and huge dunes formed. The climate was similar to the Sahara Desert.

What else was happening on Earth during this time period? The first fish and land plants appeared; there were mass extinctions; the first mammals appeared.

ACT II

<u>STRETCH! Basin and Range (20-37 mya)</u>

Changes in crustal plates caused thinning and cracking of the earth's crust. Mountains were uplifted and valleys dropped down. This formed the existing "basin and range" topography.

What else was happening on Earth during this time period? The Age of Dinosaurs had already passed during intermission between Acts I and II; the Rocky Mountains had also formed by this time.

Act III

<u>KABOOM! Volcanoes! (5-13 mya)</u>

As the crust was stretched, cracks or faults formed. Volcanoes and lava flows erupted. Rocks were tilted, folded, and moved. A fault that cut through a strato volcano ripped it into two pieces that are now 12 miles apart (Hamblin Cleopatra Volcano).

The volcanic episodes became less explosive and basalt erupted out of cinder cones onto the top of valley fill forming black-capped mesas like Fortification Hill and Callville Mesa.

Act IV

<u>A River is Born! (5 mya to present)</u>

A small stream flowing south from the Lake Mead area cut through a set of cliffs and captured an older river flowing east. This became the Colorado River, carving canyons and eroding deep valley deposits. Prior to this, the geologic story was one of building rock layers. The river changed the story to one of erosion and down cutting. The processes at work today are visible everywhere: weathering and erosion by a variety of agents.

What else was happening during this time period? Early ancestral humans appear in the fossil record during this time period; much of North America was covered by ice for almost two million years.

Student Reference:
ROCK CLASSIFICATION CHART

Rock I.D. Dichotomous Key

Geo Scene Investigation G.S.I.

1. Place 1 drop of HCl on the rock. Does it react by fizzing a lot?

A. Yes.
limestone

B. NO.
(go to # 2)

2. Are there obvious crystals?

A. Yes.
(go to #3)

B. No.
(go to #5)

3. Is the specimen dark in color?

A. Yes.
basalt

B. No.
(go to #4)

4. Is the rock coarse-grained (big grains) or fine-grained (small grains)?

A. Yes.
granite

B. No.
rhyolite

5. Are the grains rounded?

A. Yes.
sandstone

B. No.
(go to #6)

6. Does the specimen have grains too small to see, and is it soft and crumbly?

A. Yes.
shale

sample no.	identity
7	
8	
9	
10	
11	
12	

Student Reference:
MINERAL CLASSIFICATION CHART

Mineral I.D. Dichotomous Key

Geo Scene Investigation G.S.I.

1. What color was left on the streak plate by the mineral?

A. Black.
galena

B. NOT Black.
(go to # 2)

2. Is the mineral harder than glass?

A. Yes.
(go to #3)

B. No.
(go to #4)

3. What color and luster does the mineral have?

A. White and glassy.
quartz

B. Cream-colored to pink in color with some shiny glassy surfaces.
feldspar

4. Does the mineral react with HCl?

A. Yes.
calcite

B. No.
(go to #5)

5. Can paper-thin sheets peel off the mineral?

A. Yes.
mica

B. No.
gypsum

Student Reference:
ROCK AND MINERAL CLASSIFICATION PROCESS

Mineral I.D. Worksheet

Geo Scene Investigation G.S.I.

Physical properties used to identify minerals

A. color Record the color of the sample. For example: white; gray; pink; black; etc.

B. streak This is the color of the mineral when powdered. To test for streak, draw the mineral against the streak plate (the white porcelain tile in your kit). Record the color left on the streak plate.

C. luster This is the way a mineral reflects light. Does it have a metallic luster, a shiny and gold or silver color? Does it have a nonmetallic luster (does not look like a metal in color, but still may be shiny)? If it has a nonmetallic luster, record one of the following descriptors: pearly; glassy; resinous (has the appearance of resin); silky; or earthy (dull).

D. hardness This is a mineral's resistance to scratching. Draw the mineral against the glass plate. If it leaves a scratch on the glass, the mineral is harder than glass. If no scratch is seen, the mineral is not harder than glass. Record "yes" or "no" in the table.

E. reaction with dilute hydrochloric acid Place one drop of HCL on the sample. Look for "fizzing" as evidence of a reaction. Record "yes" or "no" in the table.

	A	B	C	D	E	
sample no.	**color**	**streak**	**luster**	**harder than glass?**	**reacts with HCl?**	**identity**
1						
2						
3						
4						
5						
6						

After recording properties (A-E), use the key to identify the mineral. Record the name of each mineral in the last column.

Student Reference:
ROCK AND MINERAL CLASSIFICATION PROCESS

G.S.I.

rock sample

1. Identify the rock sample.
2. Is it igneous, sedimentary, or metamorphic?
3. What are the key components or chemicals that make up this rock?
4. How did this rock form?
5. How do people use this kind of rock?

mineral sample

1. Identify the mineral sample.
2. How is the mineral formed?
3. This mineral is the main component of what rocks?
4. How do people use this mineral?

Facilitator Reference:
SPECIMEN KIT GUIDE

1
QUARTZ

Non-metallic Mineral

Chemistry: SiO_2 (silicon dioxide)
Color: White, clear, pink, purple, brown, black
Luster: Glassy
Streak: White, but harder than streak plate
Hardness: 7.0
Specific gravity: 2.6
Source: Unnamed Prospect, T28S R61E Sec. 34, Clark

1	2	3	4	5	6
7	8	9	10	11	12

2
MICA

Non-metallic Mineral

Chemistry: $KAl_2(Si_3Al)O_{10}(OH,F)_2$ (Potassium aluminum silicate hydroxide fluoride)
Color: White, silver, yellow, green, brown
Luster: Vitreous to pearly
Streak: White
Hardness: 2-2.5
Specific gravity: 2.8

1	2	3	4	5	6
7	8	9	10	11	12

3
CALCITE

Non-metallic Mineral

Chemistry: $CaCO_3$ (calcium carbonate, "fizzes" in hydrochloric acid)
Color: White, clear, yellow, pink, blue
Luster: Glassy to pearly
Streak: White
Hardness: 3.0
Specific gravity: 2.7
Source: Marigold Mine, Glamis Gold Inc., Humboldt Co., NV

1	2	3	4	5	6
7	8	9	10	11	12

Facilitator Reference:
SPECIMEN KIT GUIDE (CONTINUED)

4
FELDSPAR
(variety microcline)
Metallic Mineral

Chemistry: $KAlSi_3O_8$ (potassium aluminum silicate)
Color: White, cream
Luster: Vitreous, pearly
Streak: White
Hardness: 6.0
Specific gravity: 2.56
Source: Crystal Peak, Sierra County, CA

1	2	3	4	5	6
7	8	9	10	11	12

5
GYPSUM
(variety selenite)
Non-metallic Mineral

Chemistry: $CaSO_4 \cdot 2(H_2O)$ (hydrous calcium sulfate)
Color: Clear, white
Luster: Pearly, vitreous
Streak: White
Hardness: 2.0
Specific gravity: 2.3
Source: Empire Mine, U.S. Gypsum Co., Pershing Co., NV

1	2	3	4	5	6
7	8	9	10	11	12

6
GALENA

Metallic Mineral

Chemistry: PbS (lead sulfide)
Color: Lead gray, silvery gray, black
Luster: Metallic
Streak: Gray-black
Hardness: 2.5
Specific gravity: 7.3-7.6
Source: Doe Run Corp., Vibernum, MO

1	2	3	4	5	6
7	8	9	10	11	12

Facilitator Reference:
SPECIMEN KIT GUIDE (CONTINUED)

7
BASALT
(Igneous, Volcanic)

Description: Very finely crystalline; dark grey to purplish black rock. May contain olivine and orthopyroxene. Some samples may contain gas cavities (vesicles).
Age: Pleistocene or Holocene Epoch, up to 2 million years old
Location: The Crater, 4 miles north of Silver Peak on SR 265, T1S R39E Sec27, Esmeralda Co., NV

1	2	3	4	5	6
7	8	9	10	11	12

8
SHALE
(Sedimentary)
Layered Mudstone

Description: Very fine-grained, well-sorted. Breaks into layers. Generally soft but will not fall apart on wetting. Dark to gray to black color. Some invertebrate fossils.
Source: Diamond Peak Formation
Age: Late Mississippian to Early Pennsylvanian, 300-340 million years old.
Location: Roadcut approx. 4 miles NW of Elko, Elko Co., NV

1	2	3	4	5	6
7	8	9	10	11	12

9
SANDSTONE
(Sedimentary)

Description: Medium-grained sand (0.25-0.5 mm), well-sorted, moderately rounded quartz grains, cemented by iron oxide and calcite. Shows distinctive layering or bedding. Some faint cross-bedding may be visible.
Source: Aztec Sandstone
Age: Late Triassic – Early Jurassic Periods, approx. 200-215 million years old
Location: Las Vegas Rock Quarry near Mt. Potosi, Spring Mtns., Clark Co., NV

1	2	3	4	5	6
7	8	9	10	11	12

10
LIMESTONE
(Sedimentary)

Description: Fine-grained blue-gray rock with 50% or more of the rock composed of calcium carbonate, primarily the mineral calcite. (Contains invertebrate fossils.)
Source: Bird Spring Limestone
Age: Pennsylvanian-Permian Periods, 240-330 million years old
Location: T24S R58E SW ¼ Sec. 20, Goodsprings District, Clark Co., NV

1	2	3	4	5	6
7	8	9	10	11	12

11
GRANITE
(Igneous, Intrusive)

Description: Medium to coarsely crystalline rock, generally light colored, composed of quartz (gray, glassy), plagioclase feldspar (pinkish), biotite mica (dark brown-black, shiny round flakes) and hornblende (greenish-black rectangles). Solidifies inside crust, generally deep under volcanoes.
Source: Sand Springs Pluton
Age: Cretaceous Period, 78-82 million years old
Location: Gote Flat, Sand Springs Range, T16N R32E Sec 34, Churchill County, NV

1	2	3	4	5	6
7	8	9	10	11	12

12
RHYOLITE
(Igneous, Volcanic)

Description: A finely crystalline, light colored rock composed of the same minerals as granite. May contain volcanic glass shards and vesicles (gas bubbles).
Source: Paintbrush Tuff
Age: Miocene Epoch – 12.4-13.2 million years old
Location: Stonewall Pass – road cut along US Hwy 95, Nye County, NV

1	2	3	4	5	6
7	8	9	10	11	12

Facilitator Reference:

CLUE CARD TEXT

Possible Location – Middle of the Lake

Relative Dating
- Which rock layer is older?
- Don't date your cousin!
- Wouldn't it be great if the older rock layers had gray hair?
- The youngest rocks are usually found in the top layers of rocks.

Igneous
- "Born of fire!"
- Tall, frothy espresso.
- There's a lot of this kind of rock around volcanoes.
- Not sedimentary or metamorphic.

Water Line
- Years of drought.
- Mineral crust left behind.
- 90-feet above the lake's surface??!! Sure doesn't look that high.
- Ring around the bathtub.

Sedimentary
- Jello desserts sometimes come in layers.
- You can often find fossils in this type of rock.
- Sandstone and limestone are examples of this type of rock.
- NOT metamorphic or igneous.

Lava Flow
- Burnt ketchup cooled in place.
- Black cap.
- A blast from the past.
- Magma that flows over the Earth's surface.

Possible Location – Swallow Cove

Cross-bedding
- Formed by currents of wind or water.
- Don't be cross with me.
- This sandstone can be very colorful, composed of sweeping lines that lie at a great variety of angles.

- Your mom might be **cross** with you if you don’t make your **bed** every morning.

Cross-cutting
- Young rock intrudes into older rock.
- Where young rock and old rock meet.
- “Cutting” in front of somebody in line is rude.
- Doesn’t look like a cross.
- Younger rock using in the geology cross walk.

Wash
- Can be shaped like a “W.”
- Green stuff! Life!
- Runoff area.
- Has nothing to do with a Laundromat.

Mass Wasting
- Totally wasted, man!
- Crash, BOOM – break away – it’s gravity man!
- BIG destruction.
- Mass of rock and soil slip down the slope.

Tilting
- Pinball wizards don’t do it.
- Confused layers.
- Unsettled sediments.
- You’ll “Tilt” your head when you find these layers.

Biological Weathering
- Rocks meet their match.
- Root it out.
- These green things have muscle.
- Plants and fracturing rocks.

Mechanical Weathering
- Instead of fixing things, this mechanic breaks them!
- Rock rotting.
- This destructive process attacks the weaknesses in rock surfaces.
- Breaking down rock into soil.

Erosion
- Crumbling rocks go mobile.
- Gone with the wind…or water!
- AKA “exfoliation.”
- The result on a grand scale: The Grand Canyon!

Possible Location – Sandy Beach

Wave-cut Terraces

- Water-made floor for break dancing.
- Shelves.
- Evidence of wave retreat.
- Benches formed by wave erosion.

Coppice dunes

- Pockets of life!
- Shady places for lizards, insects, and other small creatures.
- It all started when a single plant took root and started to grow!
- Vegetated mounds of sand.

Student Reference:
SOLUTIONS TO CLUES

Solutions to Clues

Geo Scene Investigation G.S.I.

Biological Weathering

Coppice Dunes

Cross-Bedding

Cross-Cutting

Erosion

Fault

Igneous

Limestone

Magma

Mass Wasting

Mechanical Weathering

Metamorphic

Relative Dating

Sandstone

Sedimentary

Tilting

Volcano

Wash

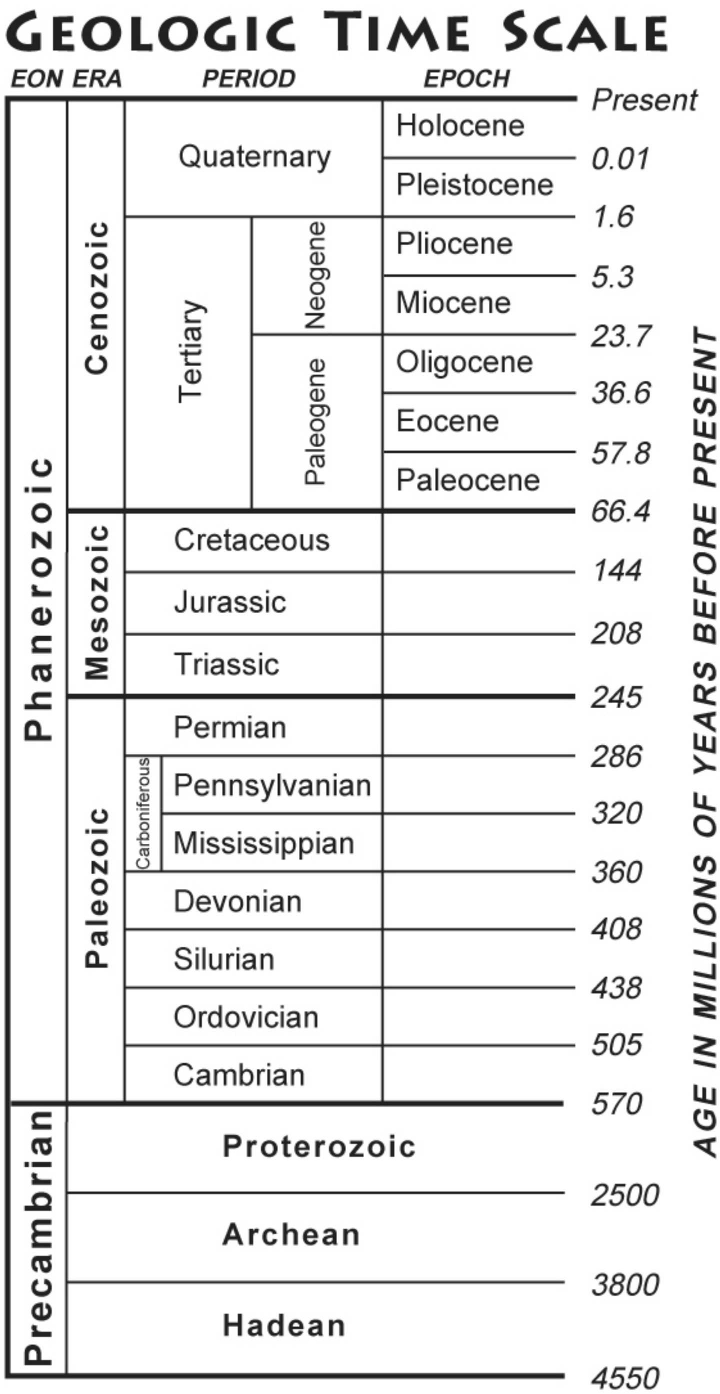
Water Line

Wave-cut Terraces or Platforms

Student Activity Material:
CARD SET WITH PHOTOS OF REGIONAL LANDSCAPES AND GEOLOGIC FEATURES AND DESCRIPTOR CARDS

Under Construction

Student Reference:
GEOLOGIC TIME SCALE

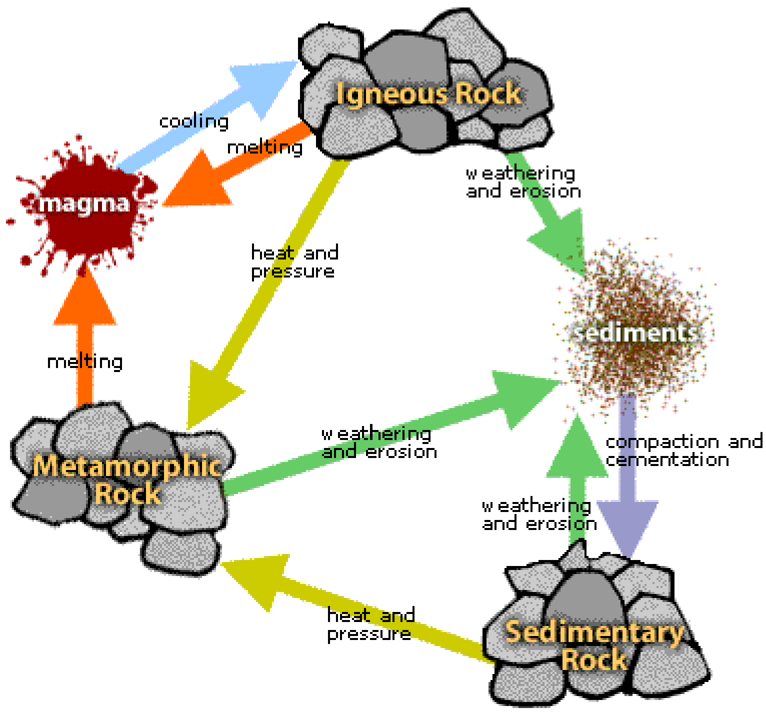


(From Decade of North American Geology, 1983)

Facilitator Reference:
ROCK CYCLE

The Rock Cycle is a group of changes. Igneous rock can change into sedimentary rock or into metamorphic rock. Sedimentary rock can change into metamorphic rock or into igneous rock. Metamorphic rock can change into igneous or sedimentary rock.

Igneous rock forms when magma cools and makes crystals. Magma is a hot liquid made of melted minerals. The minerals can form crystals when they cool. Igneous rock can form underground, where the magma cools slowly. Or, igneous rock can form above ground, where the magma cools quickly.



When it pours out on Earth's surface, magma is called lava. Yes, the same liquid rock matter that you see coming out of volcanoes.

On Earth's surface, wind and water can break rock into pieces. They can also carry rock pieces to another place. Usually, the rock pieces, called sediments, drop from the wind or water to make a layer. The layer can be buried under other layers of sediments. After a long time the sediments can be cemented together to make sedimentary rock. In this way, igneous rock can become sedimentary rock.

All rock can be heated. But where does the heat come from? Inside Earth there is heat from pressure (push your hands together very hard and feel the heat). There is heat from friction (rub your hands together and feel the heat). There is also heat from radioactive decay (the process that gives us nuclear power plants that make electricity).

So, what does the heat do to the rock? It bakes the rock.

Baked rock does not melt, but it does change. It forms crystals. If it has crystals already, it forms larger crystals. Because this rock changes, it is called metamorphic. Remember that a caterpillar changes to become a butterfly. That change is called metamorphosis. Metamorphosis can occur in rock when they are heated to 300 to 700 degrees Celsius.

When Earth's tectonic plates move around, they produce heat. When they collide, they build mountains and metamorphose (met-ah-MORE-foes) the rock.

The rock cycle continues. Mountains made of metamorphic rocks can be broken up and washed away by streams. New sediments from these mountains can make new sedimentary rock.

The rock cycle never stops.

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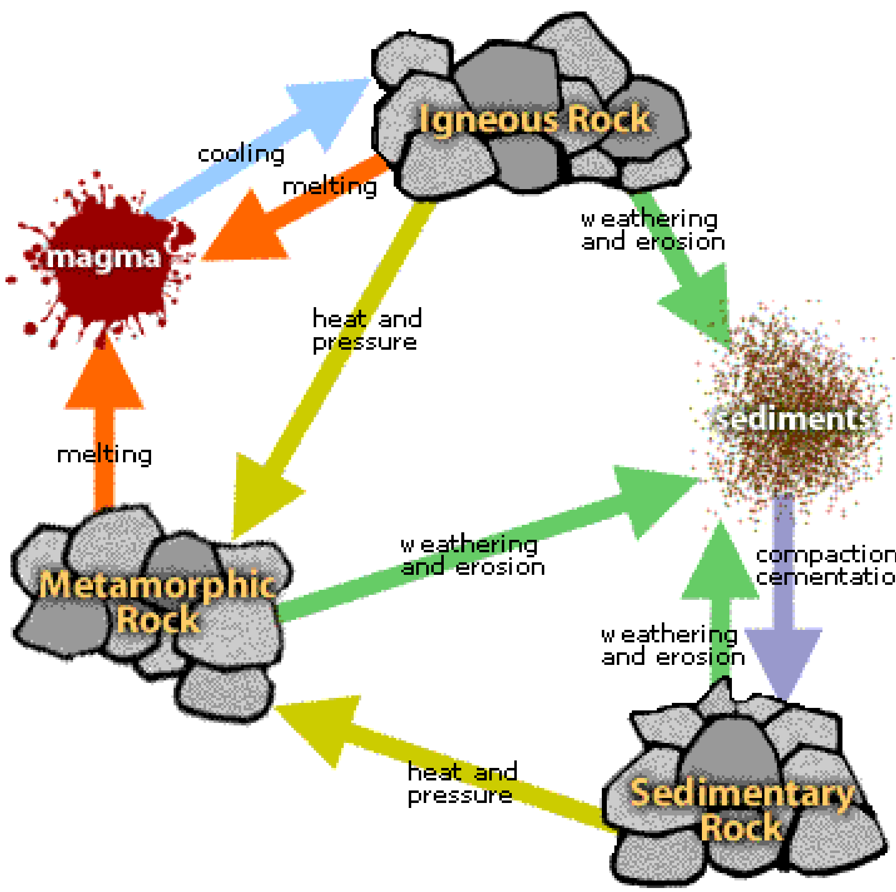
Student Reference:
ROCK CYCLE DIAGRAM



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