Geology Rocks!

Geology Activity Packet

created by

North Carolina Geological Survey

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A Short History of the Loooong History of Geology

BeforeCommonEra

~540: Xenophanes describes fossil fish and shells on mountains
~490: Herodotus noted fossils similar to Xenophanes
~310: Aristotle made observations on the slow rate of geological changes to the Earth
~300: Theophrastus wrote *On Stones*, where he described many minerals and ores, marble, and attempted to classify minerals by their hardness

CommonEra

~77-79: Pliny the Elder published a series titled Naturalis Historia that discussed minerals and metals
~1000: Abu al-Rayhan al-Biruni published writings on the geology of India, hypothesizing that the subcontinent was once a sea
~1050: Shen Kuo formulated a theory of geomorphology

17th Century (1601-1700)

1687: Isaac Newton calculated the (incorrect) age of Earth at 50,000 years old based on a globe of cooling iron
~1659: Nicolas Steno is considered a founder of modern geology and stratigraphy for his common explanations of rock formations

18th Century (1701-1800)

~1750s-1790s: increased attention to minerals due to their economic importance to mining in Europe
~1780s: James Hutton (considered to be the founder of modern geology) made considerable contributions to our understanding of Earth processes and the immensity of 'deep time'
~1790s: Etheldred Bennett was an extensive fossil collector and is considered to be the "first female geologist"

19th Century (1801-1900)

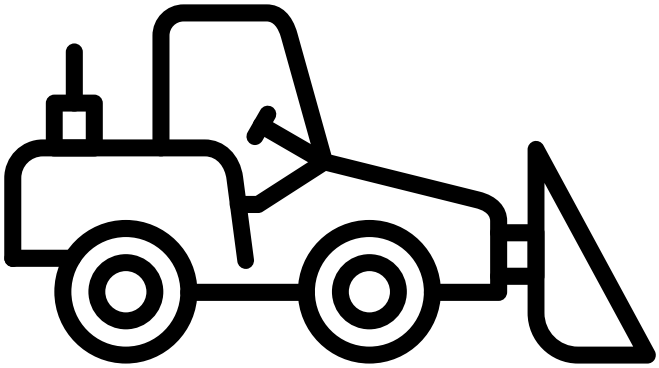
~1800: the Industrial Revolution stimulated development of the stratigraphic column and the use of fossils to distinguish rock formations and relative ages
1823: Mary Anning discovered the first complete skeleton of a Plesiosaurus
1823: A congressional Act created the North Carolina Geological Survey
~1830s: Charles Lyell proposed the theory of uniformitarianism which presents the idea that Earth's surface has been shaped by gradual processes that are still occurring today, such as erosion, volcanism, and sedimentation
1896: Florence Bascom became the first woman to work for the U.S. Geological Survey

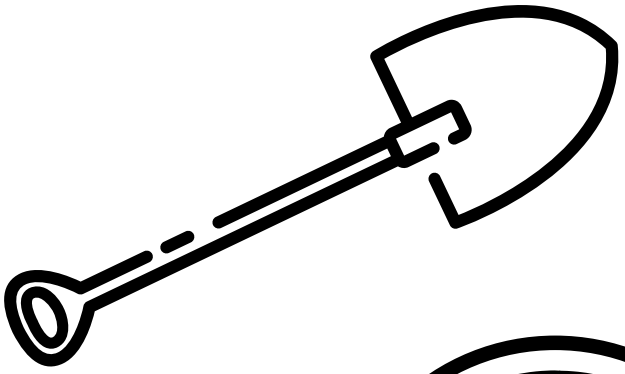
20th Century (1901-2000)

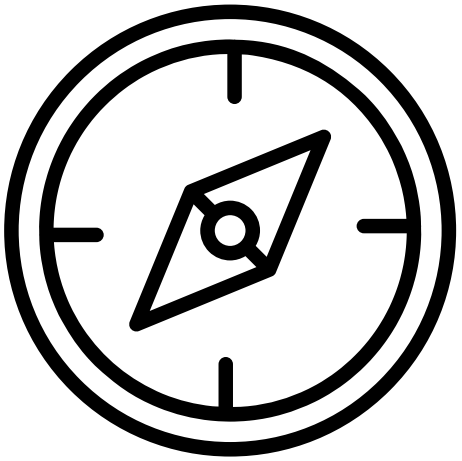
1911: Arthur Holmes used radioactive decay to measure geologic time by dating a sample at 1.6 billion years old using lead isotopes
1912: Alfred Wegener proposed the idea of continental drift
1950s: Marie Tharp collaborated with another geologist to produce the first map of the Atlantic Ocean floor
1953: Harry Hess proposed the hypothesis of seafloor spreading after discovery of the Mid-Atlantic Ridge
1963: Magnetic striping on the ocean floor was explained by Earth's reversing magnetic polarity
Mid-1960s: Development and acceptance of the theory of plate tectonics, based on geological, geophysical, and seismological data

Geology Jargon

- **Earthquake:** ground shaking caused by sudden movement of Earth's crust, usually along a fault
- **Fault:** a fracture or zone of fracture between rocks where movement has taken place
- **Fossil:** the preserved remains or traces of remains of a plant or animal from the past
- **Geologist**: a scientist who studies the structure, composition, and history of Earth
- **Geology**: the field of science that studies the Earth - how it formed, its history, its structure and composition, and the processes acting on it
- **Lava**: molten rock that is extruded onto Earth's surface by a volcano
- **Magma**: molten rock beneath Earth's surface
- **Mineral**: a naturally occurring inorganic (non living) element or compound that has an orderly internal structure, a definite chemical composition, and characteristic physical properties
- **Mining**: the extraction of rocks, minerals, or other geologic materials from the Earth
- **Rock**: a naturally occurring solid material composed of one or more minerals and makes up the crust of the Earth
    - **Igneous**: a rock that formed from molten or partially molten material (magma, lava)
    - **Sedimentary**: a rock formed from the consolidation of loose sediment, the remains of plants or animals, or from the precipitation from water solution
    - **Metamorphic**: a rock derived from preexisting rocks that were altered by heat, stress, and/or hot fluids
- **Tectonic plates**: large sections of Earth's crust that move and interact with each other at boundaries, creating volcanoes, mountains, and earthquakes
- **Volcano**: an opening in Earth's crust where lava erupts to the surface

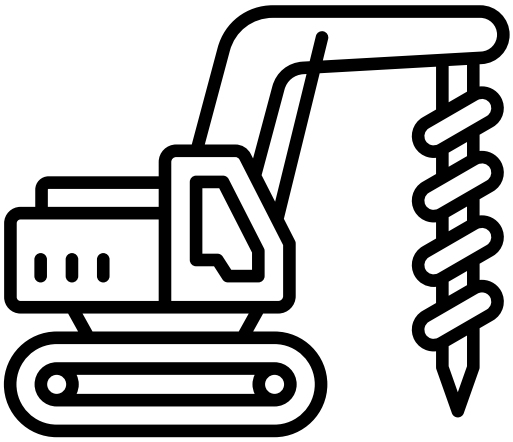


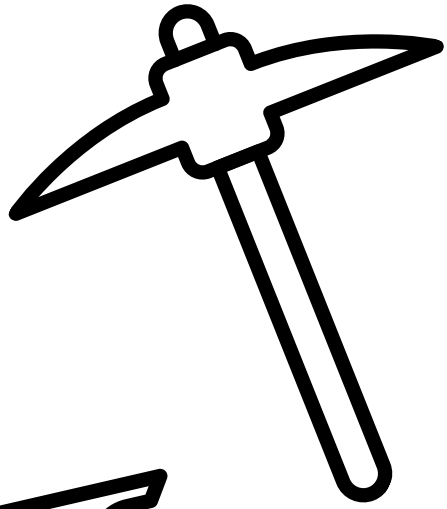


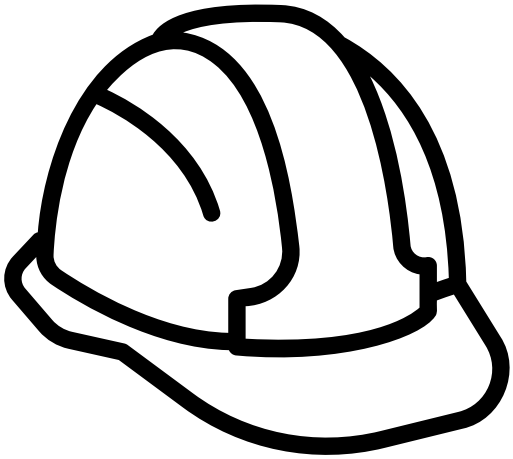


CRAZY COLORS

Some of these geologist tools are looking a little dull. Brighten them up with some crazy colors!







MINERALS

There are more than 5,000 minerals known to exist on Earth. Each of these minerals are elements or compounds of elements and all must abide by some basic properties:

1. Be inorganic (not made from living matter)
2. Occur naturally
3. Be solid at room temperature
4. Have a defined chemical composition
5. Have a regular crystalline structure (set pattern or arrangement of atoms)

Every mineral has a unique set of physical properties that can be tested, such as hardness, luster, streak, cleavage, color, magnetism, and reaction to acid.

ROCKS

A naturally-occurring solid material formed of one or more minerals and that make up the crust of Earth. Based on how they are formed, there are three types of rocks:

1. **Igneous** - formed from cooled lava and/or magma
2. **Sedimentary** - formed from the consolidation of loose sediment, the remains of plants or animals, or from the precipitation of minerals from water solution
3. **Metamorphic** - derived from preexisting rocks that were altered by heat, stress, and/or hot fluids

Rocks *generally* do not have unique physical properties like minerals do because each rock is made of different minerals in different combinations and concentrations.

Simply put, rocks are aggregates of one or more minerals and are defined by how they formed!

Common Minerals

Quartz	Feldspar
Olivine	Mica
Calcite	Amphiboles
Pyroxene	Garnet

Common Rocks

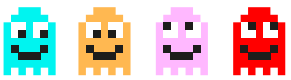
Limestone	Basalt
Shale	Sandstone
Granite	Marble
Gneiss	Schist

Rock Ruckus

Find the geoscience words in the puzzle below

A	K	L	D	G	Q	O	M	A	R	B	L	E
C	C	W	N	E	N	Q	L	S	S	I	A	A
F	O	F	U	M	P	T	Y	U	E	R	D	R
J	R	F	O	S	S	I	L	L	M	W	E	T
E	V	I	S	P	H	F	A	R	V	Q	Q	H
M	S	O	K	L	A	G	V	F	O	L	X	Q
P	Q	N	Z	W	L	Z	A	W	P	M	C	U
Q	P	X	L	A	E	N	Z	M	Q	U	L	A
D	B	E	M	D	L	O	Z	C	U	L	O	K
S	M	B	A	S	A	L	T	V	A	H	N	E
A	Y	L	G	P	R	C	D	O	R	M	M	P
M	I	G	M	O	W	R	C	P	T	E	B	J
B	U	B	A	G	L	T	E	Z	Z	W	D	G
X	B	W	T	L	A	D	O	B	Z	S	R	A
O	C	R	Y	A	C	I	M	B	M	V	M	R
E	N	M	S	G	V	N	U	I	M	O	O	N
V	T	I	D	L	I	O	Y	T	H	L	L	E
A	Z	N	W	T	U	S	F	E	G	C	S	T
C	W	E	V	Y	P	A	N	G	E	A	T	J
T	L	R	C	Q	D	U	D	E	E	N	X	H
H	C	A	M	J	S	R	M	B	Q	O	I	R
G	P	L	L	D	M	Q	A	L	Z	P	G	T

Words may be forward, backward, across, down, or diagonal



Fossil
Lava
Shale
Magma
Gold
Mineral
Cave
Dinosaur
Coal
Marble
Volcano
Gems
Quartz
Earthquake
Basalt
Gold
Moon
Pangea
Garnet

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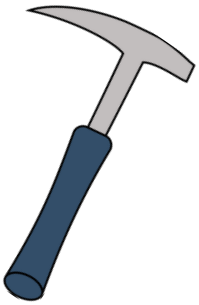


Mineral Mayhem!

While down in the quarry, Rockelle thinks she found a massive deposit of minerals so she sent a message to her headquarters, but it's in code. Help them decipher her messages!

A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	2	3	4	5	6	7	8	9	10	11	12	13	14

O	P	Q	R	S	T	U	V	W	X	Y	Z
15	16	17	18	19	20	21	22	23	24	25	26

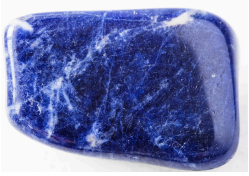
1. I found this mineral that is used to make glass: __ __ __ __ __ __
   17 21 1 18 20 26

2. I found this mineral that has also been found on Mars: __ __ __ __ __ __ __
   15 12 9 22 9 14 5

3. I think I found this red gemstone: __ __ __ __ __ __
   7 1 18 14 5 20

4. I found lots of this shiny, flat mineral: __ __ __ __
   13 9 3 1

5. I was able to scratch this mineral with my fingernail: __ __ __ __ __ __ __
   3 1 12 3 9 20 5



Vital Volcanoes

What's the first thing you think of when we say 'volcano'? Chances are you think about a tall mountain with hot lava spouting out the top, right? Most people usually think about destruction when thinking about volcanoes, but what if we were to tell you that volcanoes are essential for life on Earth? Vital Volcanoes! Vital means absolutely necessary or important and volcanoes are just that - necessary and essential for life on Earth. Read on to find out more.

Land Creation

Volcanoes have created more than 80% of Earth's surface. Erupting lava and volcanic ash solidify into rocks to create new land. Volcanoes that erupt on land can grow mountains and create larger continents. Volcanoes that erupt in the ocean can create volcanic islands.

Soil Fertility

Volcanic ash and rocks weather over long periods of time and create extremely fertile soil. Weathering releases nutrients, such as iron, magnesium, potassium, and phosphorus that are vital for plant growth. Volcanic soils also tend to be porous, which allows for good water drainage and air circulation.

Energy & Mineral Resources

Volcanoes exist because of superheated materials in Earth's interior - magma. These hot materials move tectonic plates around Earth and they also provide a source of geothermal heat, which can generate electricity. Superheated materials also produce mineral resources that humans need, including gold, copper, lead, and zinc. Superheated water associated with volcanoes can dissolve and transport minerals that can form deposits that can be mined.

Atmosphere & Climate

Volcanic eruptions release gases from Earth's interior such as carbon dioxide and water vapor. Billions of years ago, this water vapor cooled and condensed into liquid water which eventually created oceans. Released gases such as sulfur dioxide can affect Earth's climate by reacting with water vapor in the atmosphere, which can temporarily cool Earth's climate. Emitted carbon dioxide can trap heat in the atmosphere which can cause warming of the atmosphere.

Volcano Vocabulary Scramble

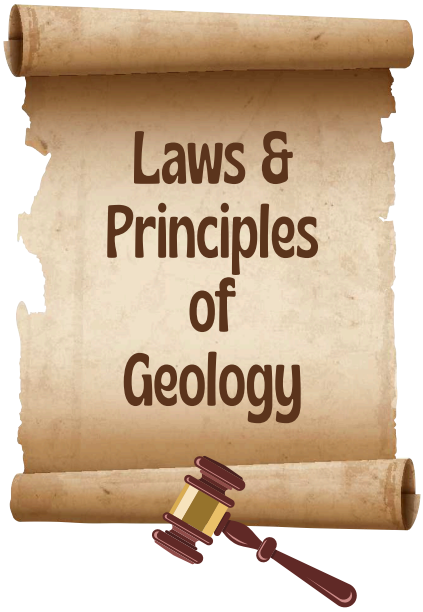
Unscramble the words in **bold** and write your answer next to the question

Answer

1. **WAIAHI** is a U.S. state that has active volcanoes. _____
2. When magma erupts from a volcano, it is called **VLAA** _____
3. Volcanic **HSA** is a mixture of small rock pieces and volcanic glass. _____
4. Volcanic activity occurs on Earth's surface, called the **RSUTC**. _____
5. The largest volcano is our solar system is on the planet **SRMA.** _____
6. **GMAAM** is molten rock inside the Earth. _____
7. The depression at the top of a volcano is called the **TCARRE**. _____
8. In 79 AD, Mt. Vesuvius erupted in the country of **LYTAI**. _____
9. Most volcanoes on Earth are found in the **RGIN** of **EFIR**. _____
10. When lava and magma cool they form **NOSGIEU** rocks. _____

"We hereby declare that there are two very important geologic laws and principles that all geologists must understand."

-Unofficially declared by the NC Geological Survey



Laws in science are statements that describe consistent and predictable phenomenon in nature. Scientific laws describe events that happen under specific conditions and are based on repeated observations and experiments.

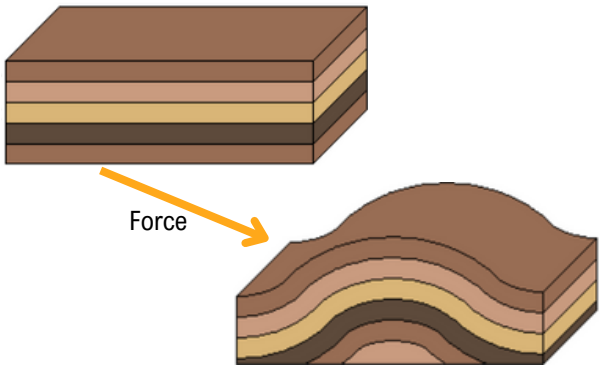
Here are a few examples of scientific laws:

- Newton's Laws of Motion: an object at rest remains at rest until acted upon by an unbalanced force
- Law of Conservation of Energy: energy cannot be created or destroyed, only transformed from one form to another
- Universal Law of Gravitation: any two objects, no matter their mass, exert gravitational force towards one another

Science **Principles** provide an understanding of how or why natural phenomena occur. Laws are often derived from, or based on, principles.

Principle of Original Horizontality

Sediments accumulate in layers over time, usually due to gravity. The layers are horizontal, or nearly horizontal, again, because of gravity. If the horizontal rock layers are tilted, folded, or faulted, it means that the layers were acted upon by a force that deformed the layers after their deposition. The layers were not formed in a tilted or folded position - they were originally formed in a horizontal position.

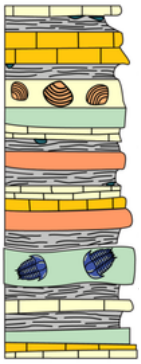


Law of Superposition

In undisturbed layers of rocks, the oldest layer is at the bottom and the youngest layer is at the top. This law assumes that the rock layers haven't been overturned or significantly disturbed by folding or faulting. The Grand Canyon is a good demonstration of this law - the oldest layers are at the bottom of the canyon and the youngest layers are at the top.

How do these 2 Laws and Principles help us to determine rock and fossil ages or the age of a geologic event?

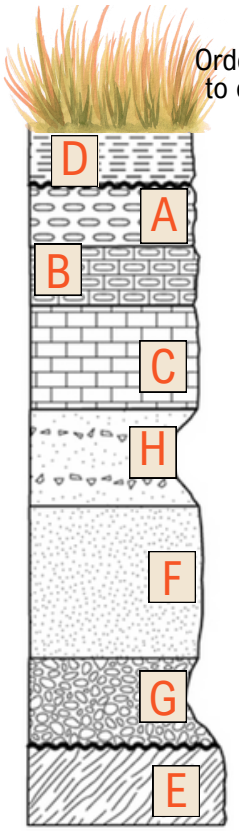
Relative age dating is a method geologists use to determine the order of past events without assigning a specific number age (absolute age). It establishes which events occurred before or after one another but doesn't determine how long ago something happened. It can help to determine when a fault or fold occurred and can help determine the ages of prehistoric organisms relative to one another by observing fossils in rock layers.



Relative Age Adventures!

Adventure #1

Order the rock layers from youngest to oldest by writing their letters on the spaces



Youngest

_____

_____

_____

_____

_____

_____

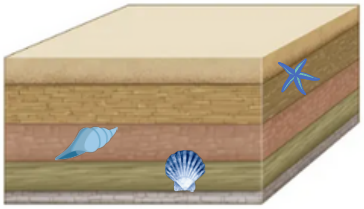
_____

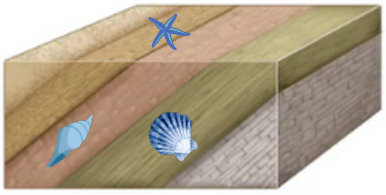
Oldest

_____

Adventure #2

Based on the images below, which of the following happened first, second, and last to these layers of rocks?
rocks layers tilted, rock layers formed, fossil shells deposited





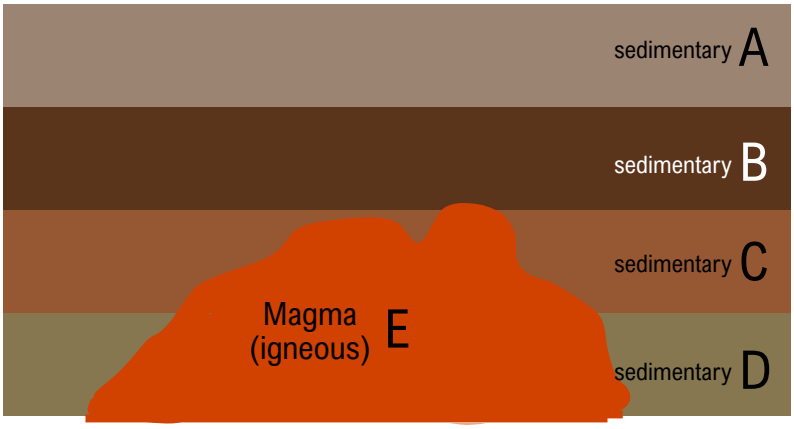
_____ First

_____ Second

_____ Last

Adventure #3

Magma (hot, melted rocks and minerals) is buoyant, which means it wants to rise up from inside Earth towards the crust. This is the same principle that applies to hot air balloons - they rise in the sky because of the hot air that's being pumped up into the balloon.
Sometimes, magma can rise up into layers of sedimentary rocks, pushing through cracks and through the rock layers.



What is the order of these rocks, from oldest to youngest (A though E)?

_____ _____ _____ _____ _____

Oldest Youngest

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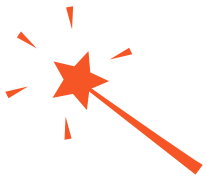
Geology

Hidden in Plain Sight



Get ready for a little magic trick. We're going to read your mind! We're going to say a word and you say the first thing that you think of. Ready?

→ **GEOLOGY** →

You said rocks, right? We told you we could read your mind!

The truth is, most people think of rocks when they hear the word geology. While this is a big part of the science of geology, geologists also study minerals, groundwater, volcanoes, earthquakes, landslides, geologic time, the moon, other planets, and so much more. Geologists also find resources - things that we use every single day. Here at the North Carolina Geological Survey, we have a saying - "If it's not grown, it's mined."
We say this because geology is EVERWHERE in your life, hidden in plain sight. Take a look at a few examples!

COPPER
- electrical wiring
- plumbing pipes
- heat exchangers
- motors
- phones & laptops

ALUMINUM
- airplanes
- medical equipment
- outdoor furniture
- phones & laptops
- house siding

GYPSUM
- drywall
- plaster
- cement
- soil amendment
- casts

PLATINUM
- catalytic converters
- spark plugs
- electrical components
- chemotherapy drugs
- surgical instruments

LITHIUM
- rechargeable batteries
- heat resistant ceramics
- automotive lubricants
- medications
- nuclear reactor coolant

QUARTZ
- concrete & cement
- watches & clocks
- glass
- sandpaper
- lasers & telescopes

MANGANESE
- steelmaking
- dietary supplement
- alkaline batteries
- glass & ceramics
- fireworks

GRAPHITE
- batteries
- fuel cells
- lubricants
- medical devices w/ electrodes
- pencils

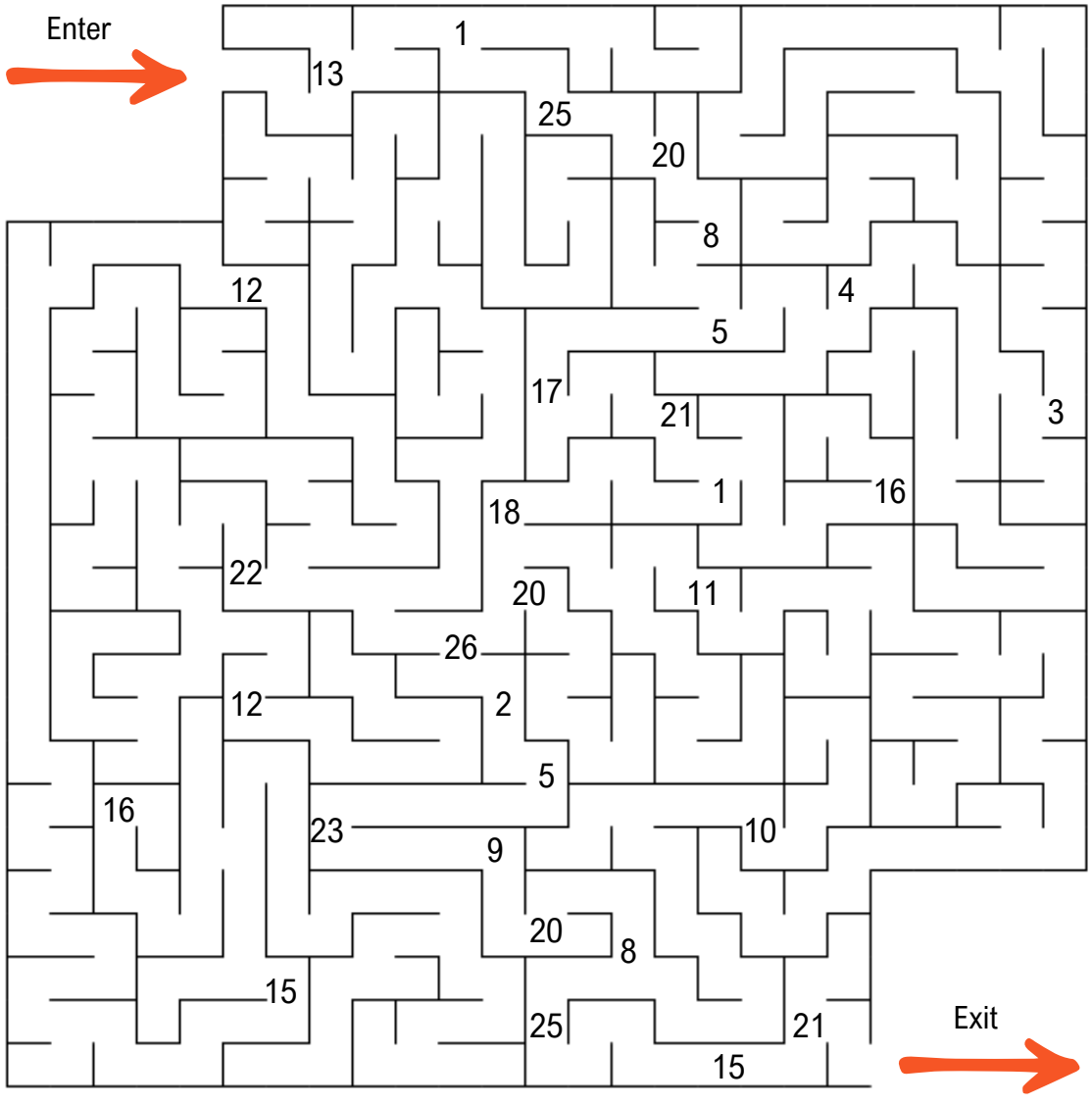
BERYLLIUM
- X-ray equipment
- golf clubs
- airplanes & satellites
- mirrors
- cell phones

Geology

Hidden in Plain Sight

Find your way out of the maze in order to decode the hidden message. On your route, you'll cross over a series of numbers. Record those numbers in the order you cross them and use the decoder to find the hidden message.

1 = A
2 = B
3 = C
4 = D
5 = E
6 = F
7 = G
8 = H
9 = I
10 = J
11 = K
12 = L
13 = M
14 = N
15 = O
16 = P
17 = Q
18 = R
19 = S
20 = T
21 = U
22 = V
23 = W
24 = X
25 = Y
26 = Z



Numbers You Crossed Over: _____

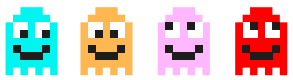
Decoded Message: _____

Rock Ruckus - Answer Key

Find the geoscience words in the puzzle below

A	K	L	D	G	Q	O	M	A	R	B	L	E
C	C	W	N	E	N	Q	L	S	S	I	A	A
F	O	F	U	M	P	T	Y	U	E	R	D	R
J	R	F	O	S	S	I	L	L	M	W	E	T
E	V	I	S	P	H	F	A	R	V	Q	Q	H
M	S	O	K	L	A	G	V	F	O	L	X	Q
P	Q	N	Z	W	L	Z	A	W	P	M	C	U
Q	P	X	L	A	E	N	Z	M	Q	U	L	A
D	B	E	M	D	L	O	Z	C	U	L	O	K
S	M	B	A	S	A	L	T	V	A	H	N	E
A	Y	L	G	P	R	C	D	O	R	M	M	P
M	I	G	M	O	W	R	C	P	T	E	B	J
B	U	B	A	G	L	T	E	Z	Z	W	D	G
X	B	W	T	L	A	D	O	B	Z	S	R	A
O	C	R	Y	A	C	I	M	B	M	V	M	R
E	N	M	S	G	V	N	U	I	M	O	O	N
V	T	I	D	L	I	O	Y	T	H	L	L	E
A	Z	N	W	T	U	S	F	E	G	C	S	T
C	W	E	V	Y	P	A	N	G	E	A	T	J
T	L	R	C	Q	D	U	D	E	E	N	X	H
H	C	A	M	J	S	R	M	B	Q	O	I	R
G	P	L	L	D	M	Q	A	L	Z	P	G	T

Words may be forward, backward, across, down, or diagonal



Fossil
Lava
Shale
Magma
Gold
Mineral
Cave
Dinosaur
Coal
Marble
Volcano
Gems
Quartz
Earthquake
Basalt
Gold
Moon
Pangea
Garnet

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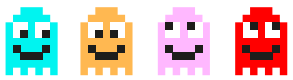
Rock Ruckus - Answer Key

Find the geoscience words in the puzzle below

A	K	L	D	G	Q	O	M	A	R	B	L	E
C	C	W	N	E	N	Q	L	S	S	I	A	A
F	O	F	U	M	P	T	Y	U	E	R	D	R
J	R	F	O	S	S	I	L	L	M	W	E	T
E	V	I	S	P	H	F	A	R	V	Q	Q	H
M	S	O	K	L	A	G	V	F	O	L	X	Q
P	Q	N	Z	W	L	Z	A	W	P	M	C	U
Q	P	X	L	A	E	N	Z	M	Q	U	L	A
D	B	E	M	D	L	O	Z	C	U	L	O	K
S	M	B	A	S	A	L	T	V	A	H	N	E
A	Y	L	G	P	R	C	D	O	R	M	M	P
M	I	G	M	O	W	R	C	P	T	E	B	J
B	U	B	A	G	L	T	E	Z	Z	W	D	G
X	B	W	T	L	A	D	O	B	Z	S	R	A
O	C	R	Y	A	C	I	M	B	M	V	M	R
E	N	M	S	G	V	N	U	I	M	O	O	N
V	T	I	D	L	I	O	Y	T	H	L	L	E
A	Z	N	W	T	U	S	F	E	G	C	S	T
C	W	E	V	Y	P	A	N	G	E	A	T	J
T	L	R	C	Q	D	U	D	E	E	N	X	H
H	C	A	M	J	S	R	M	B	Q	O	I	R
G	P	L	L	D	M	Q	A	L	Z	P	G	T

Words may be forward, backward, across, down, or diagonal



Fossil
Lava
Shale
Magma
Gold
Mineral
Cave
Dinosaur
Coal
Marble
Volcano
Gems
Quartz
Earthquake
Basalt
Gold
Moon
Pangea
Garnet

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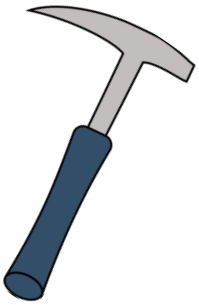


Mineral Mayhem - Answer Key

While down in the quarry, Rockelle thinks she found a massive deposit of minerals so she sent a message to her headquarters, but it's in code. Help them decipher her messages!

A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	2	3	4	5	6	7	8	9	10	11	12	13	14

O	P	Q	R	S	T	U	V	W	X	Y	Z
15	16	17	18	19	20	21	22	23	24	25	26

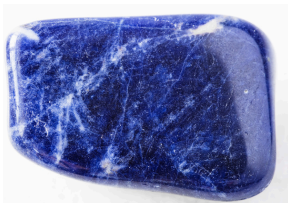
1. I found this mineral that is used to make glass: Q U A R T Z (17 21 1 18 20 26)

2. I found this mineral that has also been found on Mars: O L I V I N E (15 12 9 22 9 14 5)

3. I think I found this red gemstone: G A R N E T (7 1 18 14 5 20)

4. I found lots of this shiny, flat mineral: M I C A (13 9 3 1)

5. I was able to scratch this mineral with my fingernail: C A L C I T E (3 1 12 3 9 20 5)

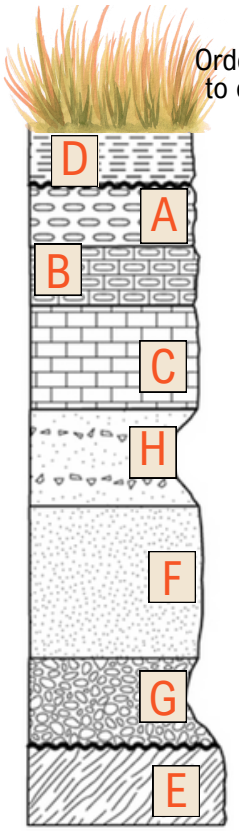


Volcano Vocabulary Scramble - Answer Key

Unscramble the words in **bold** and write your answer next to the question

	Answer
1. **WAIAHI** is a U.S. state that has active volcanoes.	Hawaii
2. When magma erupts from a volcano, it is called **VLAA**	Lava
3. Volcanic **HSA** is a mixture of small rock pieces and volcanic glass.	Ash
4. Volcanic activity occurs on Earth's surface, called the **RSUTC**.	Crust
5. The largest volcano is our solar system is on the planet **SRMA.**	Mars
6. **GMAAM** is molten rock inside the Earth.	Magma
7. The depression at the top of a volcano is called the **TCARRE**.	Crater
8. In 79 AD, Mt. Vesuvius erupted in the country of **LYTAI**.	Italy
9. Most volcanoes on Earth are found in the **RGIN** of **EFIR**.	Ring of Fire
10. When lava and magma cool they form **NOSGIEU** rocks.	Igneous

Relative Age Adventures!
Answer Key



Adventure #1

Order the rock layers from youngest to oldest by writing their letters on the spaces

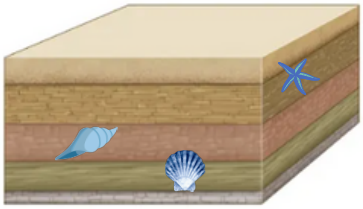
D
A
B
C
H
F
G
E

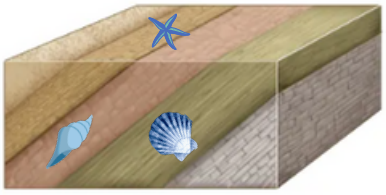
Youngest

Oldest

Adventure #2

Based on the images below, which of the following happened first, second, and last to these layers of rocks?
rocks layers tilted, rock layers formed, fossil shells deposited





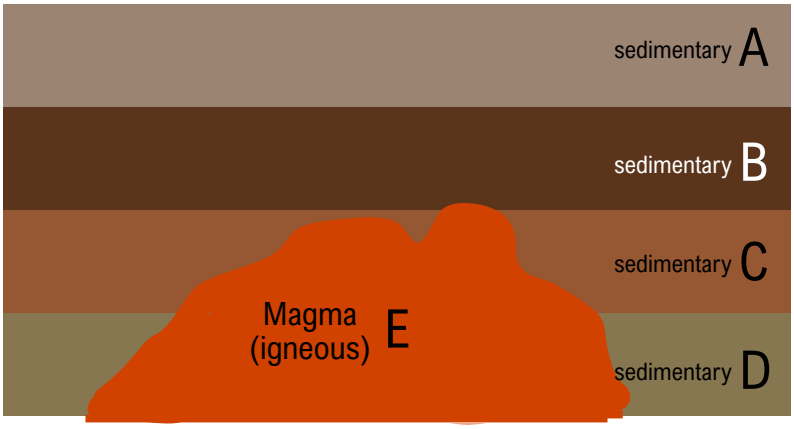
Rock layers formed _____ First

Fossils deposited _____ Second

Rock layers tilted _____ Last

Adventure #3

Magma (hot, melted rocks and minerals) is buoyant, which means it wants to rise up from inside Earth towards the crust. This is the same principle that applies to hot air balloons - they rise in the sky because of the hot air that's being pumped up into the balloon.
Sometimes, magma can rise up into layers of sedimentary rocks, pushing through cracks and through the rock layers.



What is the order of these rocks, from oldest to youngest (A though E)?

D C B E A

Oldest _____ Youngest

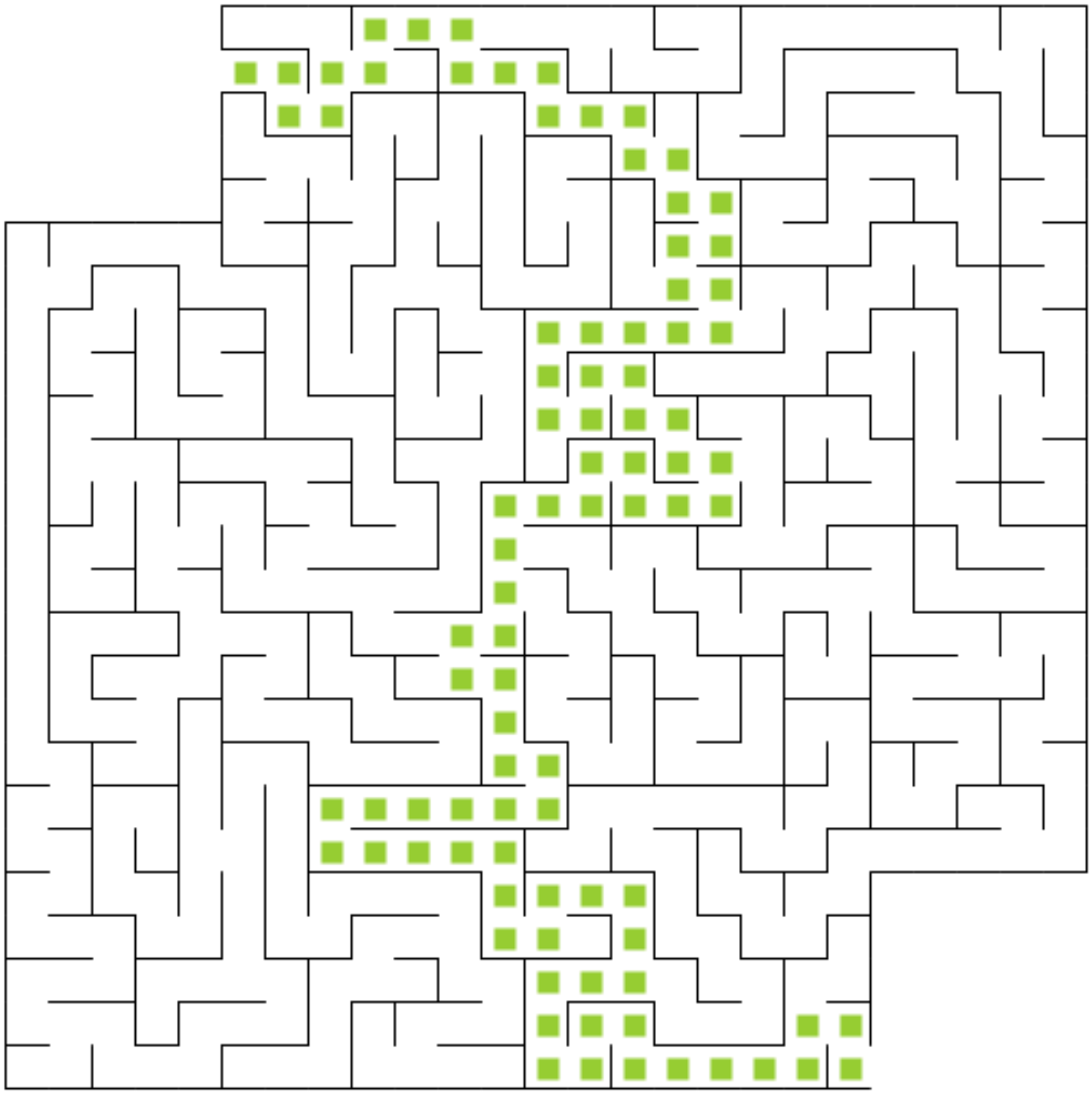
OR

D C B A E

Geology
Answer Key

Hidden in Plain Sight

Find your way out of the maze in order to decode the hidden message. On your route, you'll cross over a series of numbers. Record those numbers and use the decoder to find the hidden message.



Numbers You Crossed Over: 13 1 25 20 8 5 17 21 1 18 20 26 2 5 23 9 20 8 25 15 21

Decoded Message: May the quartz be with you