Chapters 5 and 6

Igneous, Sedimentary, and Metamorphic Rocks..

Objectives -Igneous

1. Identify and explain characteristics of igneous rocks.

This means that if I am given an igneous rock I…

a. Can use grain size to identify a rock as intrusive OR extrusive. In addition, I can discuss how the rate of cooling is related to grain size.
b. Can use color to identify a rock as light or dark color.
c. Can identify based on color if the rock has more silica OR iron and magnesium.
d. Can use color to determine the type of magma (high viscosity v. low viscosity) that formed an igneous rock.
e. Can explain how the addition/removal of water will change the viscosity and melting temperature of magma.
f. Discuss the factors that affect how rocks melt & crystallize
g. Describe uses of igneous rocks.

Objectives - Sedimentary

2. **Identify and explain characteristics of sedimentary rocks.**

This means that I:

a. Can describe and list in order the steps that form most sedimentary rocks: Uplift, weathering (both physical and chemical), erosion, deposition, burial, lithification, cementation
b. Understand and explain how flowing water can affect the weathering and erosion processes.
c. Can identify a sedimentary rock that fits into one of the other subgroups: organic & chemical
d. Describe uses of sedimentary rocks.

Objectives – Metamorphic

3. **Identify and explain characteristics of metamorphic.**

This means that I

a. Can identify a rock into a metamorphic subgroup: foliated vs. non-foliated
b. Explain the formation of metamorphic rocks and link the formation process to heat and/or pressure.

Objectives – Rock Cycle

4. Understand how rocks continuously change from 1 type to another in the rock cycle.

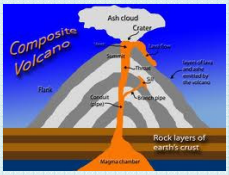
This means I can:

a. List, describe, and explain the processes and steps needed to turn an existing rock into 3 different rock types.
b. Follow a rock's change from one type to another (including movement between the Earth's interior and surface)

5. I can classify a given rock sample into:

a. One of the 3 main types of rock described above: **igneous, sedimentary or metamorphic** by using unique characteristics and/or processes that formed the rock.

Igneous Rock Definitions



- Igneous Rocks: Rocks formed from the cooling & crystallization of magma or lava
- Magma = molten rock found BELOW Earth's surface
- Lava = molten rock that reaches & flows ONTO Earth's surface

Magma

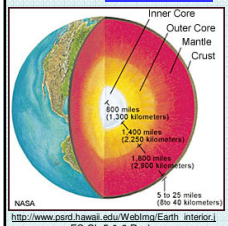
1. Origin of Magma:

A. Melting: The1st process in the formation of igneous rocks. Rocks must be melted

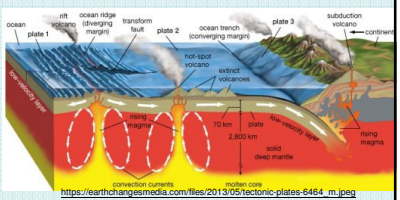
B. Hot enough temperatures are found in the upper mantle and lower crust

C. What heats the upper mantle & lower crust?

- Heat left in core from Earth's formation, & from pressure
- Radioactive decay of elements in mantle



http://www.psrd.hawaii.edu/WebImg/Earth_interior.jpg

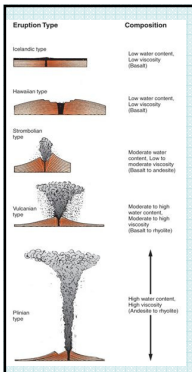


https://earthchangesmedia.com/files/2013/05/tectonic-plates-6464_m.jpeg

Classification of Magma

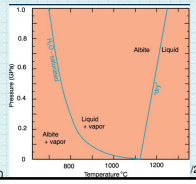
Magma Type	Color of Rock Formed	Amount of Silicon & Oxygen	Amount of Iron & Magnesium	Viscosity of Magma	Volcanic Explosiveness
Rhyolitic	Light	Lots	Little	High viscosity (thick)	More Explosive Sudden & doesn't last long Very little magma flow
Basaltic	Dark	Little	Lots	Low viscosity (flows easily)	Less Explosive Magma flows faster Flows for longer period of time

Water's Effect on Magma



When the water content of rocks increases:

1. Melting point decreases
2. Magma viscosity decreases
3. Magma explosiveness increases because:
   A. Water turns to gas in the hot magma
   B. If the water vapor can't escape from the magma, pressure builds up causing an explosion.
   C. Water vapor is the most abundant gas in magma



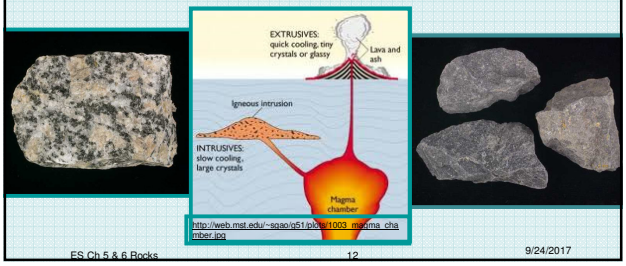
Pictures of Mineral Composition & Size

Main Observations for Igneous Rock Identification

1. Color: light vs. dark
2. Grain size: fine vs. coarse

Location of Igneous Rock Formation

1. **Extrusive** rocks: Fine / small –grained igneous rocks that rapidly cool on Earth's surface
2. **Intrusive** rocks: Coarse / large grained rocks due to slow cooling below the surface
   A. Example: The most common intrusive rock is granite



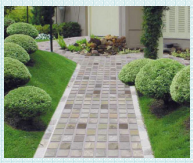
http://web.mst.edu/~sgao/g51.ipod/1003_magma_chamber.jpg

Igneous Rocks as Resources

1. Building materials: They are strong & resistant to weathering – (example – granite)








Obsidian & Pumice

2. **Obsidian:** "Black glass"
   A. Cooled so fast that very fine or no crystals are formed: EXTRUSIVE
3. **Pumice:** 50% holes due to escape of trapped gas
   A. Used for abrasive polishing mixtures & cleansers


http://geology.com/rocks/pictures/obsidian-380.jpg


http://www.kidsloverocks.com/assets/images/Obsidian-Arrowhead-320.jpg


http://hendrix2.uoregon.edu/~imamura/102/images/Density_of_pumice_and_obsidian.jpg


http://img.webmd.com/dtmcms/live/webmd/consumer_assets/site_images/articles/health_tools/pedicure_slideshow/age_rf_photo_of_pumice_stone.jpg

Videos to use AFTER Viscosities of Magma Lab

Intro to Magma; Discovery's Exploring Magma Chamber,1min 43s
https://www.youtube.com/watch?v=KtexwZeUk7w

MAGMA LAB Part #4 "Explosiveness": Magma Viscosity, Gas Content, & Milkshakes, 5min 15sec:
https://www.youtube.com/watch?v=2iaqE0xmsHI

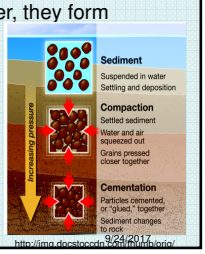
What is a Volcano? 2min 10 sec (Types of Volcanoes & Magma):
https://www.youtube.com/watch?v=zJgwNqzumL8

Composite Volcano 1min 52sec (Pompeii & Mt. Vesuvius):
https://www.youtube.com/watch?v=1u1Ys4m5zY4

Shield Volcano, 2min 5sec - Hawaii & world's most active volcano:
https://www.youtube.com/watch?v=byJp5o49IF4

Sedimentary Rock Overview

1. Most sedimentary rocks are formed when sediments are pressed & cemented together
2. **Sediments** = Little pieces of solid material (pieces of rocks, shells, minerals that precipitate out of water, etc.) that have been deposited on Earth's surface
   i. This can happen by wind, water, ice, gravity, or chemical precipitation
3. As the sediments get "**cemented**" together, they form sedimentary rocks



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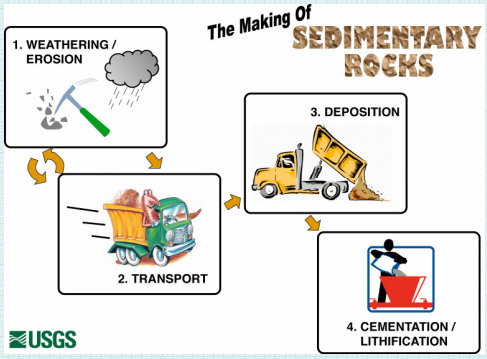
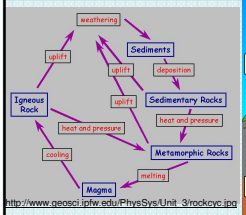
Processes/Steps to Form Sedimentary Rocks



http://education.usgs.gov/images/schoolyard/Overview.jpg

Uplift

1. **Uplift:** Rocks must be brought up to Earth's surface before the rest of the processes in the formation of sedimentary rock can occur.



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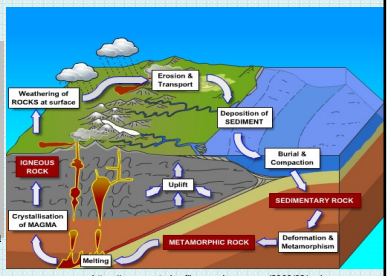
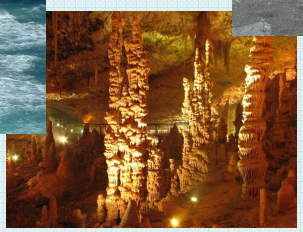


https://voyagerstories.files.wordpress.com/2009/02/rock-cycle.jpg

Weathering

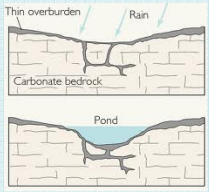
2. **Weathering**: Breaking down, wearing away & loosening of rocks into sediments (which vary in size)
   A. There are two types of weathering
      i. Chemical
      ii. Mechanical/Physical





Chemical Weathering

A. Causes include:
- i. Dissolving of rocks by acid rain
- Chemicals that change minerals in the rock (example: rusting)



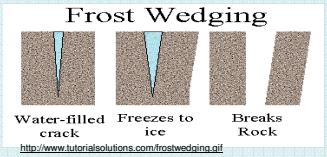

http://images.nationalgeographic.com/wpf/media-live/photos/000/021/cache/arches-sandstone-formations_2102_600x450.jpg


http://www.ladytorch.com/images/statuelibertycoppergreen.jpg

Mechanical/Physical Weathering

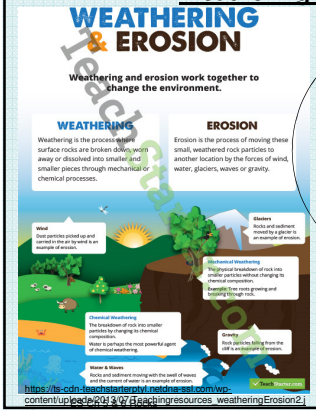
B. Mechanical/Physical causes rock to break into smaller pieces without changing the chemical make-up of the rocks.

Causes include:
- Waves (and length of time in moving water)
  - The longer it moves, the smaller it is
- frost wedging (AKA freeze & thaw)
- tree roots
- crystal growth



http://www.tutorialsolutions.com/frostwedging.gif

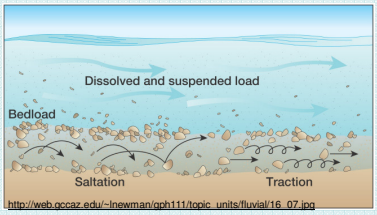
What is the Difference between Weathering & Erosion?



https://ls-cdn-teachstarterpyl.netdna-ssl.com/wp-content/uploads/2013/07/Teachingresources_weatheringErosion2.j

Erosion

3. **Erosion**: Movement or transport of sediments to new locations
   A. Possible means: Wind, moving water, gravity, glaciers
   B. How can you tell how far a rock piece has traveled?
      i. If it is moved a SHORT distance, the rock pieces still have pointed or jagged edges
      ii. The FARTHER it travels, the rock edges will become more rounded as it bounces along

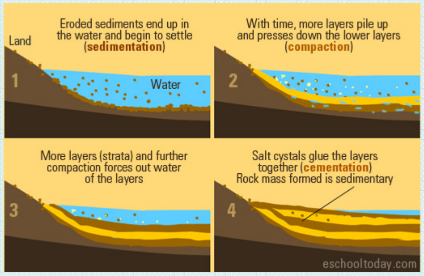


http://web.gccaz.edu/~lnewman/gph111/topic_units/fluvial/16_07.jpg

Deposition & Burial

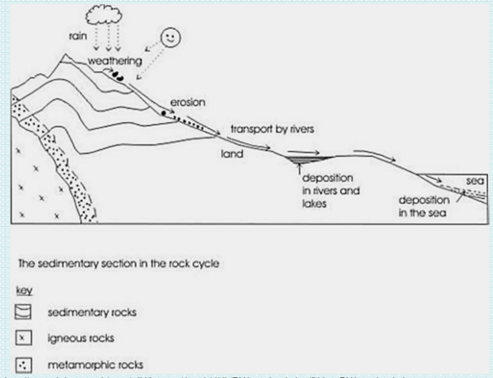
4. Deposition: The process of settling out or precipitation of sediments on the ground or bottom of bodies of water

5. Burial: Becomes covered or buried beneath more & more sediments


Land
Eroded sediments end up in the water and begin to settle (sedimentation)
Water
1
With time, more layers pile up and presses down the lower layers (compaction)
2
More layers (strata) and further compaction forces out water of the layers
3
Salt cystals glue the layers together (cementation) Rock mass formed is sedimentary
4
eschooltoday.com

http://www.eschooltoday.com/rocks/images/sedimentary-rocks-formation-process.png

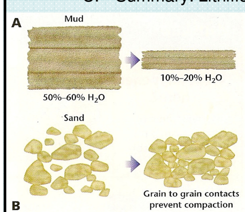
Sedimentary Process Overview

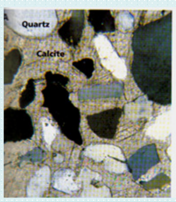


http://www.ukrigs.org.uk/esos/wiki/images/thumb/d/db/PH6_sedcycle.jpg/500px-PH6_sedcycle.jpg

Lithification

6. **Lithification** = Process that transforms sediments into sedimentary rocks.
   - Lithification means "making of stone" and has 2 parts
     - **A. Compaction**: Bottom layers of sediment are pressed TIGHTLY together by the pressure & weight of upper sediment layers
     - **B. Cementation**: Sediments are "cemented" or glued together by minerals in the water that crystalize.
     - C. Summary: Lithification turns sediments into sedimentary ROCK





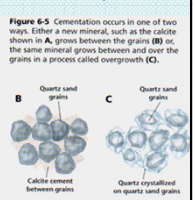
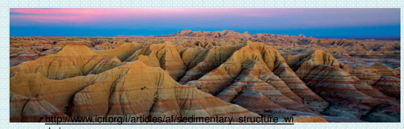


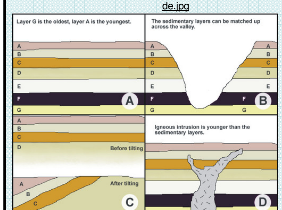
Figure 6-5 Cementation occurs in one of two ways. Either a new mineral, such as the calcite shown in A, grows between the grains (B) or, the same mineral grows between and over the grains in a process called overgrowth (C).
B
C
Quartz sand grains
Calcite cement between grains
Quartz crystallized on quartz sand grains

Features of Sedimentary Rocks

1. Layers



http://www.icr.org/i/articles/af/sedimentary_structure_wide.jpg



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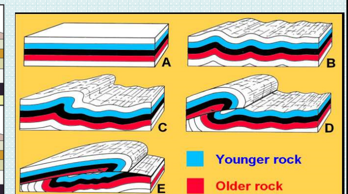
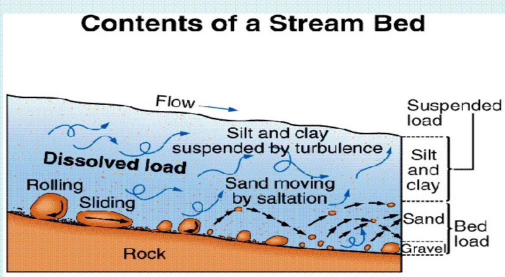


http://regentsearth.com/ILLUSTRATED%20GLOSSARY/Glossary%20Pix/Overturning.jpg

Features of Sedimentary Rocks

2. Sedimentary rocks usually form in water
3. Sedimentary rock is the most common rock on the SURFACE (not in the crust) of Earth



http://www.personal.kent.edu/~sclement/dynamics/rivers/rivers4.jpg

Features of Sedimentary Rocks

4. Fossils May Be Present

A. Fossil = preserved remains OR evidence of once-living organisms

B. Only found in sedimentary rocks. WHY? ________

C. During lithification, parts of organisms are replaced by minerals and turned into rocks

3 Main Groups of Sedimentary Rocks

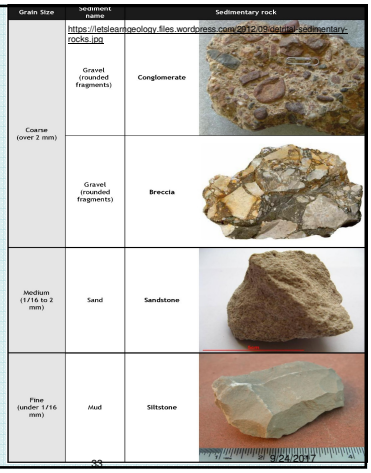
1. Most Common (AKA Clastic)
2. Organic
3. Chemical

Sec 6.2 – 3 Main Groups of Sedimentary Rocks

1. Most Common (AKA Clastic) 2. Organic 3. Chemical

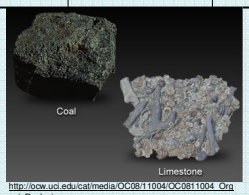
Sedimentary Rock Type	Made from	Subtypes & examples
Most Common (AKA Clastic)	Loose Sediments: broken rock pieces	**3 subgroups based on grain size**: 1.Large-grained: A. Due to high water flows & speeds which can carry large pieces. i. Example high energy water: floods, mountain streams, ocean waves 2.Medium-grained: Sand-sized grains A.Valuable reservoirs of oil, natural gas & groundwater 3.Fine-grained: A. These are made of sediments smaller than sand B. Only deposits in non-moving water

Most Common (AKA Clastic) Sedimentary Rocks



3 Main Groups of Sedimentary Rocks Table

Sedimentary Rock Type	Made from	Subtypes & Examples
Organic	Once living things	1. **ORGANIC** Limestone: shells 2. Coal: rock from buried swamp plants
Chemical	Evaporation - minerals left behind when water evaporates	**Example: CHEMICAL** limestone 1. Coastlines of the ocean, Dead Sea, or Great Salt Lake



http://ocw.uci.edu/cat/media/OC08/11004/OC0811004_OrganicRocks.jpg

http://www.dnr.mo.gov/geology/images/calciticlimestonel g.jpg

Organic Sedimentary Rocks

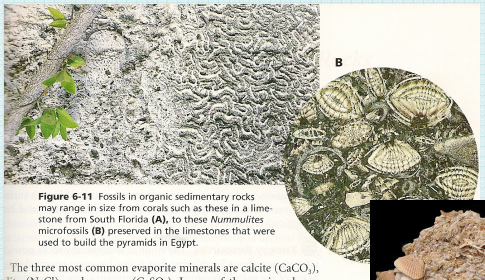
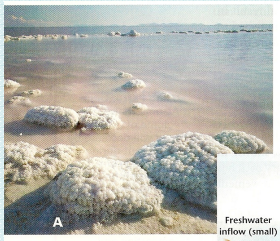


Figure 6-11 Fossils in organic sedimentary rocks may range in size from corals such as these in a limestone from South Florida **(A)**, to these *Nummulites* microfossils **(B)** preserved in the limestones that were used to build the pyramids in Egypt.

The three most common evaporite minerals are calcite ($CaCO_3$), halite ($NaCl$), and gypsum ($CaSO_4$). Layers of these minerals are

http://www.proprofs.com/quiz-school/user_upload/ckeditor/anastasia(2).jpg

Chemical Sedimentary Rock at Great Salt Lake



the concentration of dissolved minerals remains high.

As more dissolved minerals are carried into the basins, evaporation continues to remove freshwater and maintain high mineral concentrations. Over time, thick layers of evaporite minerals can accumulate on the basin floor, as illustrated in ***Figure 6-10B.***

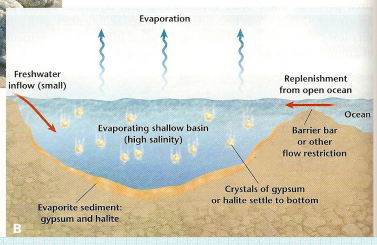
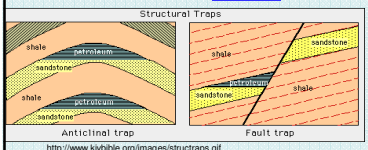


Figure 6-10 Evaporation of water from the Great Salt Lake, Utah, has resulted in salt precipitation on these boulders **(A).** The process of evaporite formation is illustrated in **B.**

Uses of Sedimentary Rocks

1. Energy
   - A. Coal
   - B. Reservoir for oil & gas when porosity (open space) present
2. Limestone to make cement



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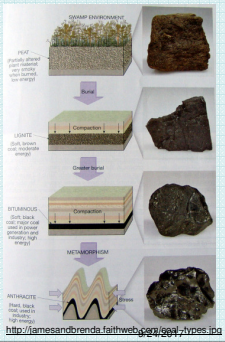
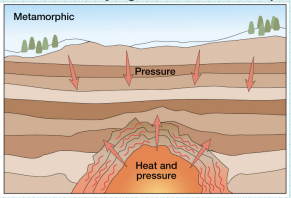


http://jamesandbrenda.faithweb.com/coal-types.jpg

Metamorphic Rocks

1. Rocks that change form while remaining solid

2. **Method of Formation:**
   - A. Pressure and Temperature increase with depth
   - B. Temperature and pressure combine to alter the rock **WITHOUT MELTING** (If it melts, igneous rock is formed)
   - C. Hot temperature is due to Earth's internal heat
   - D. Pressure comes from overlying rocks or tectonic plate movement

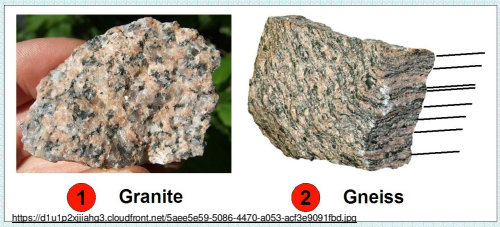


Metamorphic Rock Classification

3. Types of Metamorphic Rocks
   - A. Foliated
   - B. Non-Foliated

Types of Metamorphic Rock

A. Foliated Metamorphic Rocks have visible crystal layers or elongated (flattened) mineral crystals
   - i. Lines may be straight or wavy
   - ii. The minerals in these rocks have been squeezed into parallel layers by intense pressure



https://d1u1p2xjjiahq3.cloudfront.net/5aee5e59-5086-4470-a053-acf3e9091fbd.jpg

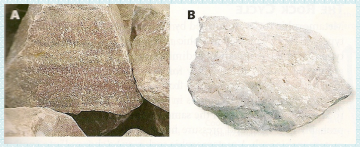
Types of Metamorphic Rocks

B. Non-foliated Metamorphic Rocks – Rocks that do NOT have distinct layers or bands of crystals
   - i. The majority of these are formed by extreme heat (NO MELTING!!)

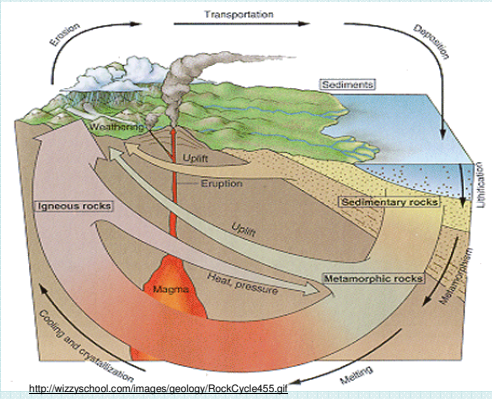
http://www.marble.com/articles/wp-content/uploads/2010/03/Limestone-big.jpg

http://www.nwnature.net/cam/science/rocks/web_rocks/marble2.jpg

Foliated v. Non-Foliated



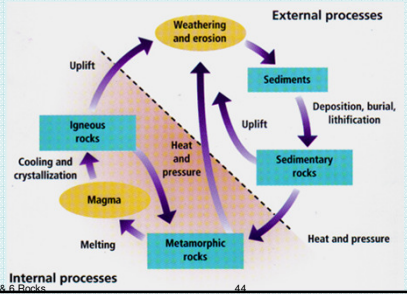
The Rock Cycle



http://wizzyschool.com/images/geology/RockCycle455.gif

The Rock Cycle

1. Is the continuous changing & remaking of rock
2. The type of rock that results is based on how new rock type is formed.
3. Describe how an igneous rock could change into:
   i. Metamorphic Rock:
   ii. Sedimentary Rock:
   iii. Igneous Rock:



The End!! ☺

Lab Slides, Study Table & Extensions Follow

TT #13 & Table 6-1 p122 Clastic Classification

Table 6-1 Classification of Clastic Sediments

Particle Size	Sediment		Rock
> 256 mm	Gravel	Boulder	Conglomerate
256–64 mm		Cobble	
64–2 mm		Pebble	
2–0.062 mm	Sand		Sandstone
0.062–0.0039 mm	Silt		Siltstone
<0.0039 mm	Clay		Mudstone or shale

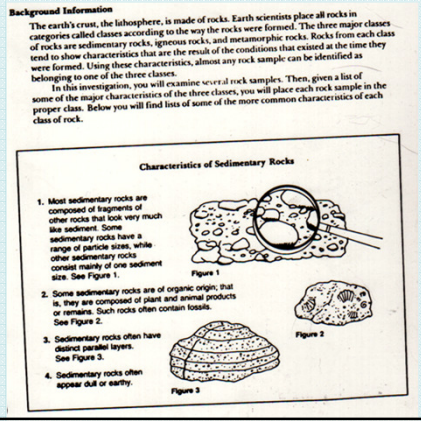
TT #14 & Table 6-2 p128 Sedimentary Classification

Table 6-2 Classification of Sedimentary Rocks

Rock Type	Rock Name	Method of Formation
Clastic		
Coarse grained	Conglomerate or breccia	Lithification of clastic sediments
Medium grained	Sandstone	
Fine grained	Shale	
Organic		
Calcium carbonate–shells	Limestone	Accumulation and lithification of remains of living things
plant matter	Coal	
Chemical		
Calcite	Evaporite	Precipitation of dissolved minerals from water
Halite		
Gypsum		

Lab: Classifying Rocks, Instructions

NOTE: These diagrams are in the note packet. Good summary of differences between the 3 types of rock. Use to study for exam in preparation for rock sample questions.

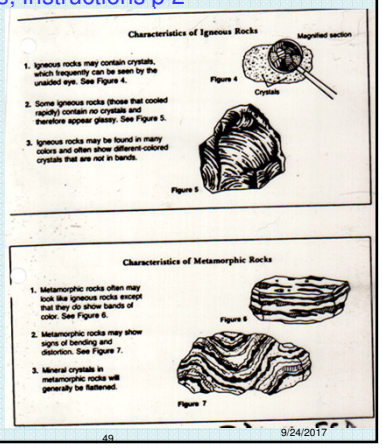


Lab: Classifying Rocks, Instructions p 2

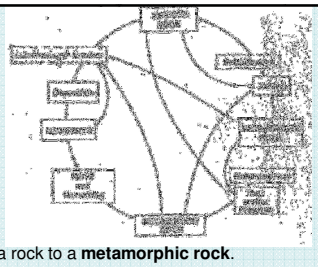
Use magnifying glass.

In addition, if identified as: (Write at top of table)

1. Sedimentary- classify as
   - A. clastic, organic or chemical
2. Igneous-list both of the following
   - A. Felsic, intermediate or mafic
   - B. Intrusive or extrusive



Rock Cycle Examples



1. Examples:

- Heat and pressure may change a rock to a **metamorphic rock**.
  - Using the diagram above, what type of rock may be changed into a new metamorphic rock? _____
- Melting followed by crystallization will change a rock to an **igneous rock**.
  - Using the diagram above, what type of rock may be changed into a new igneous rock? _____
- Uplift, weathering, erosion, deposition, burial and lithification will form a **sedimentary rock**.
  - Using the diagram above, what type of rock may be changed into a new sedimentary rock? _____

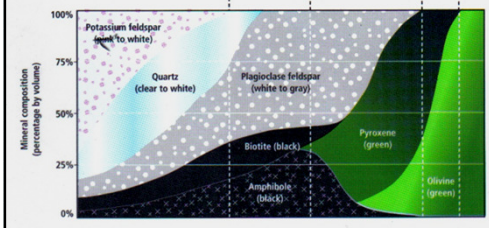
Review of Metamorphic

1. **What are the 2 types of Metamorphic Rock?**
2. **Classify each of the rocks below into one of those 2 types.**
3. **What are the 2 processes that cause metamorphic rock?**
4. **Which 1 of th3 2 processes most involved in each rock below? Evidence?**

TT #12 & Table 5-2 p. 107 Classification of Igneous Rocks

Table 5-2 Classification of Igneous Rocks

	Felsic	Intermediate	Mafic	Ultramafic	Texture
Extrusive	Obsidian		Basaltic glass		Glassy (non-crystalline)
	Rhyolite	Andesite	Basalt		Fine-grained
Intrusive	Granite	Diorite	Gabbro	Peridotite, Dunite	Coarse-grained
	Pegmatite				Very coarse-grained



Which category rock (felsic, intermediate…) would it be if it contains:

7%olivene
20% feldspar
70% pyroxene
3% amphibole

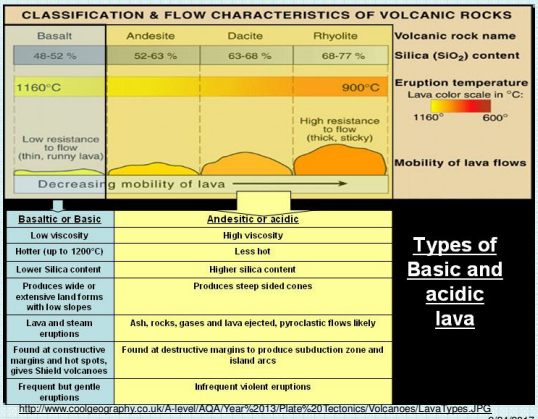
Website for Clicker Review:

Clicker Review http://studyjams.scholastic.com/studyjams/jams/science/rocks-minerals-landforms/rock-cycle.htm

Clicker Review
http://www.learner.org/interactives/rockcycle/testskills.html

Video: Khan Academy http://www.khanacademy.org/partner-content/mit-k12/mit-k12-biology/v/rock-cycle

Magma Viscosity by Location



http://www.coolgeography.co.uk/A-level/AQA/Year%2013/Plate%20Tectonics/Volcanoes/LavaTypes.JPG