Intermediate Science 7

UNIT 3
EARTH'S CRUST

TOPIC 5: ROCKS AND MINERALS

Why Are Rocks Useful?

- Tools
- Building material
- Monetary currency
- Jewelry
- Entertainment
- Keepers of history
- Provide direction

Mining in Newfoundland and Labrador ... The past

- Iron ore (Bell Island)
- Copper (Buchan's)
- Zinc (Daniel's Harbour)
- Copper (Tilt Cove)

Mining In Newfoundland And Labrador... The present

- Gold (Nugget Pond)
- Granite (Lumsden)
- Iron ore (Labrador City)
- Slate (Burgoyne's Cove)
- Gypsum (Flat Bay)

Questions to Ponder

- 1.How do the crystals or minerals form in a rock?

- 2. Why do some rocks have layers?

- 3. Why do some rocks have rounded particles while others have angular particles?




Rocks Are All Around Us!

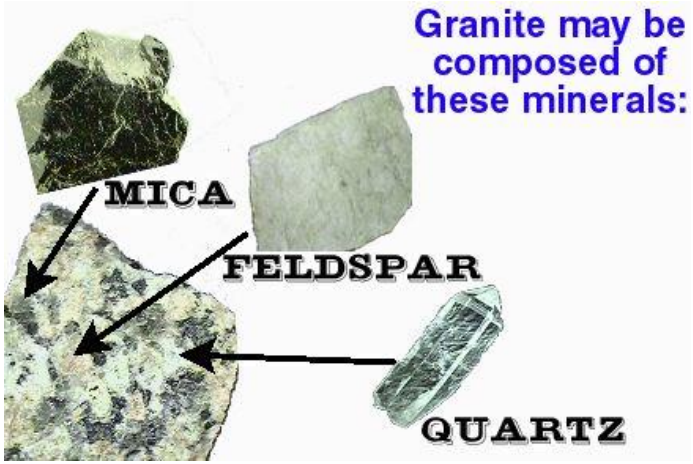
Rocks are all around us. They make up the backbones of hills and mountains and the foundations of plains and valleys. Beneath the soil you walk on and the deep layers of soft mud that cover the ocean basins is a basement of hard rock.

What Is A Rock?

ROCK: is the hard, solid part of the earth. It is made of a combination of two or more minerals in various amounts. Think of a chocolate chip cookie as a rock. The cookie is made of flour, butter, sugar & chocolate. The cookie is like a rock and the flour, butter, sugar & chocolate are like minerals. You need minerals to make rocks, but you don't need rocks to make minerals. All rocks are made of minerals.

For example

Granite



What are Rocks Made of?

Rocks are made up mostly of crystals of different kinds of minerals, or broken pieces of crystals, or broken pieces of rocks. Some rocks are made of the shells of once-living animals, or of compressed pieces of plants. We can learn something about the way a rock formed from by looking carefully at the evidence preserved inside.

Minerals

Minerals: a pure, naturally occurring solid substance found in rocks. There are more than 3000 different minerals. Minerals are made of chemicals - either a single element or a combination of elements. There are 103 known chemical elements.

Element is a pure substance that can not be further broken down into other substances.

The majority of minerals consist of two or more elements.

For example:

Quartz =====> silicon
Oxygen

Elements

Element: **a pure substance that cannot be further subdivided, composed of only one type of particle.**

1 H																	2 He
3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
55 Cs	56 Ba	57 La	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
87 Fr	88 Ra	89 Ac	104 Unq	105 Unp	106 Unh	107 Uns	108 Uno	109 Une	110 Unn								

58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

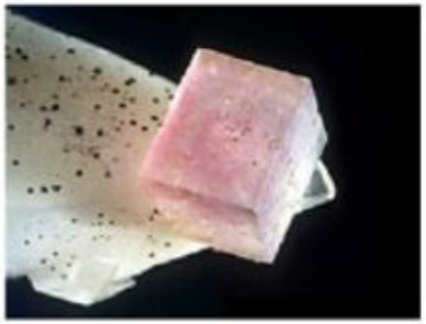
MINERALS IN OUR ENVIRONMENT

Loading

Smithsonian Institution
Halite

Chip Clark
Smithsonian Institution
Quartz

Chip Clark,
Smithsonian Institution
Gypsum



Smithsonian Institution
Fluorite

Doug Martin
Graphite

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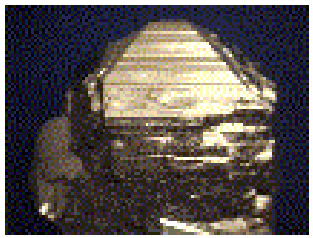
Gold

Properties of Minerals:

- **1) Lustre:** a description of how a minerals shines under light.

Silver= shiny



- **2) Streak:** the powdery mark left by some minerals when they are scraped against a hard surface.

3) Hardness: this can be determine by scratching one minerals against another. The harder mineral leaves a mark on the softer. Scientist also use a scale called “Moh’s Hardness scale” to measure hardness. This scale is named after Fredrich Mohs. Higher the number, harder the substance

Mohs' Hardness Scale									
1	2	3	4	5	6	7	8	9	10
Talc	Gypsum	Calcite	Fluorite	Apatite	Feldspar	Quartz	Topaz	Corundum	Diamond

To use the hardness scale, try to scratch the surface of an unknown sample with a mineral or substance from the hardness scale . If the unknown sample cannot be scratched by feldspar (6) but it can be scratched by quartz (7), then it's hardness is between 6 and 7. An example of a mineral that has a hardness between 6 and 7 is pyrite (6 to 6.5).

Common Objects and Their Hardness Values				
2.5	3.5	5.5	6.5	8.5
Fingernail	Penny	Glass	Steel knife	Emery cloth

Mohs Hardness Scale

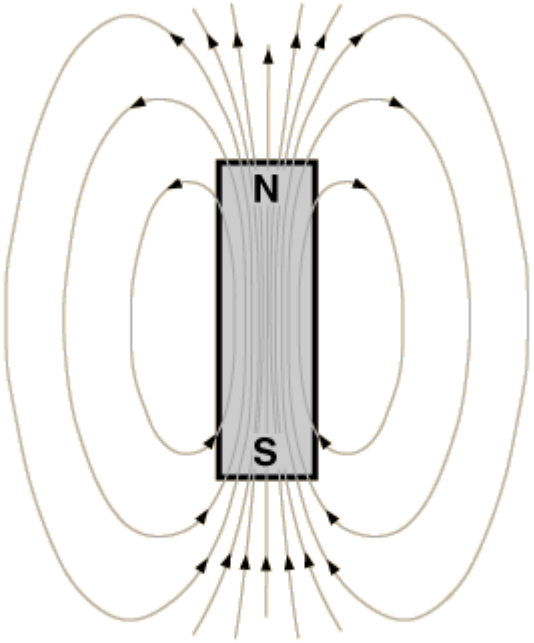
Mineral Name	Scale Number	Common Object
Diamond	10	
Corundum	9	Masonry Drill Bit (8.5)
Topaz	8	
Quartz	7	Steel Nail (6.5)
Orthoclase	6	
Apatite	5	Knife/Glass Plate (5.5)
Fluorite	4	Copper Penny (3.5)
Calcite	3	
Gypsum	2	Fingernail (2.5)
Talc	1	

Increasing Hardness

4) Colour: we notice the color of a mineral first. Some minerals are easily identified by color because they are never any other color. For example, malachite is always green

5. Transparency : If the light enters and exits the surface of the substance in relatively undisturbed fashion, then the substance is referred to as transparent. If the light can enter and exit the surface of the substance, but in a disturbed and distorted fashion, then the substance is referred to as translucent. If the light can not even penetrate the surface of the substance, then the substance is referred to as opaque.

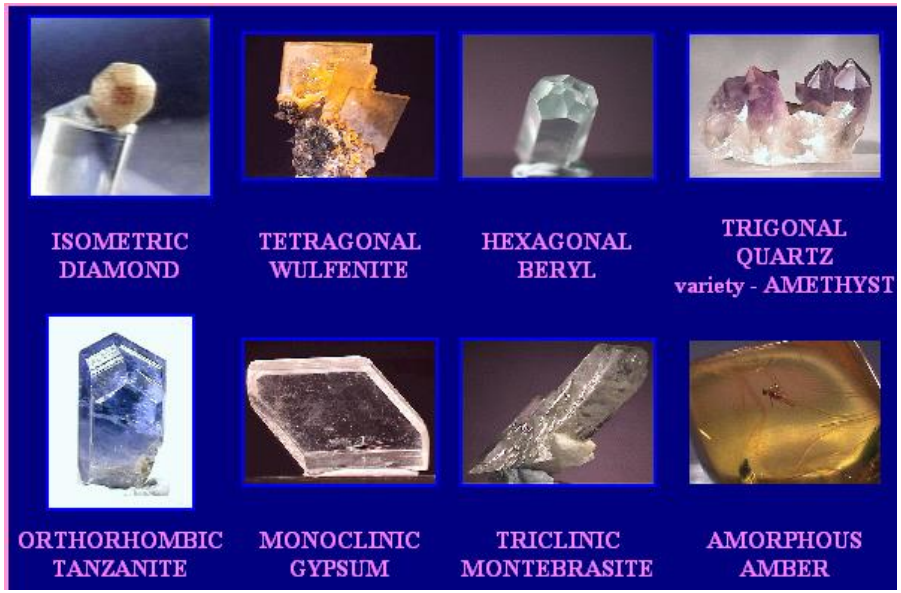
6) Magnetic



7) Effervescence (Fizz) (NOTE: add vinegar to chalk - limestone)

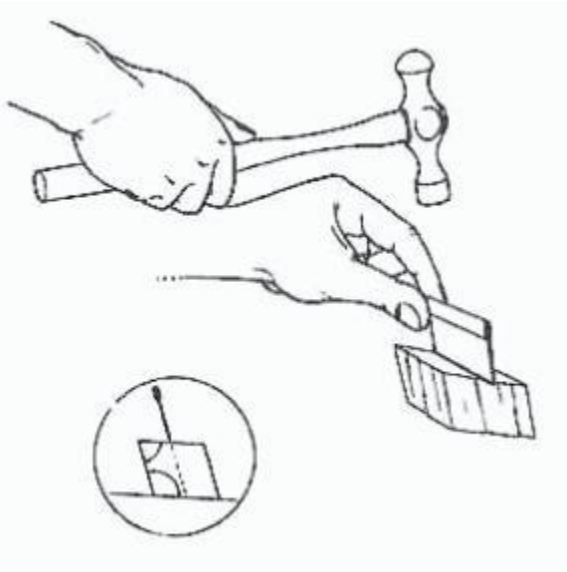
8. Crystal: a naturally occurring piece of solid with, with straight edges, flat sides and regular angles**.**

All minerals occur in the form of crystals, although some crystals may be too small to be seen with the naked eye (magnification). Each type of mineral has a certain type of geometric shape:



Minerals can be identified by how the crystals break:

1) Cleavage: the tendency of a mineral to split most easily along a flat surface parallel to its crystal faces It is a smooth break



Fracture: When a crystal breaks Into pieces with rough and uneven surfaces.

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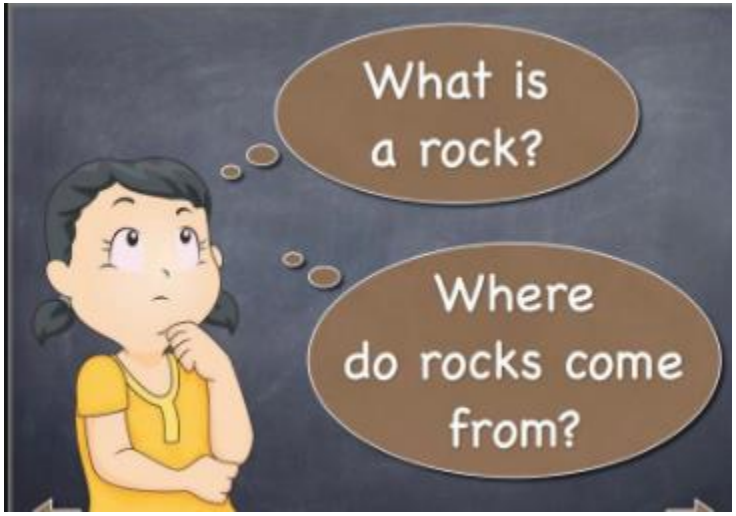
EARTH'S CRUST

TOPIC 6: CLASSIFICATION OF ROCKS

Where Do Rocks Come From?

- Rocks are divided into three basic types, **igneous**, **sedimentary** and **metamorphic** , depending upon how they were formed. Plate tectonics provides an explanation for how rocks are recycled from igneous to sedimentary to metamorphic and back to igneous again.

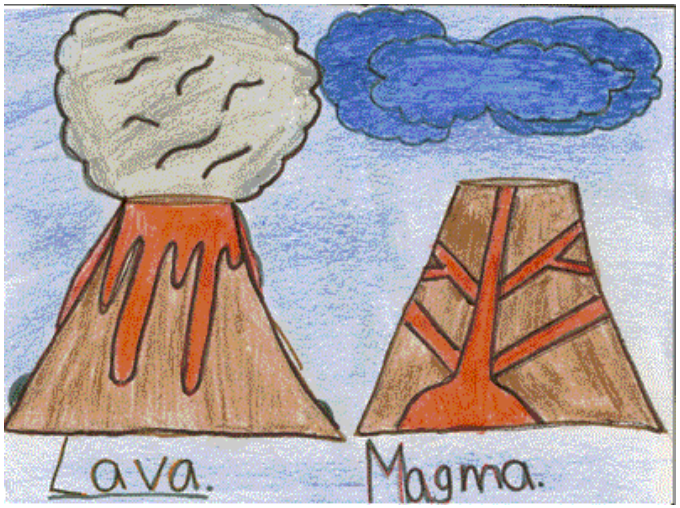


Igneous Rocks- "Born of fire"

- **Igneous rock:** is a type of rock that is formed due to the cooling of Magma. **Magma** refers to the hot rock found at great depths below the earth's surface. Sometimes magma comes to the top of the earth's surface. As it breaks the earth's crust it loses some of the dissolved gases and vapor, and is now called **lava.** For example, lava comes from volcanoes.

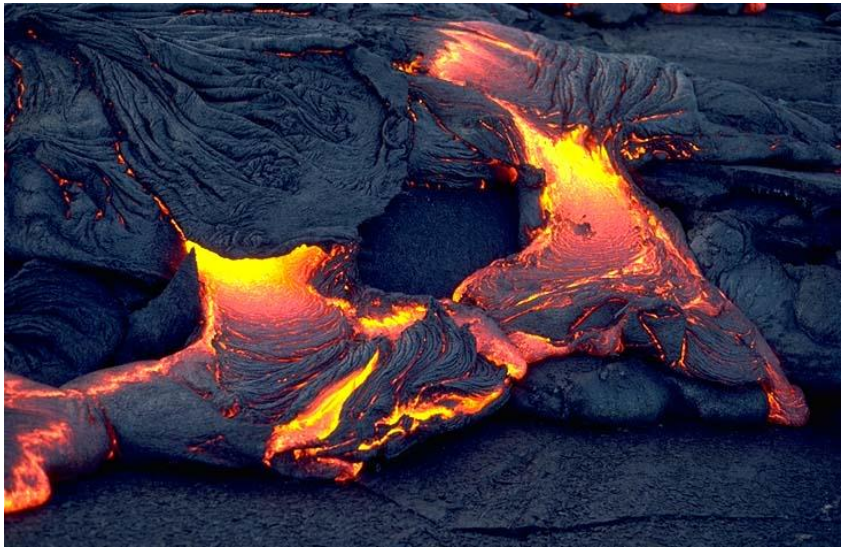
  • It composes more than four-fifths (4/5) of the Earth's crust

  • the word igneous comes from the Latin word *ignis*, meaning "fire".



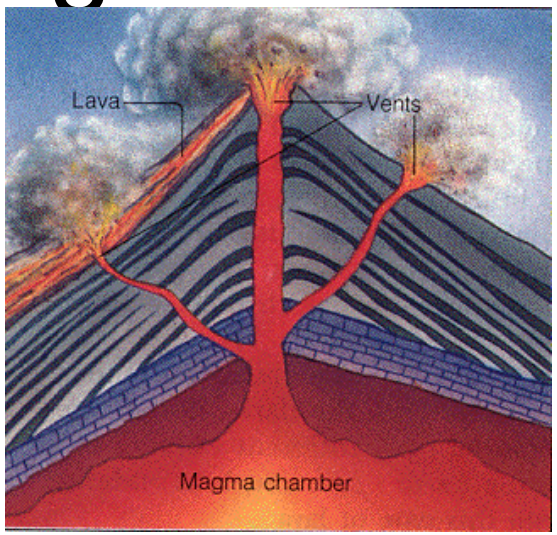
Molten Rock can form…

Above the ground



Lava

Below the ground



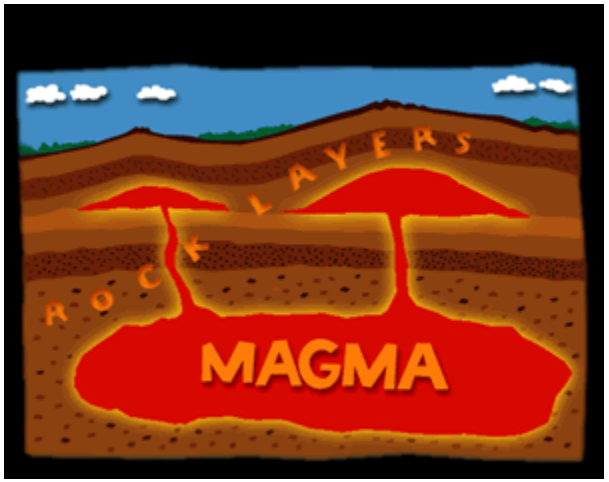
Magma

There are two main types of Igneous Rocks. There are:

1) **Intrusive Rock:** A type of rock formed from magma that hardens beneath the earth's surface.
Examples: Basalt, Rhyolite, Obsidian and Pumice

Gabbro

Granite



2) **Extrusive Rock:** A rock formed from lava that hardens on the earth's surface.

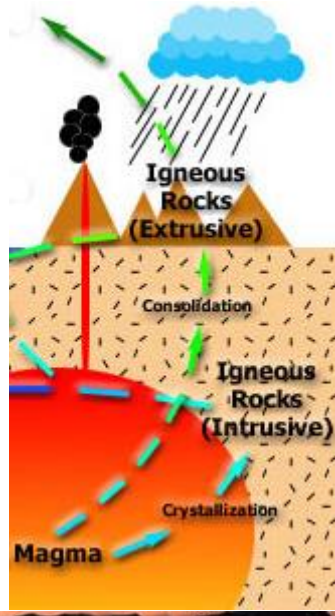
Examples: volcanic rock, Granite, Gabbro, Diabase and Pegmatite

Basalt

Obsidian

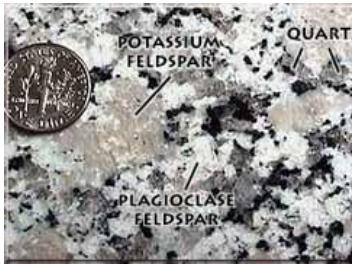
Rhyolite

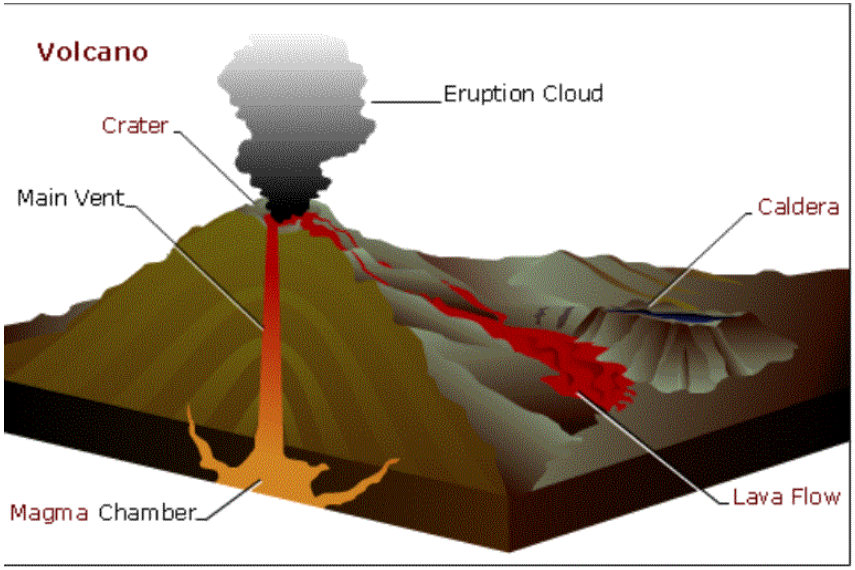
There is a relationship between *where igneous rocks are formed*, *rate of cooling*, and *crystal size.*



Extrusive igneous rocks ((volcanic)- When lava is exposed to the surface, it cools and solidifies rapidly as a result of being exposed to air and water, forming small crystals. The crystals are too small to see without magnification.

Intrusive igneous rocks (plutonic)- When magma Remains insulated in the Earth's crust, it cools and solidifies slowly, forming large crystals.





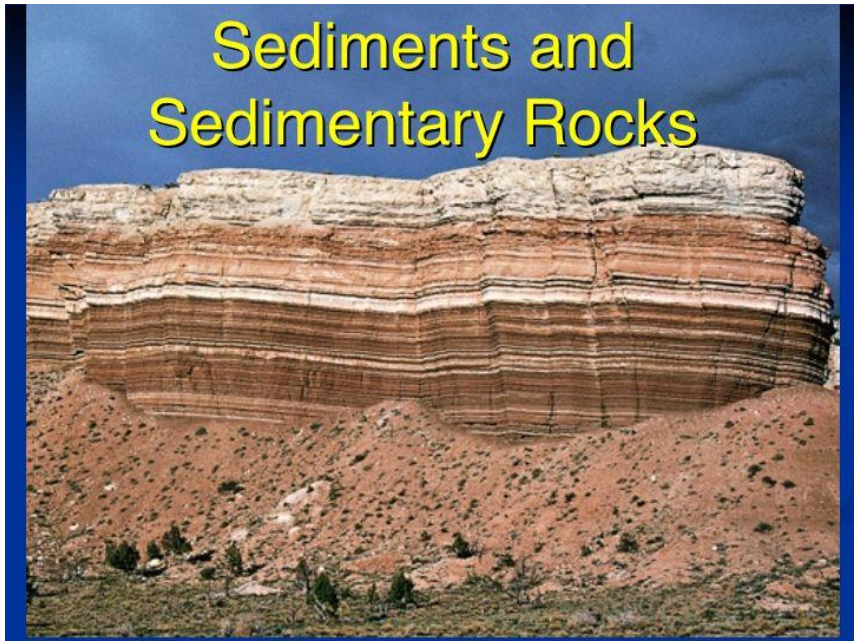
Hyperlink to volcano on teacher domain

Sedimentary Rocks - “ Layer upon Layer”

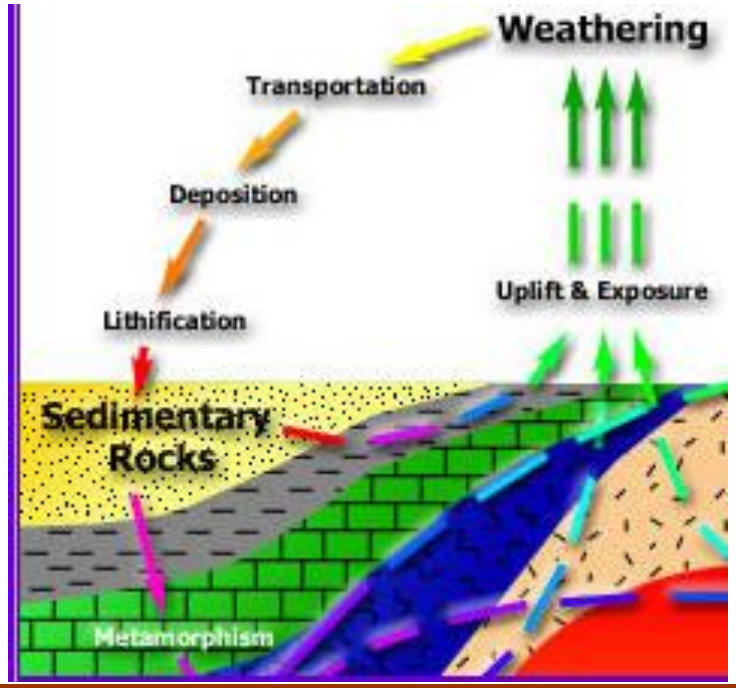
- **Sedimentary Rock** is a type of rock formed by the build up of sediments over time. Most layered rock is sedimentary rock, made from small fragments of rock material closely packed and cemented together.

Sediment: refers to materials that is suspended in water and that settles at the bottom of a body of water.

=> The horizontal layers of rock are called **beds**.



Any rock (igneous, sedimentary, or metamorphic) exposed at the Earth's surface can become a sedimentary rock. The forces of wind, rain, snow, and ice combine to break down or dissolve (weather), and carry away (transport) rocks exposed at the surface. These particles eventually come to rest (deposited) and become hard rock (lithified).



Sedimentary rocks tell us what the Earth's surface was like in the geologic past. They can contain fossils that tell us about the animals and plants or show the climate in an area. Sedimentary rocks are also important because they may contain water for drinking or oil and gas to run our cars and heat our homes.

Sedimentary rock is less plentiful that igneous rock in the earth’s surface. Nevertheless, Sedimentary Rock makes up about 75% of the rock that is exposed on the surface of the land.

The different types of sediments that can be used to form different sedimentary rock:

1) It can be made of compressed mud that is a mixture of clay and silt (fine particles of mineral matter). Example Shale

2) Large granules of sand.
Example: Sandstone

3)Rounded pebbles and small stones.
Example: Conglomerate

Clastic sedimentary rocks form by weathering processes which break down rocks into pebble, sand, or clay particles by exposure to wind, ice, and water.

So, how can you tell grain size? Easy, your fingers can feel the grains of sandstone, even at the fine-grained end. Shale will feel smooth to your fingers but it can be further separated into siltsone and claystone by rubbing a little across your teeth. Siltstone will feel gritty and claystone will feel smooth

Nonclastic sedimentary rocks form from chemical reactions, chiefly in the ocean.

Limestone=composed of the mineral calcite, may contain marine fossils, formed by precipitation from water

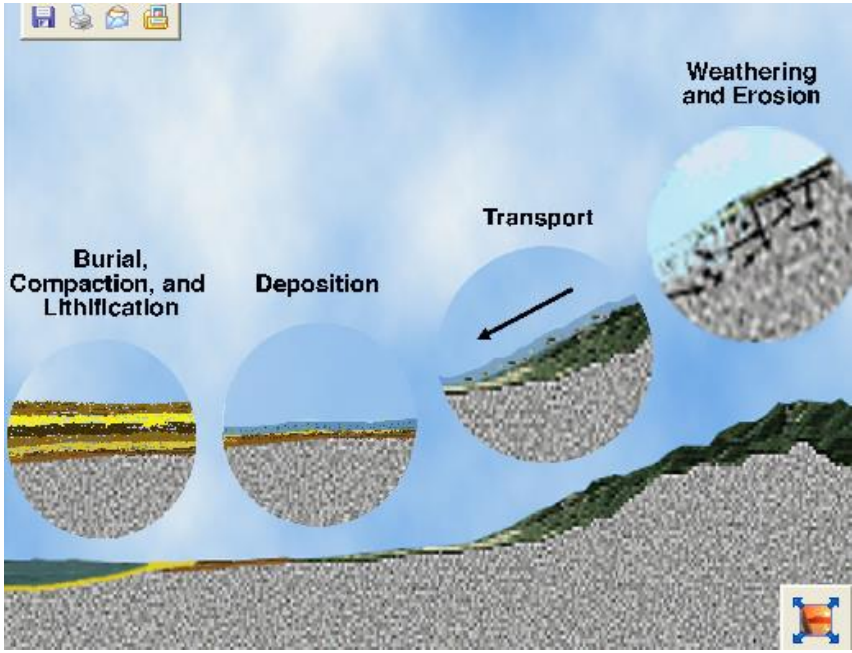
Rock salt= composed of the mineral halite (salt), formed by evaporation

Rock gypsum= composed of the mineral gypsum, formed by evaporation

Chert=composed of microscopic mineral grains of quartz, very hard with sharp edges

Process Involved In The Formation Of Sedimentary Rock

- Weathering
- Erosion (Transportation)
- Deposition
- liftification



Deposition In a River System.

- **deposition is *the settling of eroded materials (Sediments). It* represents the end of the journey (at least temporarily) for weathered material.**

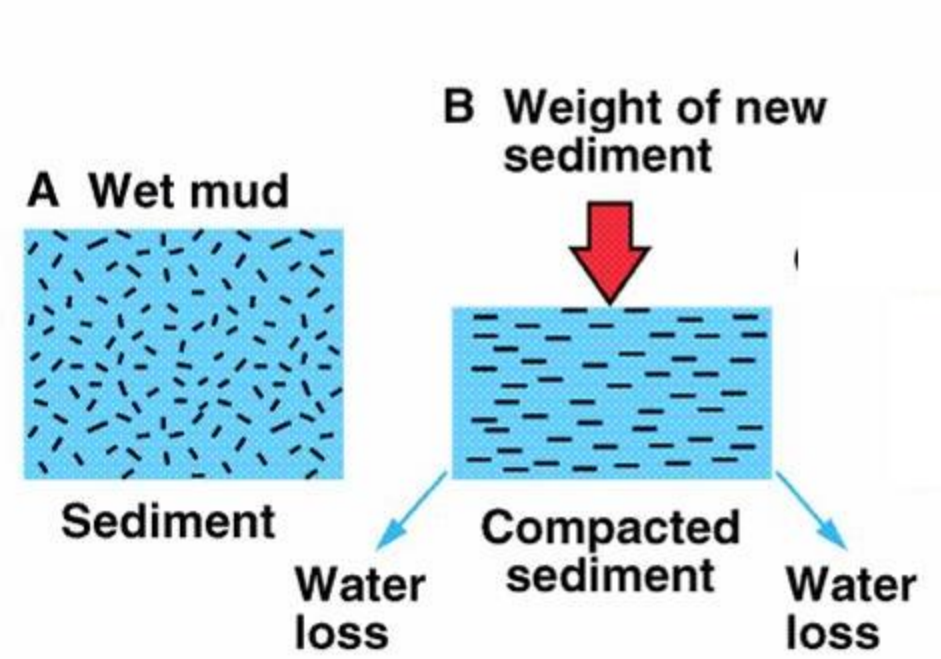
NOAA

Lithification : How Sedimentary Rock is formed

- **=> Small fragments of the earth's surface are constantly being worn away and moved from one place to another by erosion(Wind, ice , water).**
- **=> Over a long period of time large amounts of eroded materials are carried from the land into lakes and oceans, where they eventually settle to the bottom.**
- **=> the layered appearance of sedimentary rock is produced by slow collection of sediment settling on top of other sediment.**

=>**This build up sediment on top of each other produces horizontal layers of called beds.**

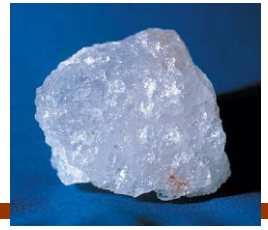
=> The layers of rock are pushed together or <u>compacted</u> by the mass of sediments and water on top of them. This pressure causes these sediments to form rock.



Precipitation –Formation of rock salt, gypsum and Limestone.

- **Gypsum - large beds of gypsum formed when sea water evaporated, leaving dissolved calcium and sulfate to form deposits of gypsum. Gypsum is so soft that it can be scratched with the fingernail.**

- **Rock salt - salt from the ground. Salt that occurs in hard massive layers beneath the ground is called rock salt. These deposits were formed by the evaporation of large parts of oceans millions of years ago. They occur along with deposits of such minerals as calcium carbonate and potash, which are found in seawater.**



Limestone

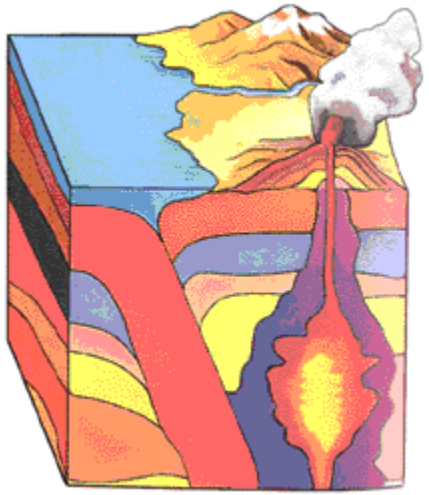
Most freshwater and sea water dissolved calcium carbonate . All limestones are formed when calcium carbonate crystallizes out of solution. This occurs when water evaporates. Such evaporation takes place in the hot lagoons of many coral reefs. The high temperature causes the water on the surface to evaporate. A white "lime" mud is deposited at the bottom of the sea.

***Demonstration*: Limestone can easily be dissolved by acids. If you drop vinegar on limestone it will fizz. (Put a limestone rock into a plastic jar and cover it with vinegar. Cover the jar and watch the bubbling of the calcium carbonate).**

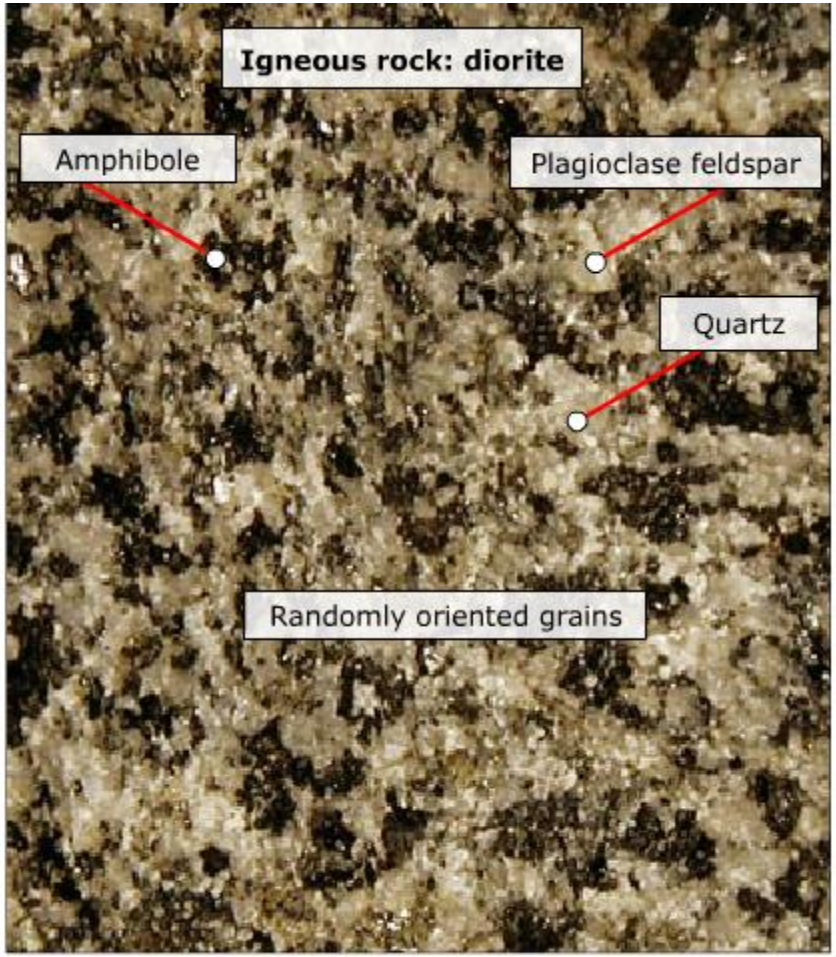
Metamorphic Rock- “Changing Form”

“meta” means change

“morph” means form



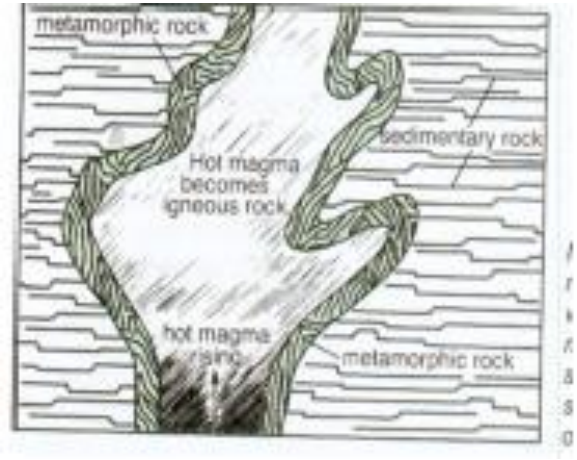
- Metamorphic Rock forms from the other two main types; igneous and sedimentary. Metamorphic rock forms when heat or pressure, or both, cause changes in the "parent" rock. A parent rock is usually a Igneous or Sedimentary rock that changes form and becomes a Metamorphic Rock. It is possible that metamorphic rock may be changed to such an extent that it does not resemble the parent rock. Often, however, geologists can trace the relationships between metamorphic rock and the parent rock from which it was formed.


Igneous rock: diorite
Amphibole
Plagioclase feldspar
Quartz
Randomly oriented grains


Igneous rock
Heat and pressure
Metamorphic rock

Metamorphic rock may be formed by:

1) Hot Magma that heats and squeezes the surrounding areas.



2)The burial of the rocks deep in the earth's crust.

3) Movements in the earth's crust may also affect the rock by deforming it.

Example:

Metamorphic Rock **Parent Rock**

marble ---------- **limestone {sedimentary rock}**

Common Characteristics:

- same level of hardness

- both made from mineral, calcite

- both bubble and fizz if placed in vinegar

Other Examples:

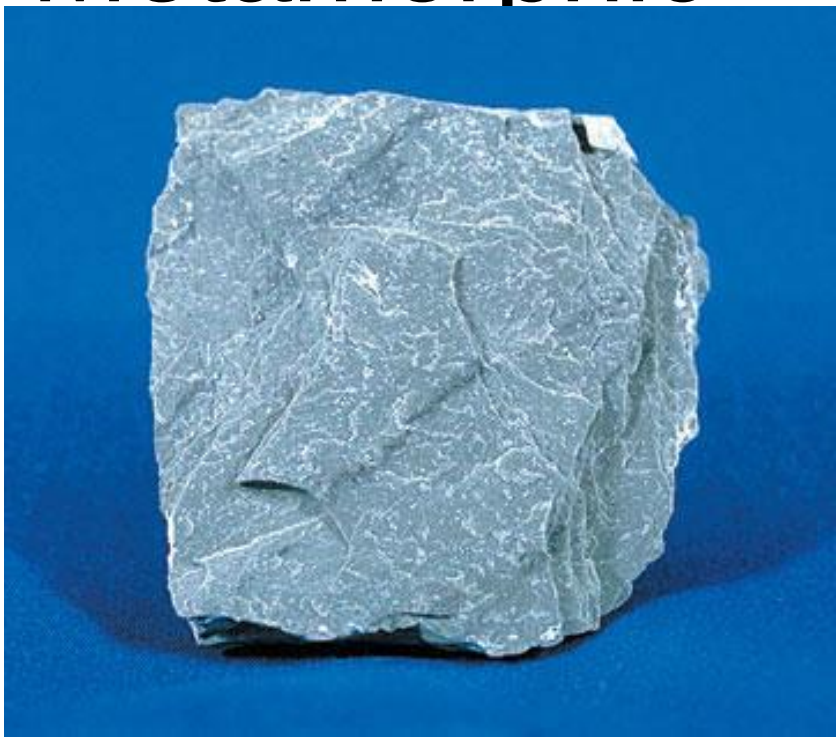
Metamorphic Rock		Parent Rock
slate	----------	shale {sedimentary rock}
		
Quartzite	----------	sandstone {sedimentary rock}
		
gneiss	----------	granite {igneous rock}
		

Parent Rocks…

- Sedimentary

PARENT: Shale

- Metamorphic



Slate

- Sedimentary

PARENT: Limestone

- Metamorphic

Marble

- Sedimentary

PARENT: Sandstone

- Metamorphic

Quartzite

- Igneous

PARENT: Granite

- Metamorphic

Gneiss

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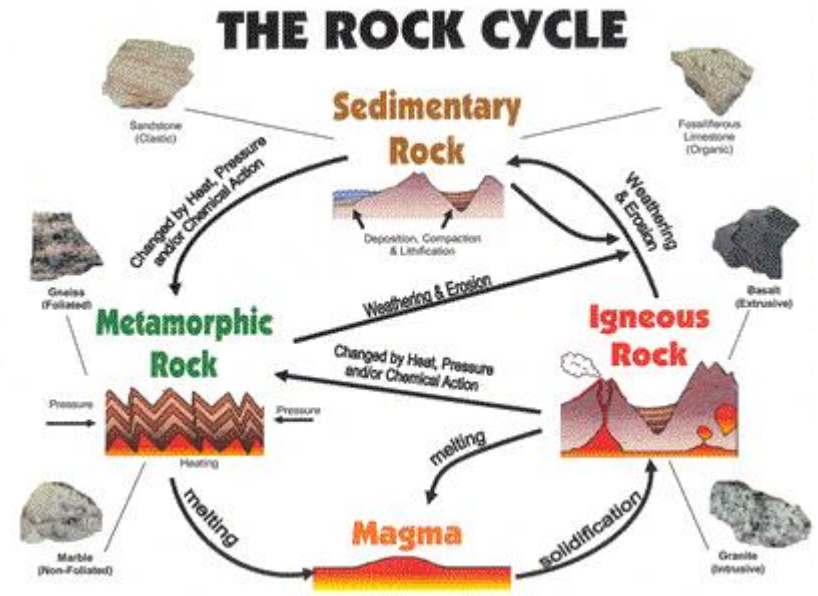
UNIT 3
EARTH'S CRUST

TOPIC 5: ROCK CYCLE

The Rock Cycle

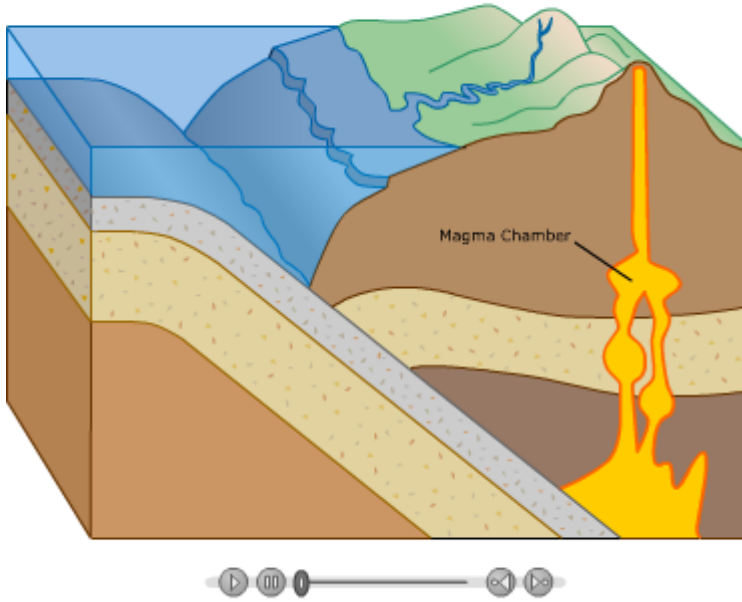
A natural cycle.

Represents a change process where the same materials are cycled throughout, producing different products under varying conditions.

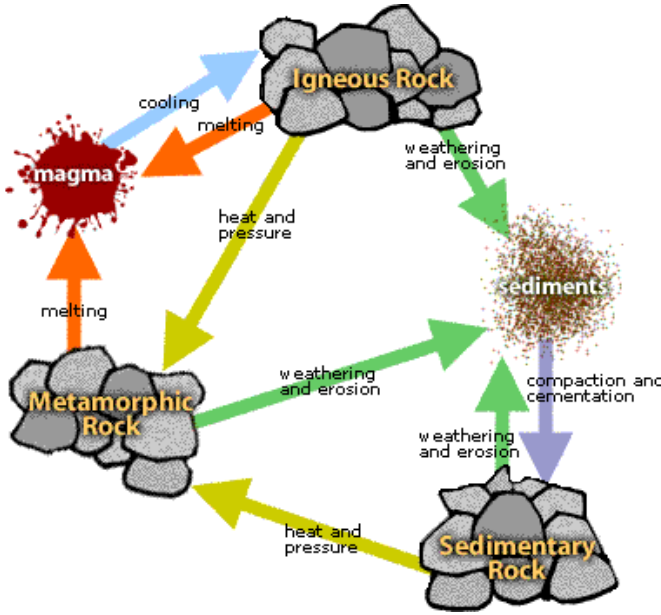


THE ROCK CYCLE

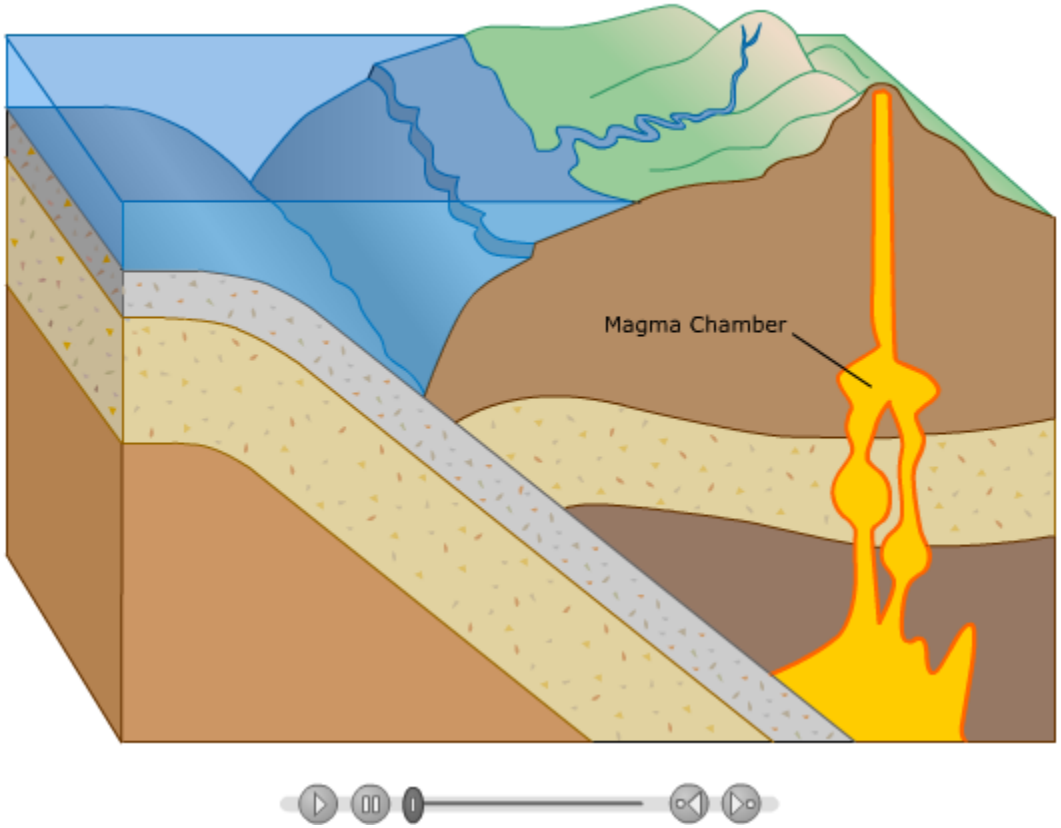
- James Hutton (1727–1797), a 18th century farmer and founder of modern geoscience, created the concept of the rock cycle, which shows a relationship between igneous, sedimentary, and metamorphic rocks. The upper part of the earth (mantle, crust and surface) can be envisioned as a giant recycling machine; matter that makes up rocks is neither created nor destroyed, but is redistributed and transformed from one rock type to another.



Let us look at the rock cycle by starting at Magma. Any rock that is heated at depths may melt into magma, and later form igneous rock. Any rock that is exposed on the Earth's surface may broken into sediments, and may later become sedimentary rock. It is the physical environment that determines what type of rock is formed. If the environment of a rock changes the rock also changes.



A rock may become so altered by a change in environment that it can no longer be classified in its original family. It has changed from one family to another. Over a long period time, a single piece of the Earth's crust may be transformed into all three families of rock. Each family is linked to others in a cycle.


Magma Chamber

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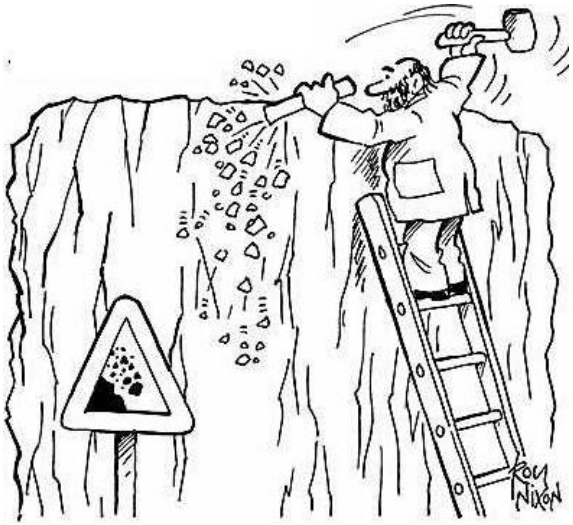
TOPIC 8: Geological Time Scale



History of Rocks

- All rocks are not the same age. Different rocks were formed at different times. Geologists have observed the "birth" of young rocks as they cooled from red-hot lava, while some of the oldest rocks on Earth are estimated to be 4 billion years old.

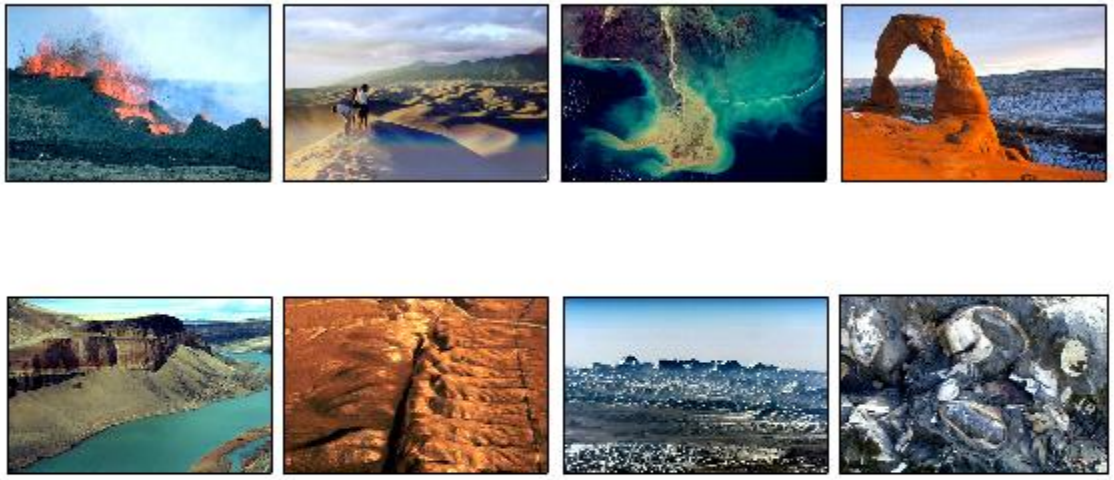
- Scientists who study the past try to put events in their proper order. When we discuss events that happened in historical times, we often use dates or numbers, but we do not have to do so.

Written records are available for only a tiny fraction of the history of Earth. Understanding the rest of the history requires detective work: gathering the evidence and making comparisons.

- Hence there are two ways of looking at the age of something.

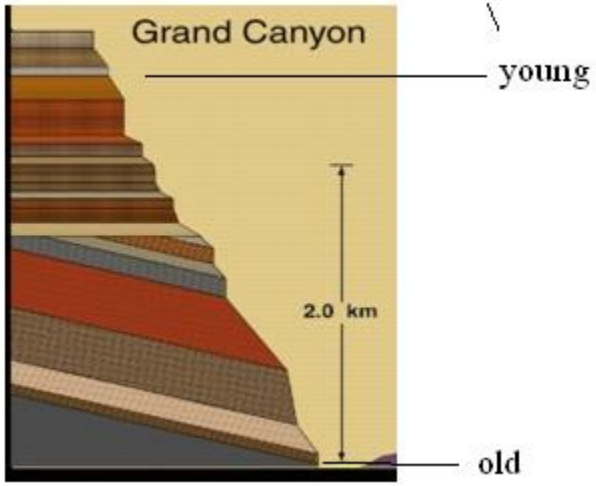
Evidence of the Past

Everywhere you look, you can find rocks that show evidence of past geologic events.



How Rocks Show Their Age

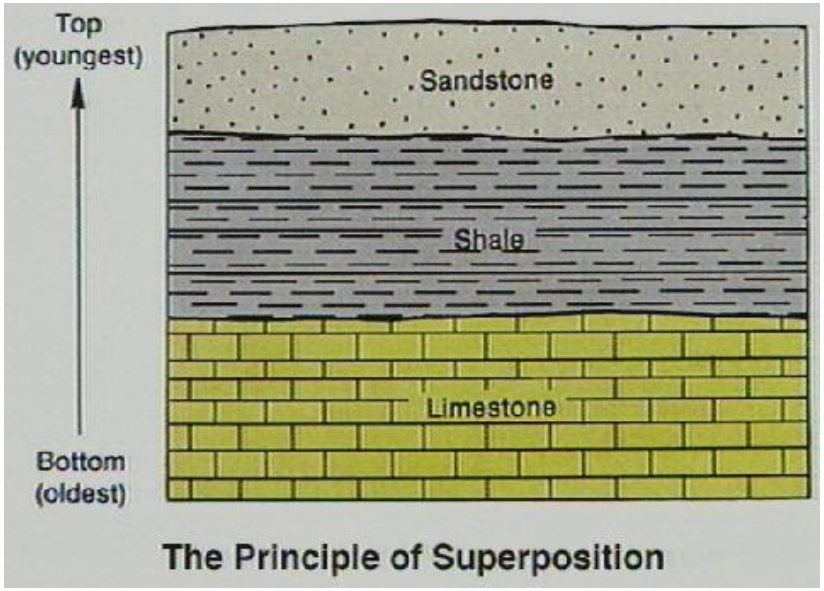
- **We know that rock is formed by deposited sediment.**



Principle of Superposition: any sedimentary rock in a horizontal section of layered rock is younger than the rock just beneath.

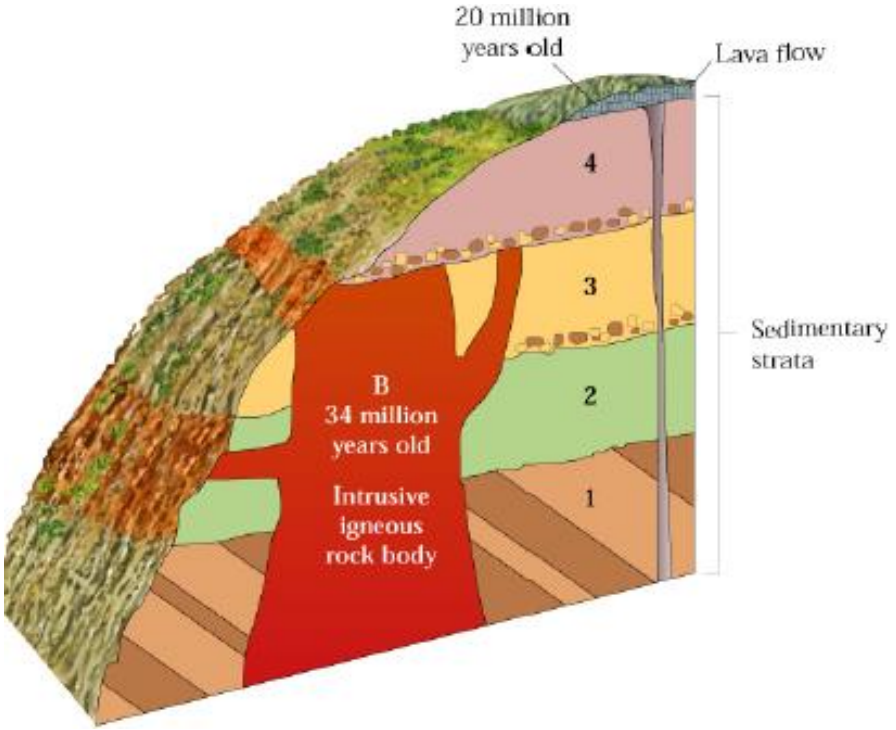
Principle of Superposition

If we stack books on top of each other, the book found at the bottom is the "oldest". Similarly, if we have layers of rock formed, producing sedimentary rock, the layer found at the bottom is the oldest, while the youngest is at the top.



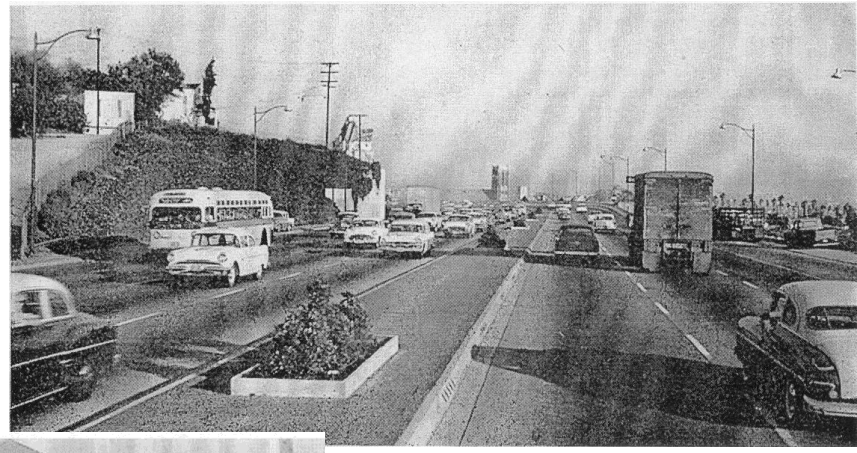
The principle of superposition is used to determine the relative ages of the layers

However, be careful of the presents of Metamorphic rock.



This diagram depicts a section of sedimentary rock that has a band of intrusive igneous rock running through it. Which rock is the youngest?.....Since the igneous rock intruded after the sedimentary rock was formed, the igneous rock is younger than the rock that surrounds it.

ACTIVITY



1) Which of the following is the oldest picture? How Do you know

Fossil Timekeepers

- **Fossils: the rock like remains or traces of an organism. A researcher by the name of William smith realized that fossils could indicate the relative age of rock.**

Fossils provide important clues to the history of the Earth and can be used to reconstruct events of the past. The fossil is buried at the time the organism dies. Only a small fraction of organisms become fossilized. The reason for this is that the process of fossilization usually works only on hard parts, such as teeth, bones, shells, and wood fibres, which many organisms do not have.

GEOLOGIST RECOGNIZE BASICALLY TWO TYPES OF FOSSILS

- 1. Body Fossils - the actual body or body parts of an organism

- 2. Trace Fossils - any evidence of past life that is not a body fossil; examples: tracks, trails, burrows borings, impressions,

Fossils

- The remains of organisms that lived long ago.
- Some of the oldest rocks and fossils are found in our province.

WAYS IN WHICH FOSSILS ARE FORMED:

1. cast: **A type of fossil made when sediment slowly fills a mould, showing the original of the organism.**

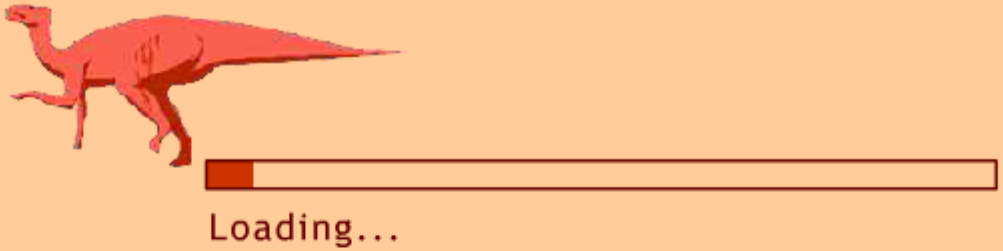
2. Petrified fossil (actual remains): when a fossil formed from minerals complete replace the original porous materials of an organism. It is the remains of plants and animals that have turned to stone

3. Actual remains preserved in ice.

4. Mould/Imprints: **is a type of fossil. It is a cavity made by an imprint of an organism or its tracks.**

5. Resin fossils: Smaller animals, such as insects, spiders and small lizards, can be trapped in resin (amber), which is secreted from trees. These fossils can be found in sandstones or mudstones or washed up on beaches like those around the Baltic Sea.

How a Dinosaur Became a Fossil




TYPES OF FOSSILS
Loading

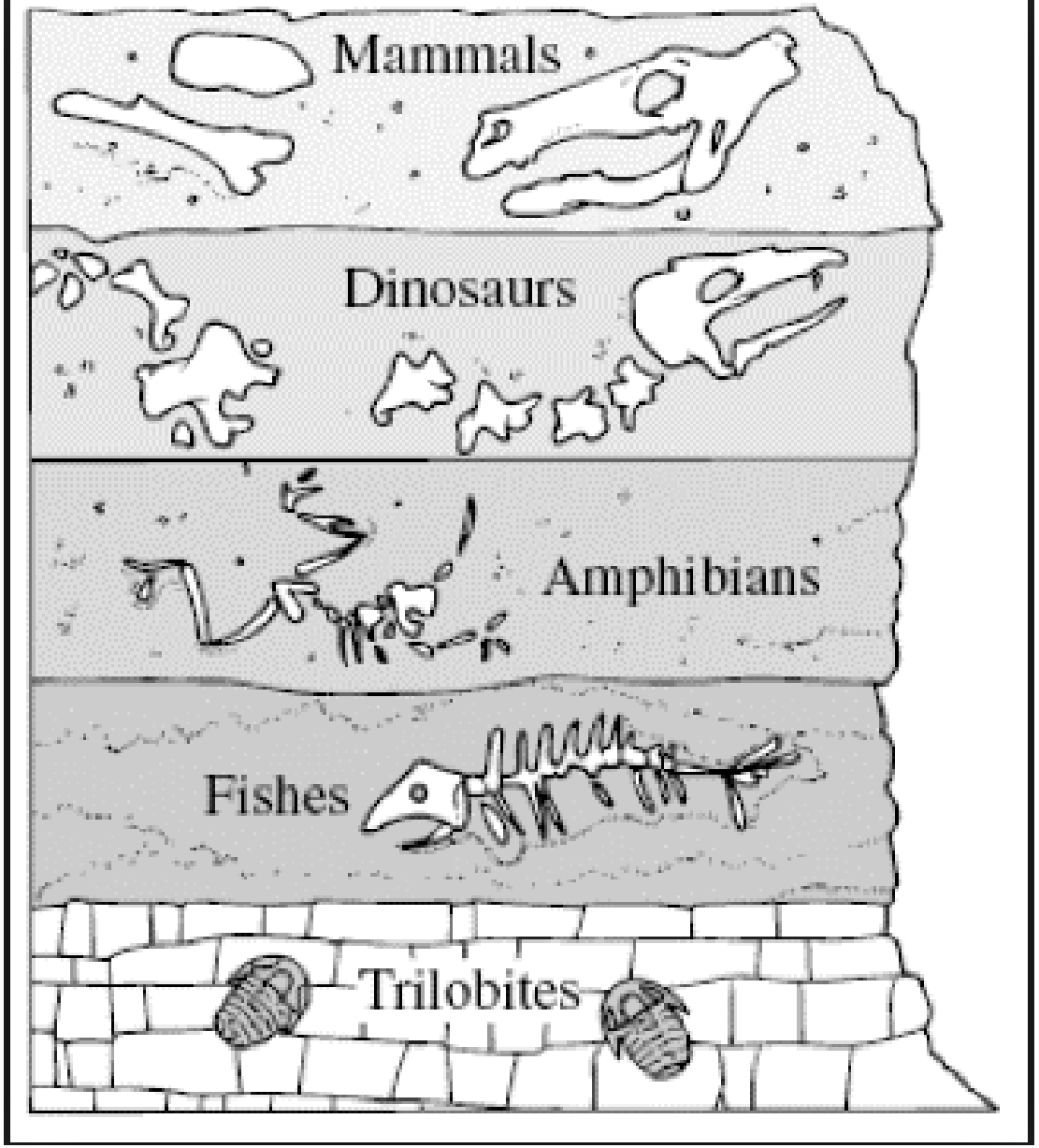
This piece of the ancient Borden Sea's delta can teach us much more about ancient life on earth.

Fossils

LOADING...

Fossils Revisited

- In the early 1800s, an English surveyor named William Smith discovered that **fossils** could be used in determining the relative age of rocks. Smith, while digging canals and tunnels, recorded the appearance of the fossils and where they were found. He came to realize that certain fossils were always formed in certain layers or areas of rock. In other words, Type A fossils always occurred above Type B, which were always found above Type C. This same sequence was found in areas many kilometres away. Therefore, by matching up similar fossils, geologists can compare the ages of rock in different locations.

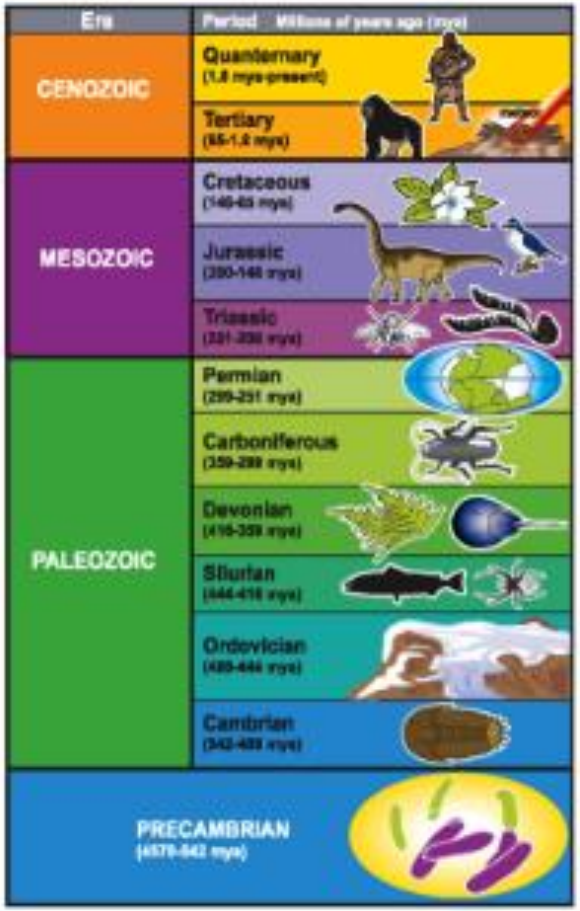

Mammals
Dinosaurs
Amphibians
Fishes
Trilobites

Geological Time Scale

- The evidence of fossils shows that different species (kinds) of organisms lived on the Earth at different times in the past. For example, **trilobites** were sea-living organisms that are commonly found in fossils, but no such organisms live in the world today.
- Geologists can study this similar sequence of fossils in areas where layers of sedimentary rock are deeply eroded such as the Grand Canyon.
- Geologists can reconstruct a history of the Earth from the evidence of rocks. This geological history of the Earth is known as the **Geological Time Scale**.
- See page 180 in text book

Geological Time Scale

- Divides Earth's history into smaller units (eras) based on the appearance of different kinds of life forms in the fossil record.

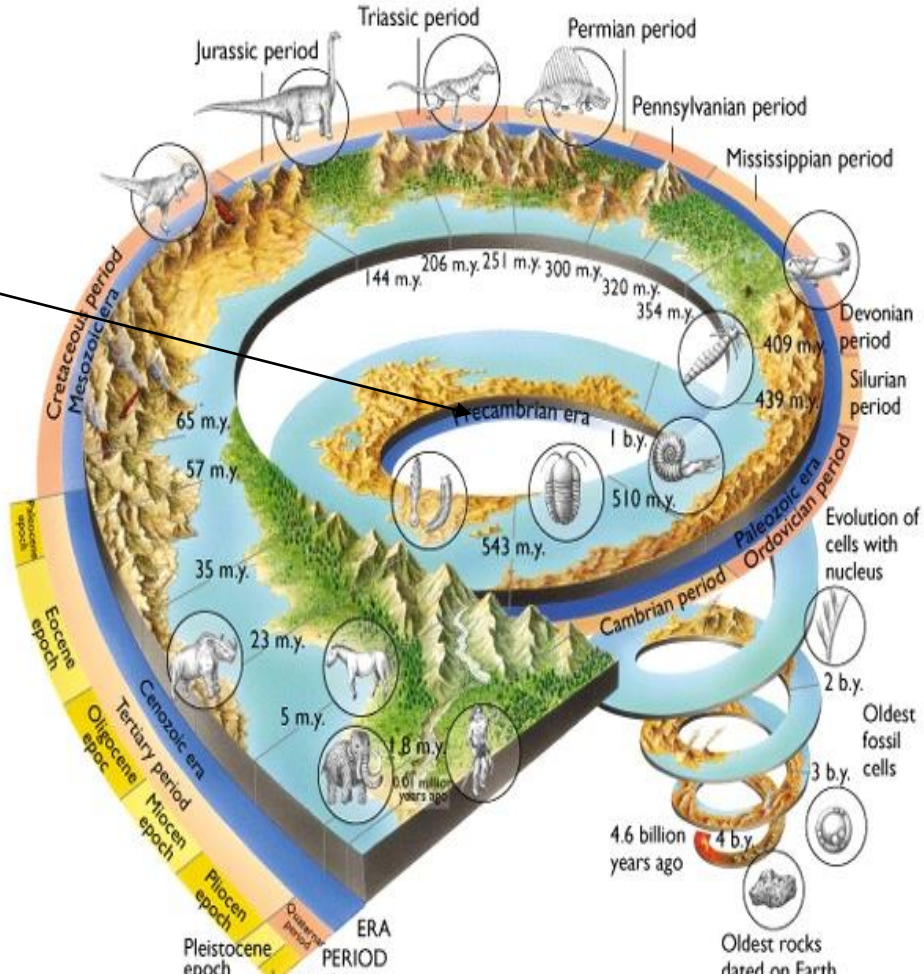


The Four Main Eras…

1. Precambrian Era

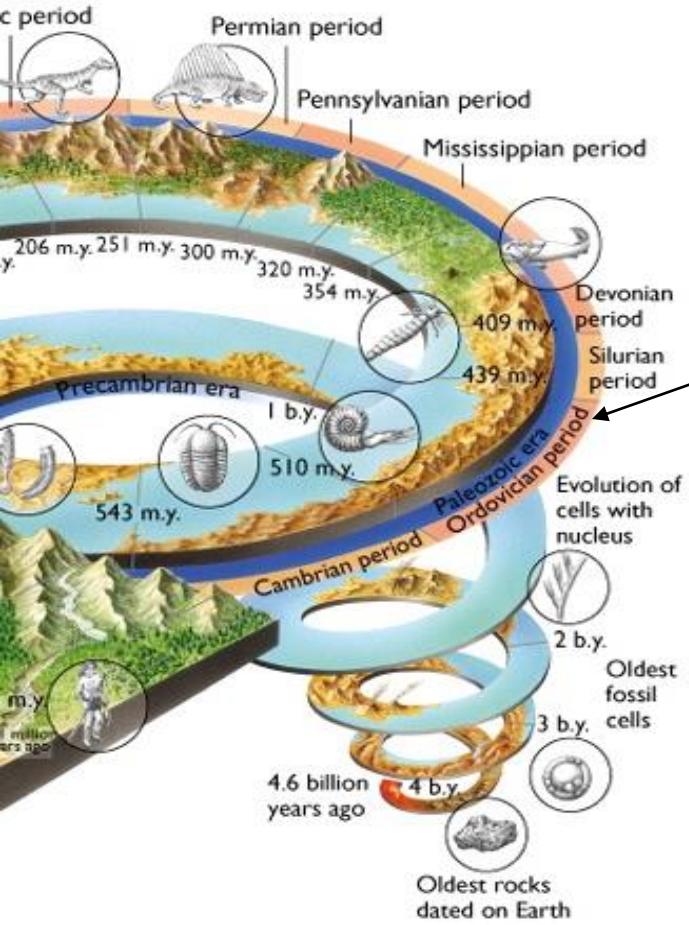
- 4600 million years ago
- Formation of the Earth and the appearance of simple life forms.
- Ex. bacteria

Pre-Cambrian



2. Palaeozoic Era

- **590 million years ago**
- **Appearance of more complex life forms.**
- **Ex. plants, amphibians and reptiles**

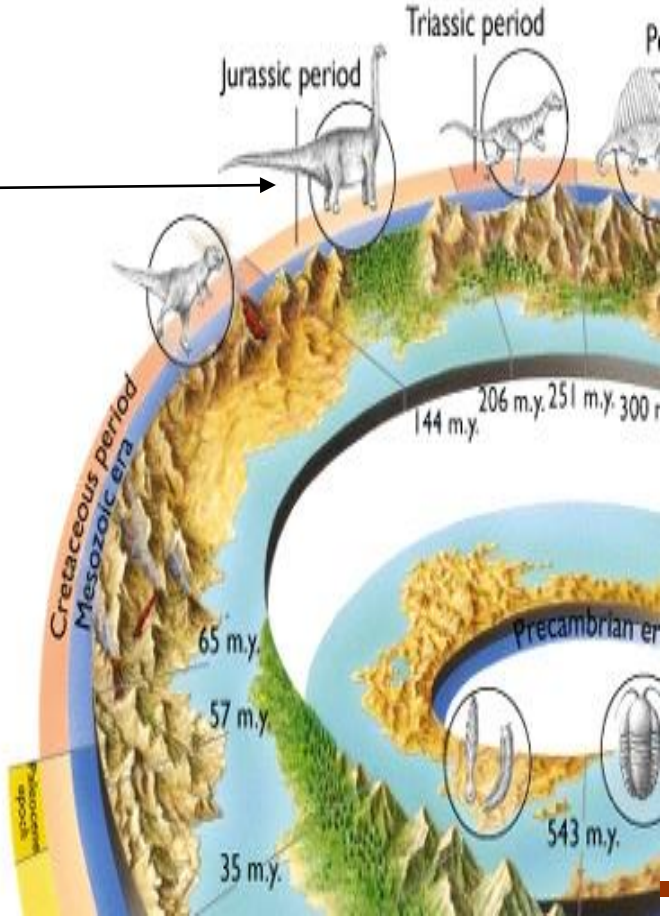


Paleozoic Era

3. Mesozoic Era

- 248 million years ago
- Appearance and extinction of dinosaurs.
- First mammals, birds and flowering plants.

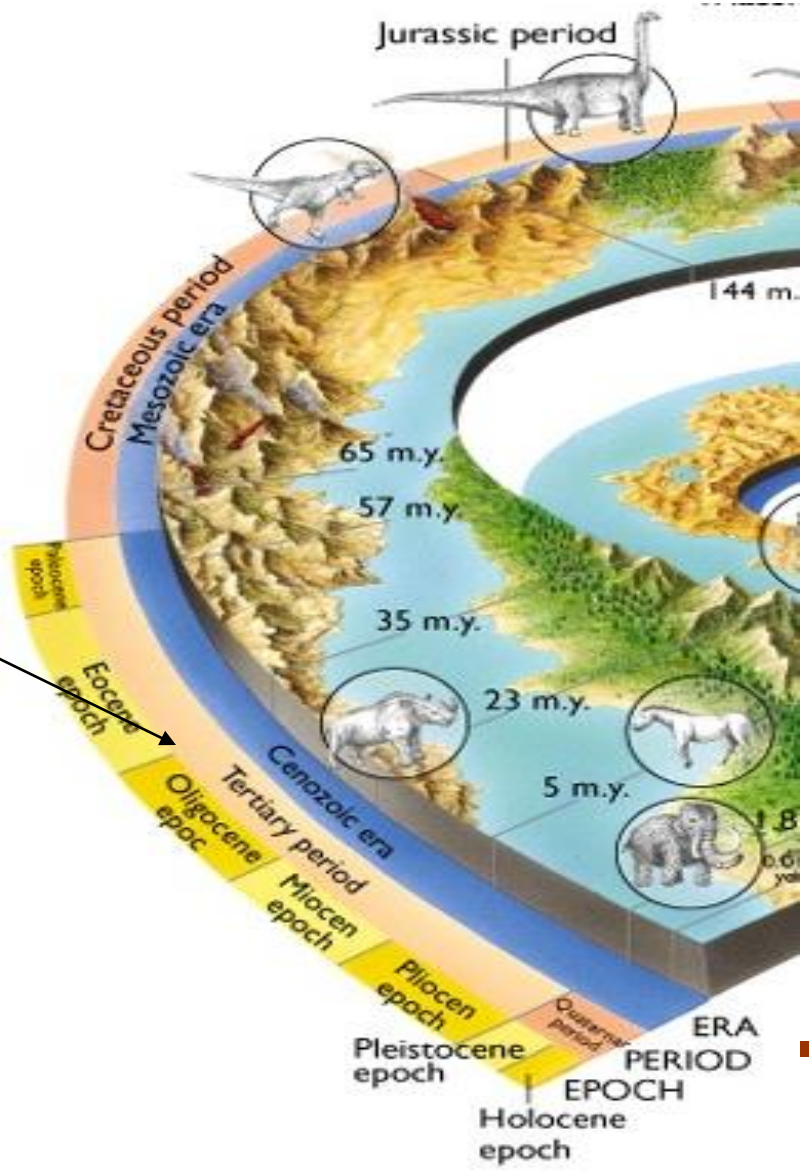
Mesozoic Era

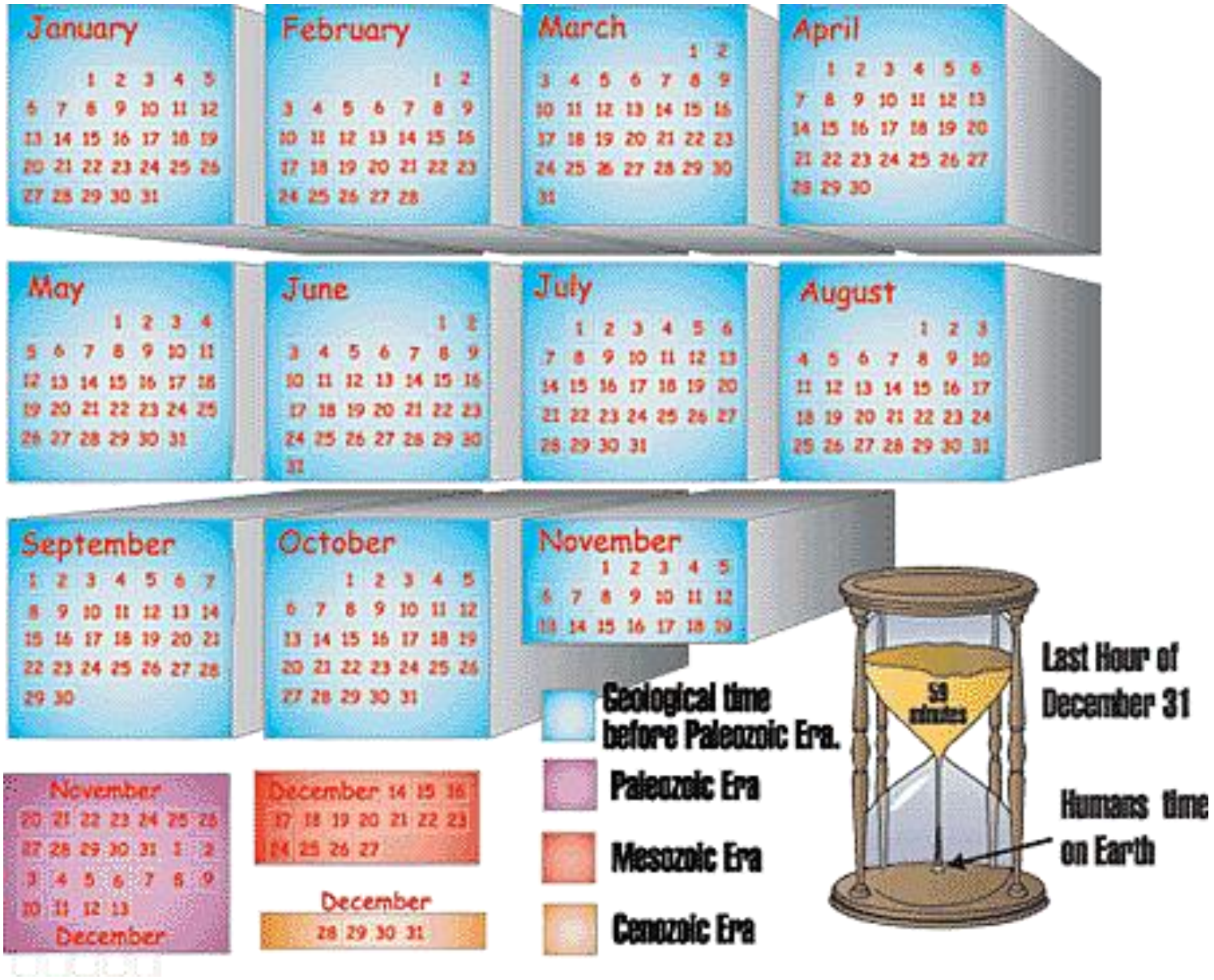


4. Cenozioc Era

- 65 million years ago to the present.
- Appearance of Humans

Cenozoic Era




January
February
March
April
May
June
July
August
September
October
November
December
Geological time before Paleozoic Era.
Paleozoic Era
Mesozoic Era
Cenozoic Era
59 minutes
Last Hour of December 31
Humans time on Earth