Rocks and Minerals

I. Minerals

A. **A mineral is** (1) naturally occurring (2) inorganic (3) solid that has a (4) definite chemical composition and (5) crystal structure

1. naturally occurring:
   a. minerals - quartz, pyrite
   b. not minerals - cement, steel
2. inorganic: not formed from living things or the remains of living things
   a. coal is NOT a mineral because it comes from plants
   b. amber is NOT a mineral because it comes from tree sap
   c. pearls is NOT a mineral because it comes from oysters

ESRT Pg. 16

3. Definite chemical composition:

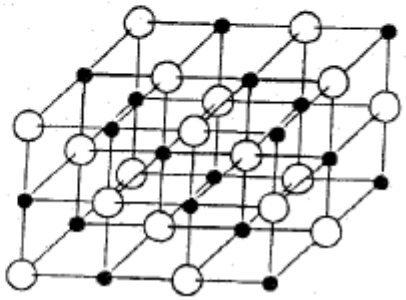
Name of Mineral	Chemical Formula	Chemical Name	Elements and No.atoms/Molecule
halite	NaCl	sodium chloride	1 sodium 1 chlorine
quartz	SiO_2	silicon dioxide	1 silicon 2 oxygen
pyrite	FeS_2	iron sulfide	1 iron 2 sulfur
hematite	Fe_2O_3	iron oxide	2 iron 3 oxgyen
magnetite	Fe_3O_4	iron oxide	3 iron 4 oxygen
calcite	$CaCO_3$	calcium carbonate	1 calcium 1 carbon 3 oxygen
graphite	C	carbon	1 carbon
diamond	C	carbon	1 carbon
sulfur	S	sulfur	1 sulfur

4. solids – have a definite size/volume and a definite shape.

oil is NOT a mineral because it is a liquid

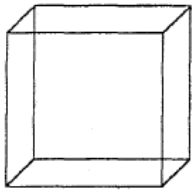
5. Crystal Structure:

atoms are arranged in repeating geometric patterns



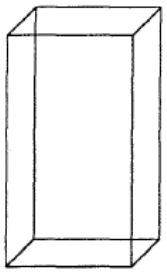
The six basic crystal systems:

CUBIC or ISOMETRIC



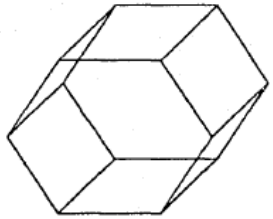
Galena, Halite, Pyrite

TETRAGONAL



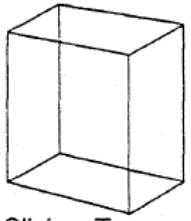
Chalcopyrite

HEXAGONAL



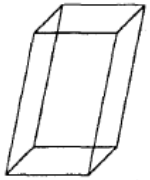
Quartz, Calcite

ORTHORHOMBIC



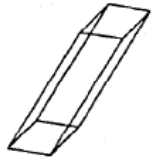
Olivine. Topaz

MONOCLINIC



Mica, Gypsum

TRICLINIC

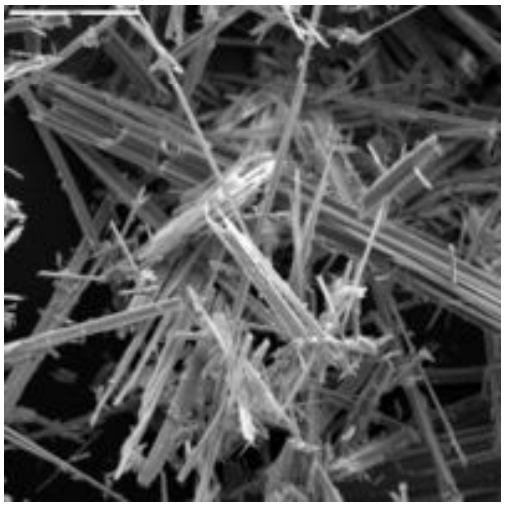


Feldspar, Turquoise

B. Formation of Minerals-

1. from cooling lava/magma

2. When water evaporates, dissolved minerals settle out -called "precipitates"



Mineral growth

Giant Crystal Caves

II. **Identifying Minerals** – minerals can be identified by their physical and/or chemical properties.

A. Physical Properties

1. Color-

a. Some minerals have only one color:

(1) malachite - green

(2) sulfur - yellow

b. Other minerals have many colors:

(1) quartz - clear, pink (rose), purple (amethyst), white (milky), grey-brown (smoky), etc.

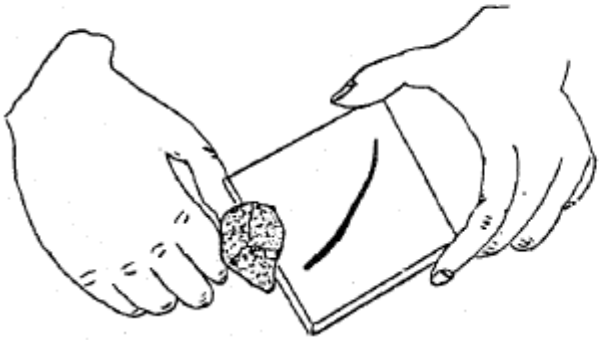
(2) hematite - black, grey, reddish brown, dark red

c. Color can vary as the result of:

(1) Natural coloring agents - impurities

(2) Weathering – exposure to the environment (air, temp changes, pollution)

2. Streak- the color of the powder when a mineral is rubbed on a streak plate



a. Hematite – Colors: dark red, reddish brown, gray, black

Streak: reddish-brown

b. Quartz - Colors: colorless, variety of colors

Streak: white/colorless

3. **Luster-** the way a mineral shines or reflects light from its surface

a. Metallic - looks like gold or silver

examples: galena, pyrite, graphite, magnetite

b. Nonmetallic - does NOT look like a metal

(1) pearly - mica

(2) glassy - quartz, halite

(3) dull, earthy - bauxite

(4) waxy - talc

(5) brilliant - diamond

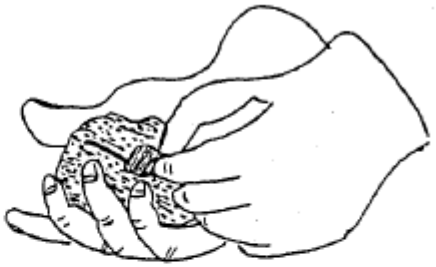
4. Hardness - a measure of how easily a mineral can be scratched

a. Softest mineral - talc

b. Hardest mineral - diamond

c. Moh's Hardness Scale

NUMBER	NAME OF MINERAL
1	talc
2	gypsum
3	calcite
4	flourite
5	apatite
6	feldspar
7	quartz
8	topaz
9	corundum
10	diamond



HARDNESS OF COMMON OBJECTS

2.5 fingernail

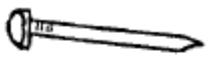
3.5 copper

4.5 iron nail

5.5 glass

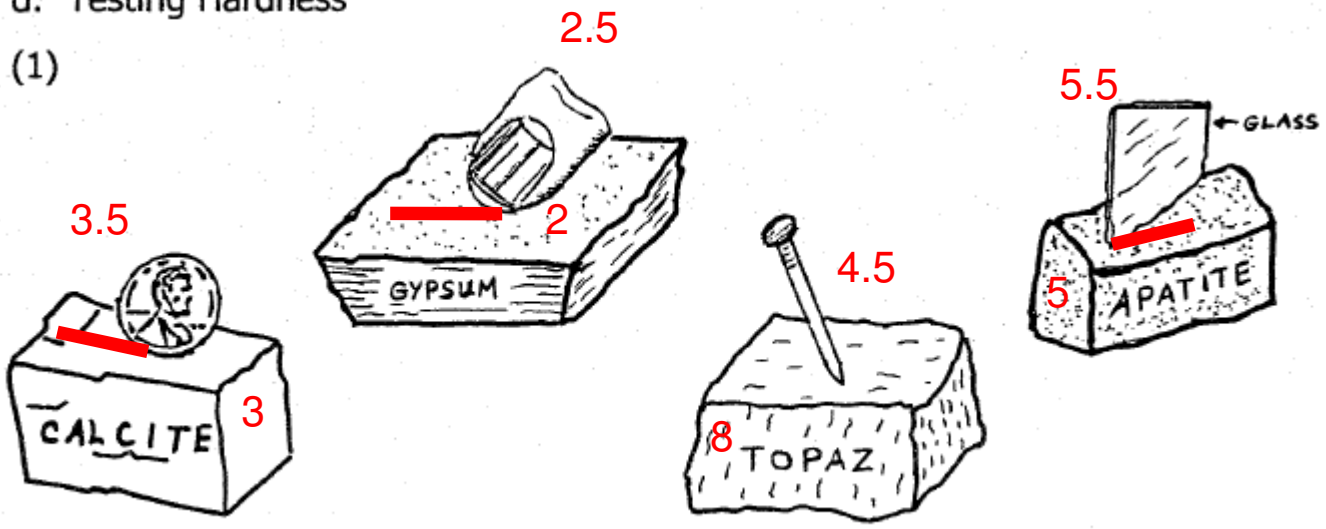
6.5 steel file

7 streak plate



d. Testing Hardness

(1)



yes yes no yes

(2) (a) Will the mineral fluorite, hardness 4, be scratched by:

a piece of glass? yes

your fingernail? no

an iron nail? yes

(b) Will the mineral quartz, hardness 7, be scratched by:

a piece of glass? no

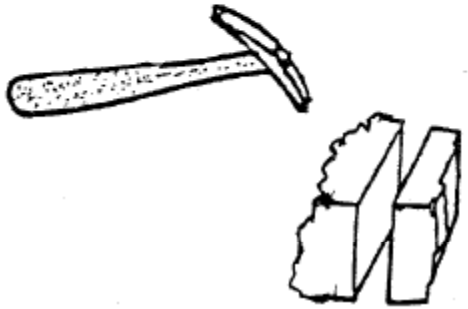
a copper penny? no

a steel file? no

Pages 5 & 6

e. What determines Hardness? - the mineral's internal arrangement of atoms

5. Cleavage and Fracture –



a. Cleavage - when a mineral splits along smooth, flat surfaces

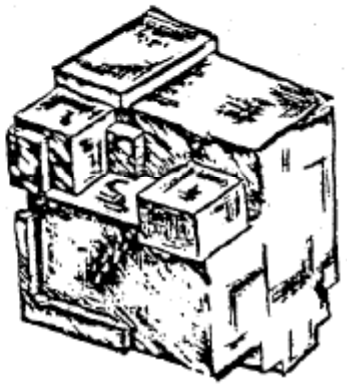
(1) examples of cleavage:

(a)The mineral mica cleaves in

one direction(s).

(b)The mineral galena cleaves in

three direction(s).



(2) What determines cleavage?

internal structure/ bonds of atoms

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(3) Cleavage should NOT be confused with crystal shape. Cleavage is a property of the way a mineral breaks, while crystal shape is a property of the way a mineral grows. When minerals have plenty of space to grow, they form crystals.

b. Fracture - when a mineral breaks along curved or irregular surfaces

(1) examples of minerals that show fracture:

sulfur, bauxite, hematite, quartz

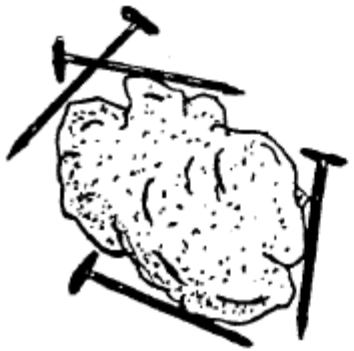
6. **Density or Heft –** due to the kinds of atoms a mineral contains, and how closely packed the atoms are, different mineral samples of the same size have different densities and feel heavier or lighter when lifted (or measured). A piece of gold has 8 times as much mass as a piece of halite that is the same size.

B. Chemical Properties

Calcite reacts with hydrochloric acid. It forms bubbles of carbon dioxide gas.

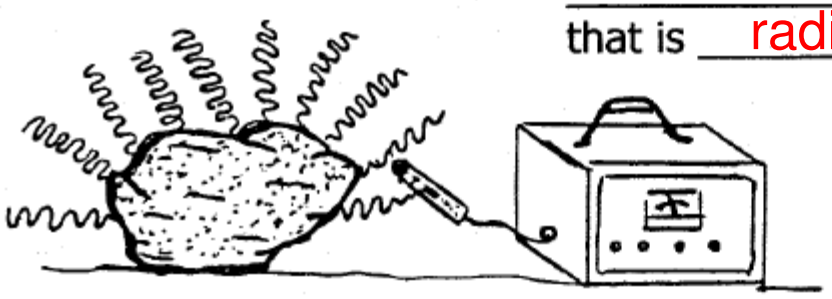
$CaCO_3 + 2HI \quad CaCl_2 + H_2O + CO_2$

C. Special Properties –



Lodestone, a form of the mineral magnetite, is naturally magnetic

Iceland spar, a form of the mineral
calcite, produces
double refraction.

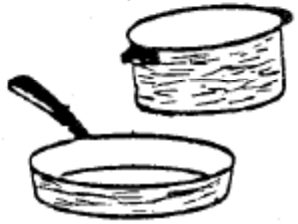
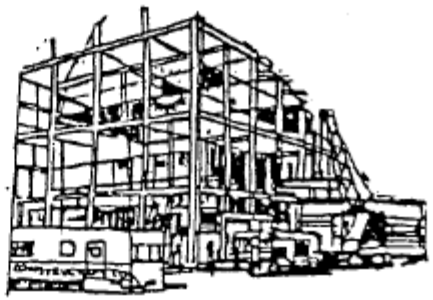


Pitchblende is an example of a mineral
that is radioactive.

III. Uses of Minerals

A. Ore – a mineral that contains metals and nonmetals that can be mined or removed in usable amounts for a profit

1. Metals – elements that have shiny surfaces and are able to conduct heat and electricity
   a. examples

	METAL	MINERAL(S)	USE
1.	iron	hematite Fe_2O_3	 
		magnetite Fe_3O_4	 

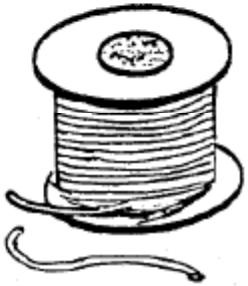
2. aluminum

bauxite
$\underline{Al}(OH)_3$
$\underline{Al}O(OH)$
$H\underline{Al}O_2$

3. copper

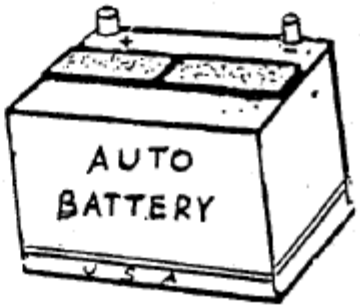
chalcopyrite
$\underline{Cu}FeS_2$

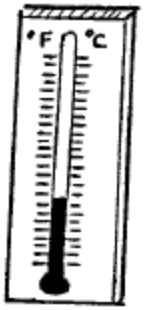
malachite
$\underline{Cu}_2CO_3(OH)_2$



4. lead

galena
$\underline{Pb}S$



METAL	MINERAL(S)	USE
5. silver	argenite AgS_2	
6. gold	gold Au	
7. mercury	cinnabar HgS	

Alloys

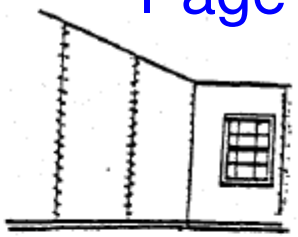
b. Alloy - a mixture of two or more metals or a mixture of metals and nonmetals.

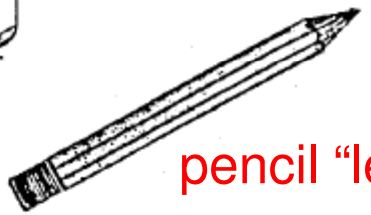
1. tin + copper → bronze
2. copper + zinc → brass
3. iron + chromium + limestone → steel
4. lead + tin → pewter

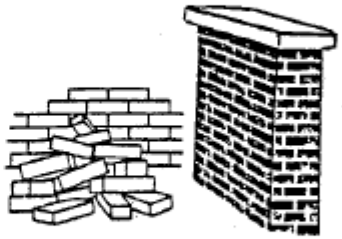
2. Nonmetals – elements that have dull surfaces and are poor conductors of heat and electricity.

	MINERAL(S)	USE
a.	Halite	 table salt

	MINERAL(S)	USE
b.	Gypsum	wallboard
c.	Sulfur	matches
d.	Talc	
e.	Graphite	pencil “lead”
f.	Kaolinite	bricks
g.	Calcite	cement







B. GEMS – minerals that have the following desirable qualities:

Hardness, color, luster, clarity, durability, rarity

1. precious stones - diamonds, rubies, sapphires, emeralds
2. semiprecious stones - amethyst, garnet, topaz
3. gems that are NOT minerals - pearls, amber

Birthstone Gems

JANUARY: Garnet  *faith*	FEBRUARY: Amethyst  *peace*	MARCH: Aquamarine  *love*	APRIL: Diamond  *virtue*
MAY: Emerald  *wealth*	JUNE: Pearl  *beauty*	JULY: Ruby  *passion*	AUGUST: Peridot  *dignity*
SEPTEMBER: Sapphire  *clarity*	OCTOBER: Opal  *purity*	NOVEMBER: Citrine  *hope*	DECEMBER: Blue Topaz  *strength*

Select month to view collection.

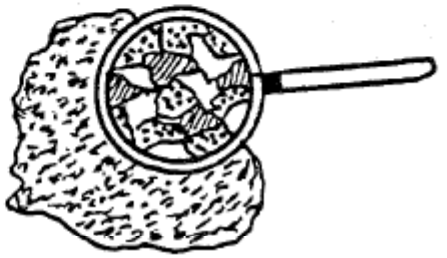
Petrology - the branch of science that studies rocks.

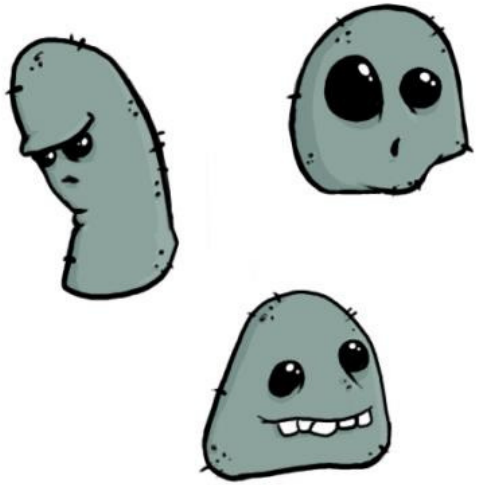
I. CLASSIFICATION OF ROCKS

A. Rocks are classified on the basis of their formation/origin

B. The three groups of rocks are:

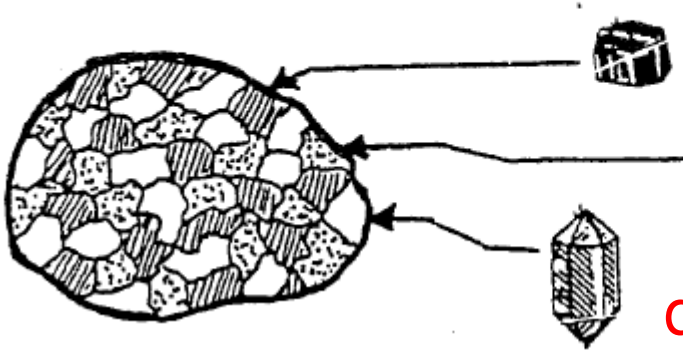
1. sedimentary
2. igneous
3. metamorphic





II. ROCKS IN RELATION TO MINERALS

A. Many kinds of rocks are composed of minerals

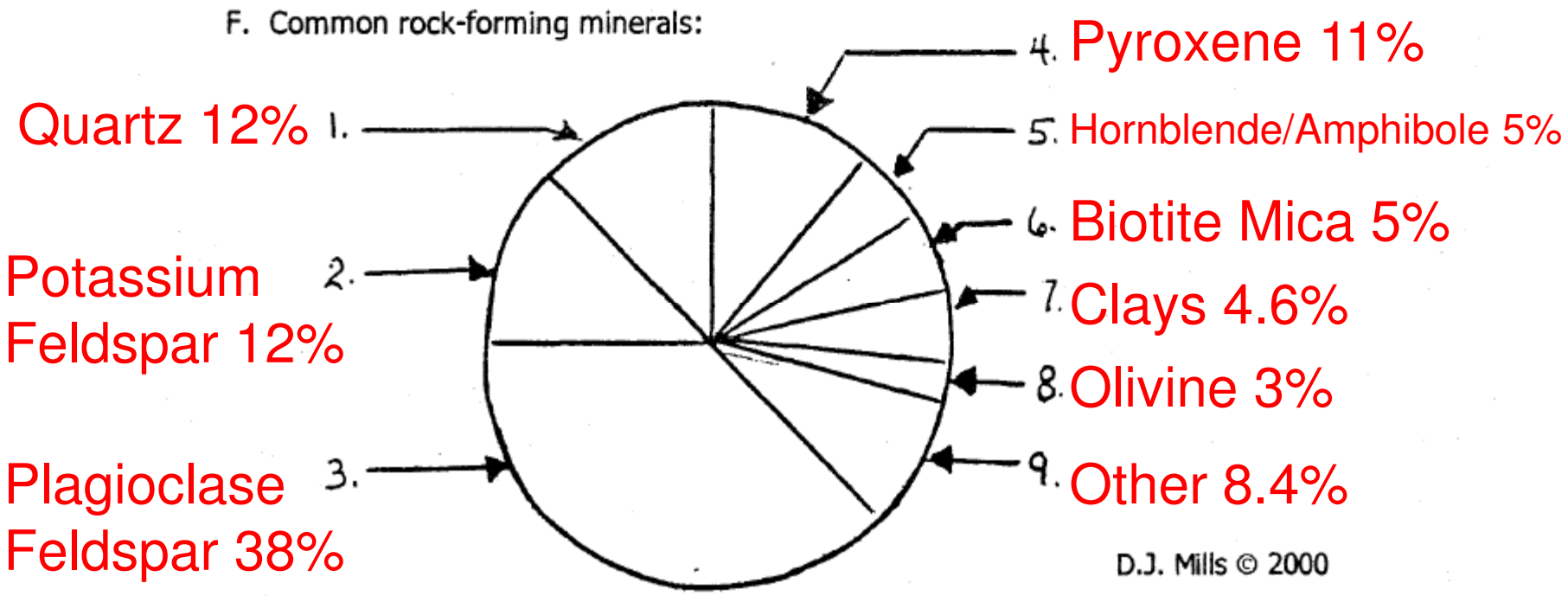


B. Some rocks are monomineralic - composed of only one mineral (limestone → calcite)

C. Most rocks are polymineralic - composed of two or more minerals (granite)

D. LETTERS:WORDS::MINERALS:ROCKS

E. There are almost 3000 types of minerals, but only 8 of these minerals (mineral families) make-up 90 % of the rocks of Earth's crust.


F. Common rock-forming minerals:
Quartz 12%
1.
Potassium Feldspar 12%
2.
Plagioclase Feldspar 38%
3.
4. Pyroxene 11%
5. Hornblende/Amphibole 5%
6. Biotite Mica 5%
7. Clays 4.6%
8. Olivine 3%
9. Other 8.4%
D.J. Mills © 2000

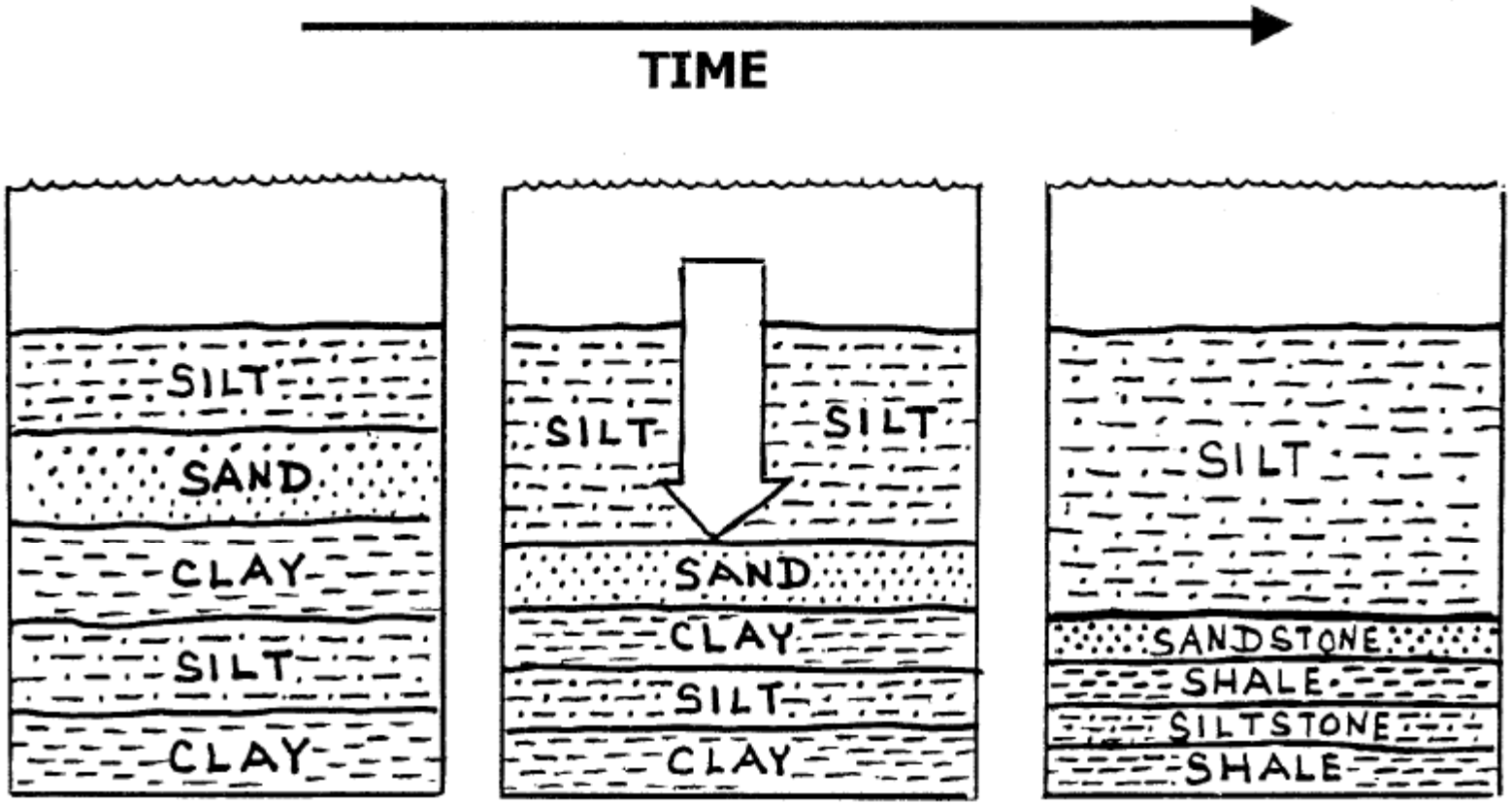
Sedimentary Rock Video

III. SEDIMENTARY ROCKS

A. Rocks that usually form in layers from the accumulation of sediments, organic matter, or chemical precipitates

1. Most sedimentary rocks are made-up of solid sediments that have been weathered from other rocks. The weathered sediments are then eroded (transported) b water, wind, and moving ice. Eventually the eroded sediments are deposited at new locations either in water or on land. Most sedimentary rocks form in layers underwater in lakes, seas or oceans.

2. From sediments to rocks:



layers of sediments deposited and acculumulate

pressure + weight squeezes lower layers

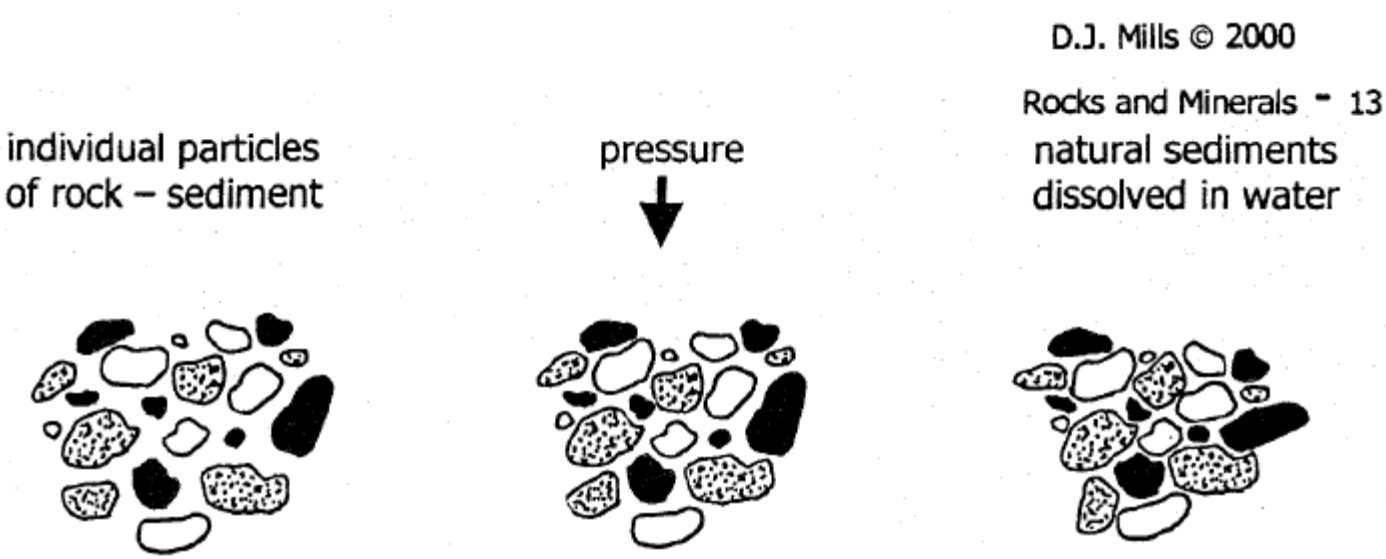
sediment compacted into rock

B. Types of Sedimentary Rocks

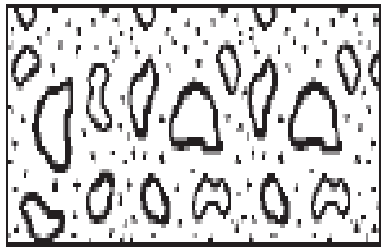
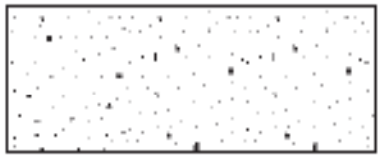
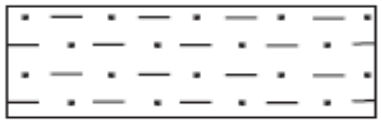
1. CLASTIC - form from rock particles/sediments that are pressed and cemented together

a. compaction – pressed by weight of overlying rock

b. cementation – glued by natural cement in water (calcite)



c.

ROCK NAME	GRAIN SIZE (CM)	COMMENT	MAP SYMBOL
conglomerate	boulders 25.6 / cobbles 6.4 / pebbles 0.2	Various size rock Particles and mud Silt and sand cemented together	
sandstone	sand .006	Fine to coarse grains cemented together	
siltstone	silt .0004	very fine grained	
shale	clay	compact, may split easily	

Clastic Rocks

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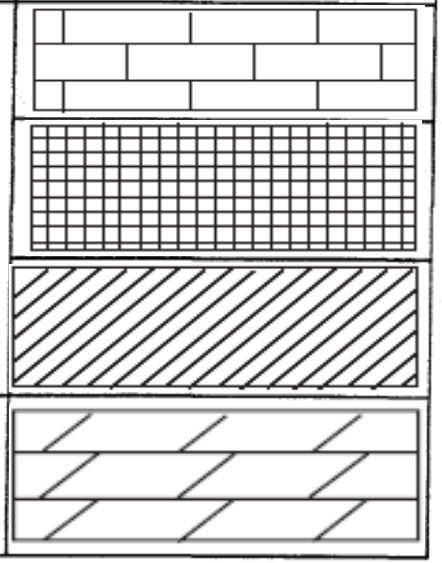
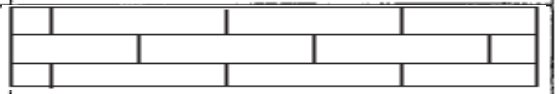
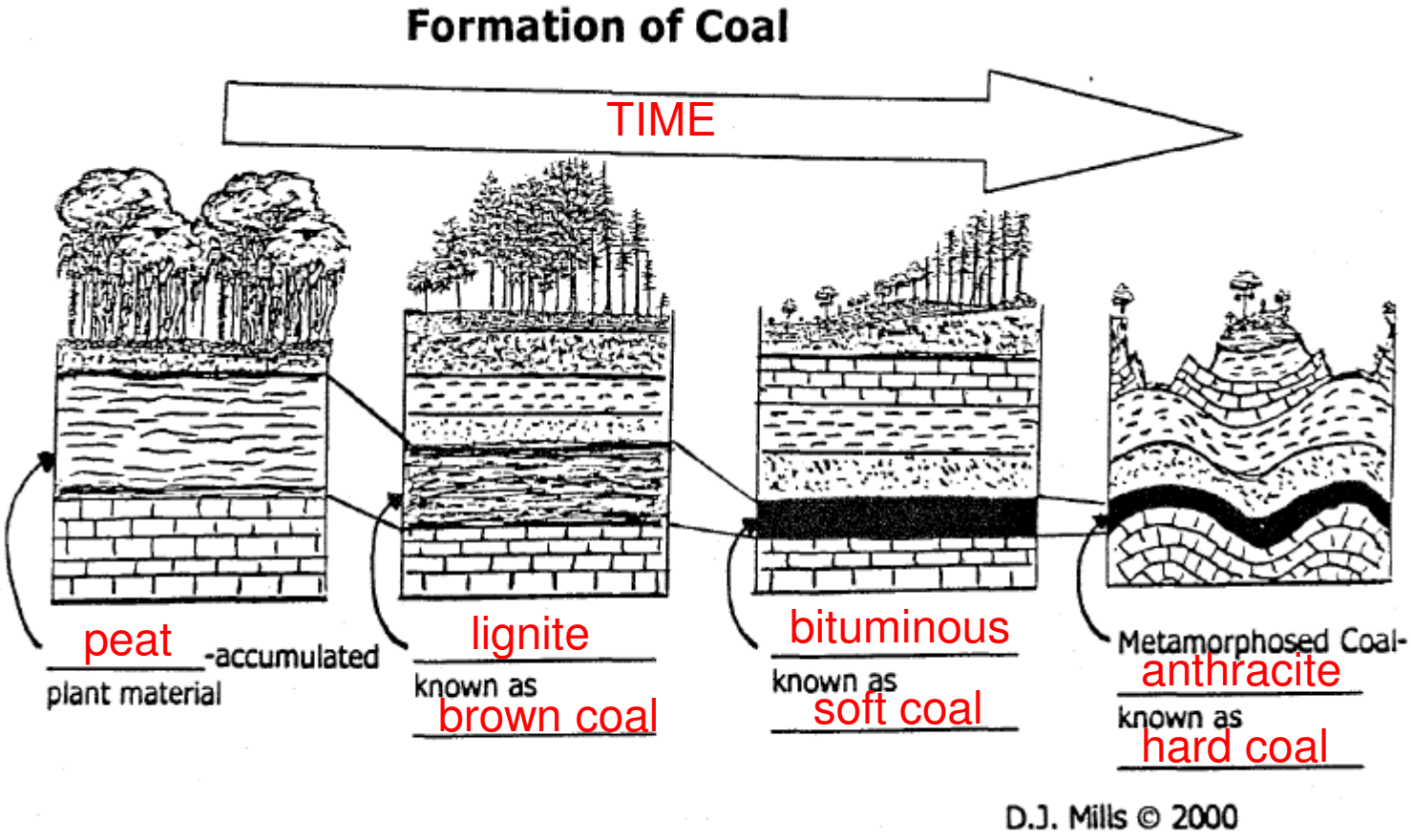
2. Chemical - form from dissolved minerals in water that settle-out (precipitate)

(Dissolved mineral left behind when water evaporates)

ROCK NAME	COMPOSITION	COMMENT	MAP SYMBOL
limestone	calcite	Minerals dissolved in water precipitate out and forms as crystals on the sea floor Includes evaporites	
rock salt	halite		
rock gypsum	gypsum		
dolostone	dolomite	Changed form of limestone	

3. Organic - form from the accumulation of plant and/or animal matter that undergoes a transformation into rock

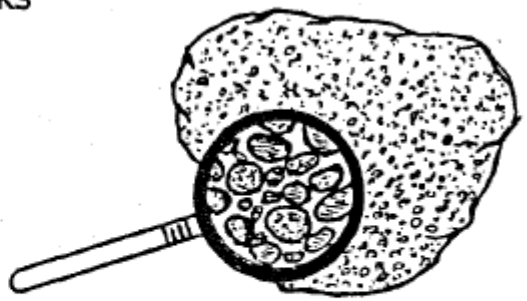
ROCK NAME	COMPOSITION/COMMENT	MAP SYMBOL
limestone	Cemented shell fragments	
coal	Carbon from plant remains	



Coal formation

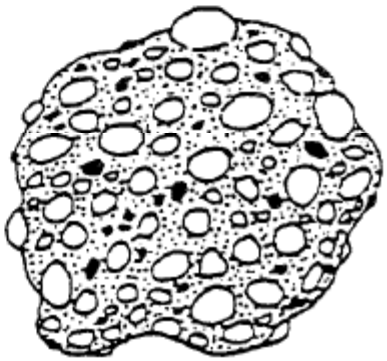
C. Important characteristics of sedimentary rocks
   1. They are composed of rock fragments or organic particles.

sediments →



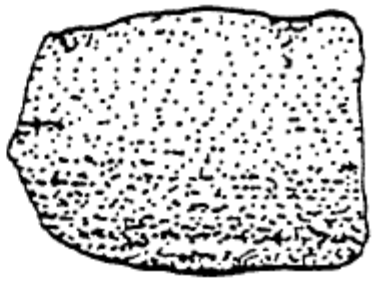
   a. Some have a range of particle or sediment size

conglomerate →



   b. Others consist mainly of one size of sediments – due to sorting during deposition

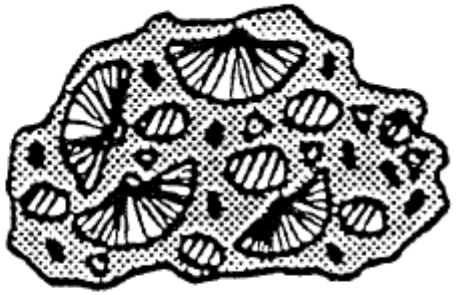
sandstone →



2. Some are organic – they form from plant and animal remains

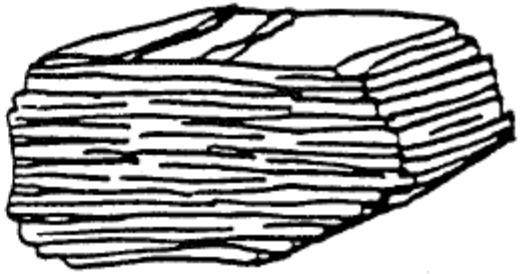
fossils

fossil limestone →



3. form in layers called strata or beds

shale →



Igneous Rock Video

IV. IGNEOUS ROCKS

A. Forms from the cooling and solidification (crystallization) of molten lava and magma

1. When molten(liquid) lava or magma ___cools___ and ___solidifies___, crystals of different minerals form the rock.
   a. The rock contains a crystalline structure of intergrown crystals of different ___sizes___, ___shapes___ and ___composition___
   b.

Crystallization

B. Types of Igneous Rocks

1. Extrusive/Volcanic -
- forms from the **fast** cooling of lava near the Earth's surface
- **small** or **no** crystals
- smooth/fine texture

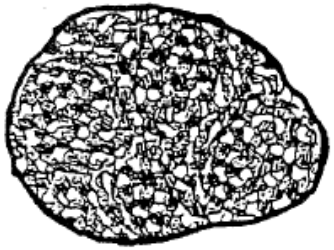
glassy

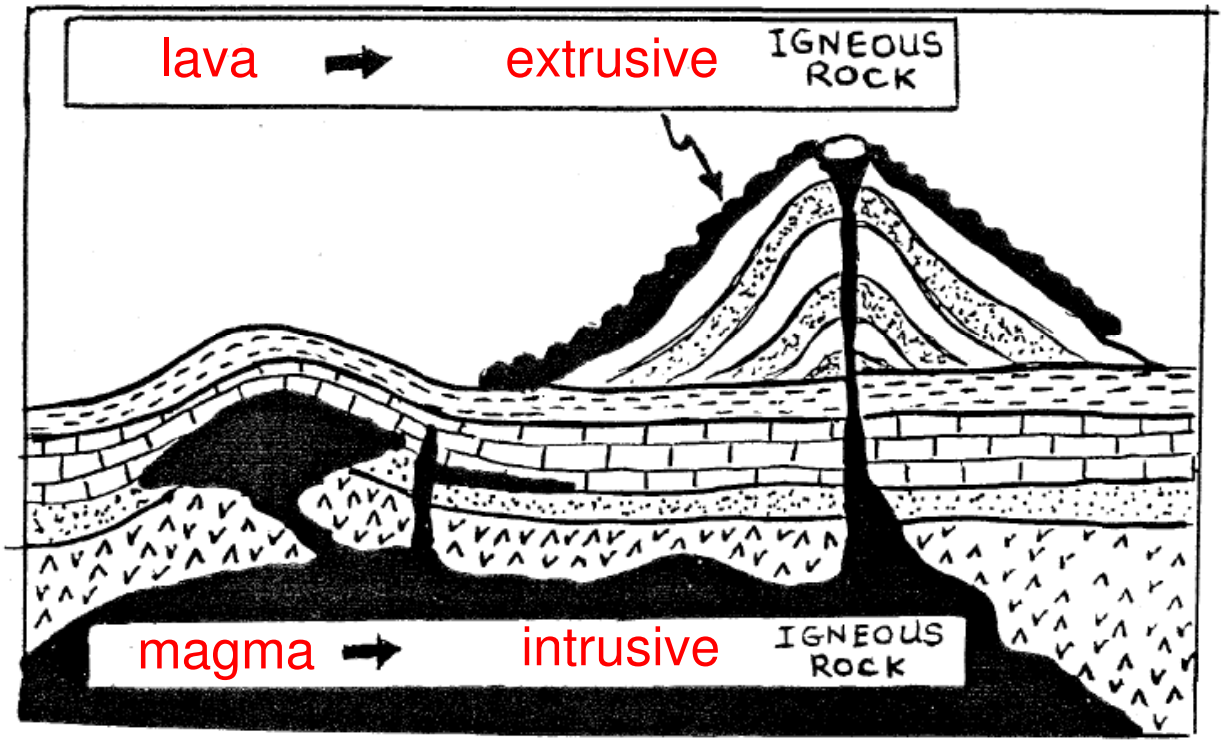
fine

2. Intrusive/Plutonic -
- forms from the **slow** cooling of magma within the Earth
- **large** crystals
- coarse/rough texture

coarse

3.



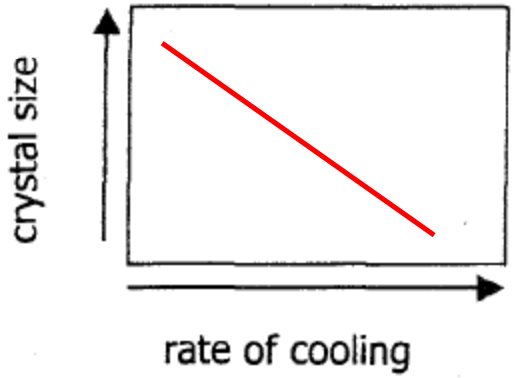


	ENVIRONMENT OF FORMATION		
	EXTRUSIVE (volcanic)		INTRUSIVE (plutonic)
RATE OF COOLING	very fast	fast	slow
GRAIN SIZE	non-crystalline	less than 1 mm	1 mm or larger
TEXTURE	glassy	fine	coarse
EXAMPLES	obsidian	basalt rhyolite	granite gabbro

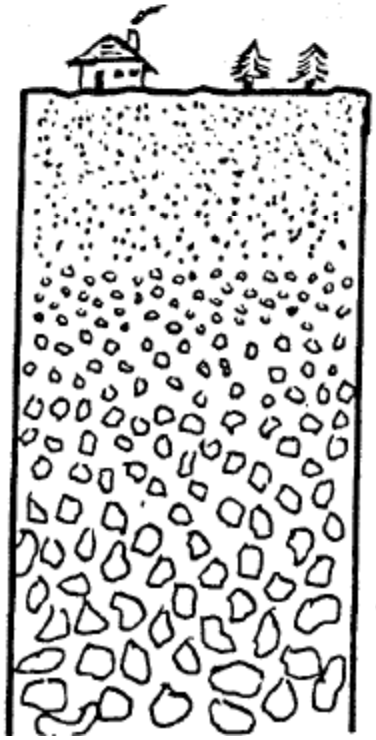
5. Relationship between crystal size and rate of cooling (the environment effects the cooling rate)

a. As rate of cooling increases, crystal size decreases

b.



c.

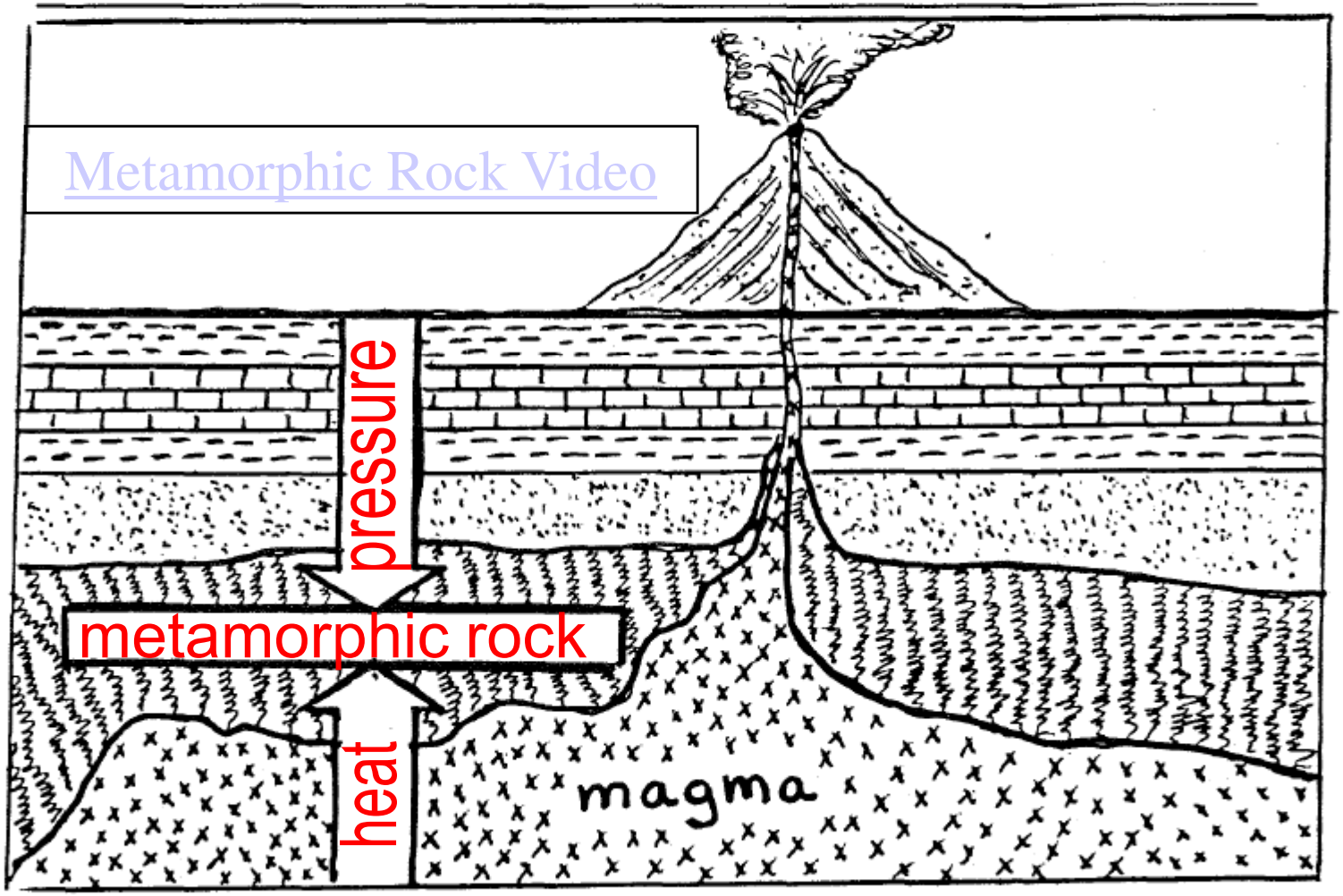


no crystals / crystals	very fast / cooling
small / crystals	fast / cooling
large crystals / crystals	slow / cooling

V. METAMORPHIC ROCKS

A. Form from other preexisting rock (sed., met., ign.) that have been changed

B.



C. Conditions that cause rocks to undergo metamorphism include:

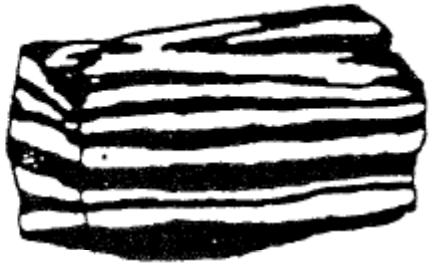
1. heat
2. pressure
3. chemical activity

Such conditions are often associated with deep burial and pressure that result from mountain formation. Therefore, metamorphic rocks are often found in mountainous regions where weathering and erosion have exposed this rock that was once deeply buried.

Under conditions of high temperature and high pressure, many metamorphic rocks form by the process of recrystallization. This is the growth of new mineral crystals from the sediments of a sedimentary rock or the growth of new mineral crystals from the crystals of an igneous or metamorphic rock. Recrystallization occurs without true melting.

D. Changes in a rock caused by metamorphism:

1. ___increased density___
2. ___new minerals___
3. ___Banding___ - is a layered arrangement of firmly joined crystals of minerals; the minerals are aligned in layers or bands. These bands are formed when rock is subjected to extreme pressure and temperature. Usually, the greater the pressure and temperature, the thicker the bands.



4. ___Distorted structure___ - is the curving and folding of the bands. These distortions of once horizontal bands are caused by great environmental pressure exerted on the rock from different directions.

E. Types of metamorphic rocks:

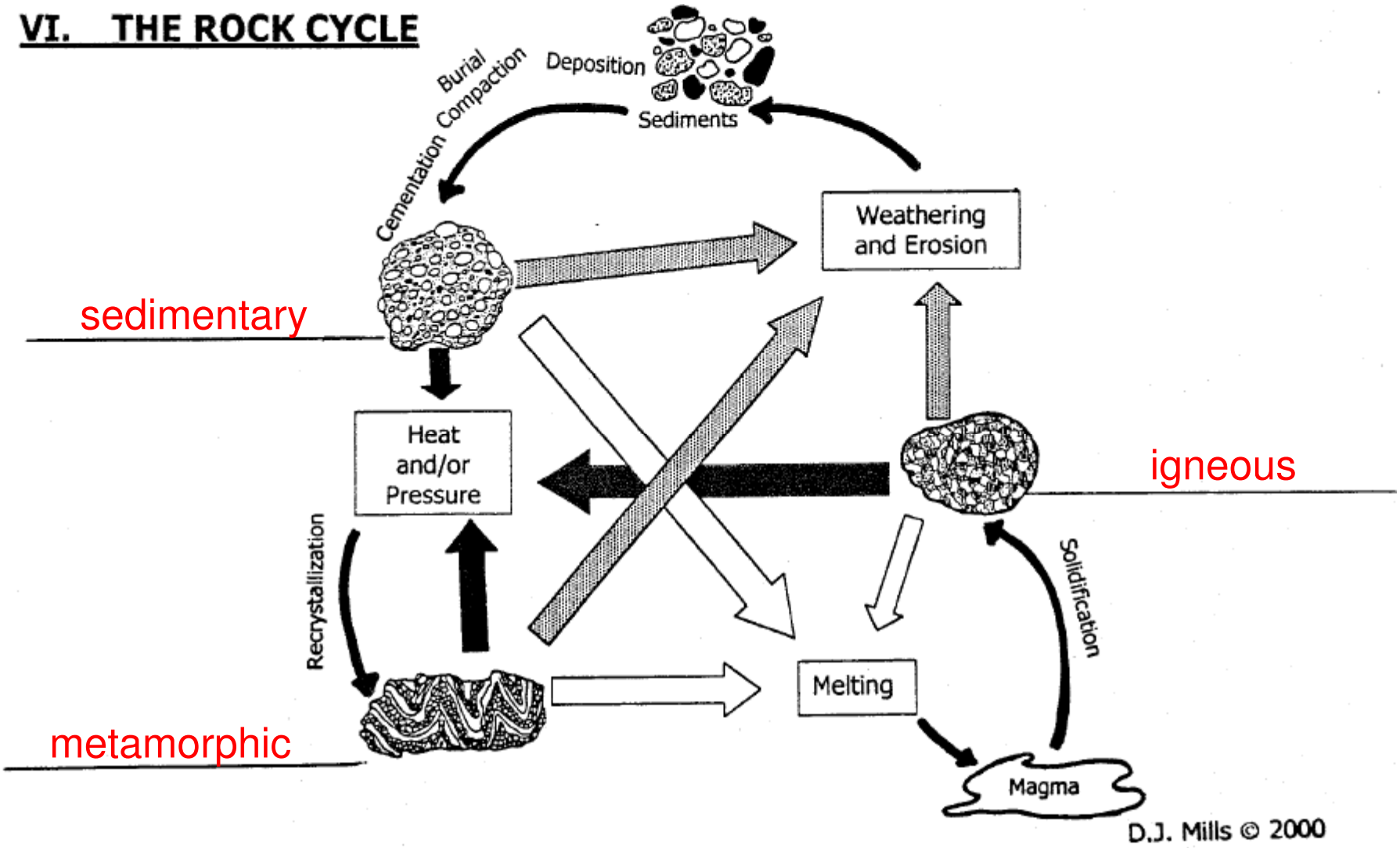
1. Foliated - have mineral crystals arranged in parallel layers or "bands"

2. Nonfoliated - DO NOT have mineral crystals in bands, DO NOT break in layers/sheets

F.

	METAMORPHIC ROCK		ORIGINAL ROCK	ORIGINAL TYPE
foliated	slate	←	shale	sed.
	schist	←	slate	met.
	gneiss	←	granite	ign.
nonfoliated	marble	←	limestone	sed.
	quartzite	←	sandstone	sed.
	anthracite coal	←	bituminous coal	sed.

VI. THE ROCK CYCLE



SEDIMENTARY

Clastic	Organic	Chemical
conglomerate	bituminous coal	rock gypsum
sandstone	limestone	rock salt
siltstone		dolostone
shale		limestone

IGNEOUS

Intrusive (plutonic)	Extrusive (volcanic)
granite	pumice
gabbro	basalt
	rhyolite
	obsidian

METAMORPHIC

Foliated	Nonfoliated
schist	anthracite coal
slate	quartzite
gneiss	marble

Pages 22-23

Famous Rocks

Stonehenge: bluestone

Grand Canyon: layers of sed. rock

Pyramids: limestone

White House: sandstone

David: marble

Vietnam Wall: gabbro

Cleopatra's Needle: granite

Lincoln Memorial: marble