Name:

Rocks and Minerals

I. Minerals

A. **A mineral is** 1 a naturally occuring 2 inorganic 3 has a definite chemical composition 4 is a solid 5 and has a cyrstal 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
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 oxygen
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	Surfur	1 sulfur

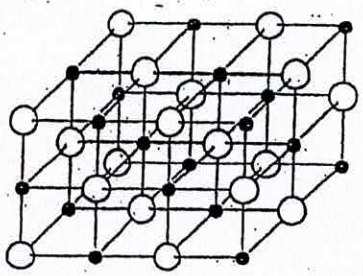
4. solids – have a definite size/volume and a definite shape

oil is NOT a mineral because it is a liquid

5. Crystal Structure:

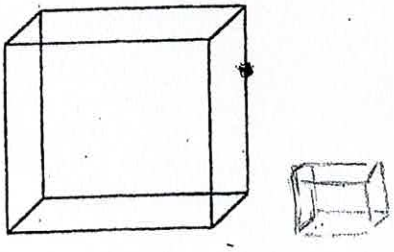
atoms arranged in repeating patterns

Characteristic geometry of its internal structure of atoms.



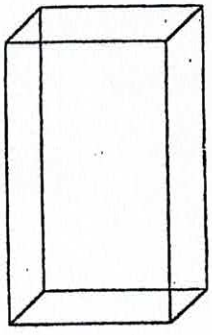
The six basic crystal systems:

CUBIC or ISOMETRIC



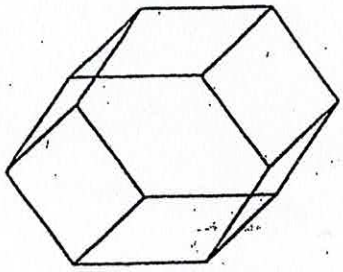
Galena, Halite, Pyrite

TETRAGONAL



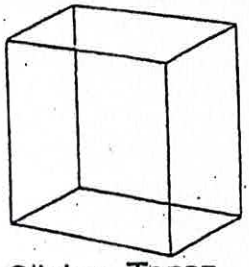
Chalcopyrite

HEXAGONAL



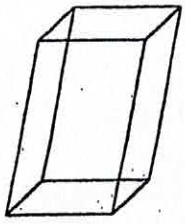
Quartz, Calcite

ORTHORHOMBIC



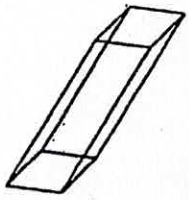
Olivine. Topaz

MONOCLINIC



Mica, Gypsum

TRICLINIC



Feldspar, Turquoise

B. Formation of Minerals-

1. from cooling lava / magma

2. When water evaporates, dissolved minerals remain behind

When a solution (water) is saturated with minerals, minerals will settle out of solution - "precipitate"

I. **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.

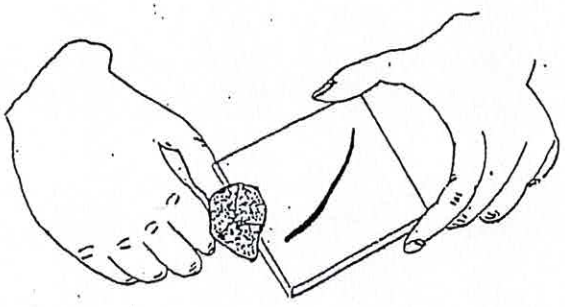
(2) hematite - black, grey, reddish brown, dark red.

c. Color can vary as the result of:

(1) natural coloring agents - impurities

(2) Weathering, exposure to environment: air, temperature 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 it surface

a. Metallic - shines/reflects light like the surface of polished metal.

examples: galena, pyrite, graphite, magnitite.

b. Nonmetallic - non-metal

(1) pearly - Mica

(2) glassy - quartz, halite

(3) dull, earthy - bauxite

(4) waxy - talc

(5) brilliant - diamond

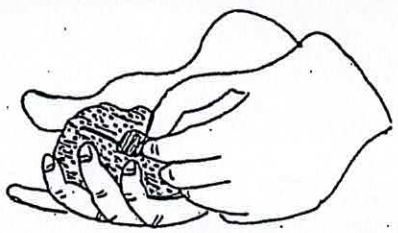
4. Hardness - a measure of how easily a mineral can be Scratched

a. Softest mineral - talc

b. Hardest mineral - diamond

c. Moh's Hardness Scale essrt pg 16

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



HARDNESS OF COMMON OBJECTS

2.5 fingernail

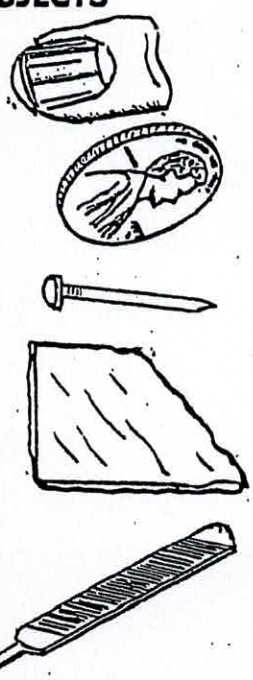
3.5 copper

4.5 iron nail

5.5 glass

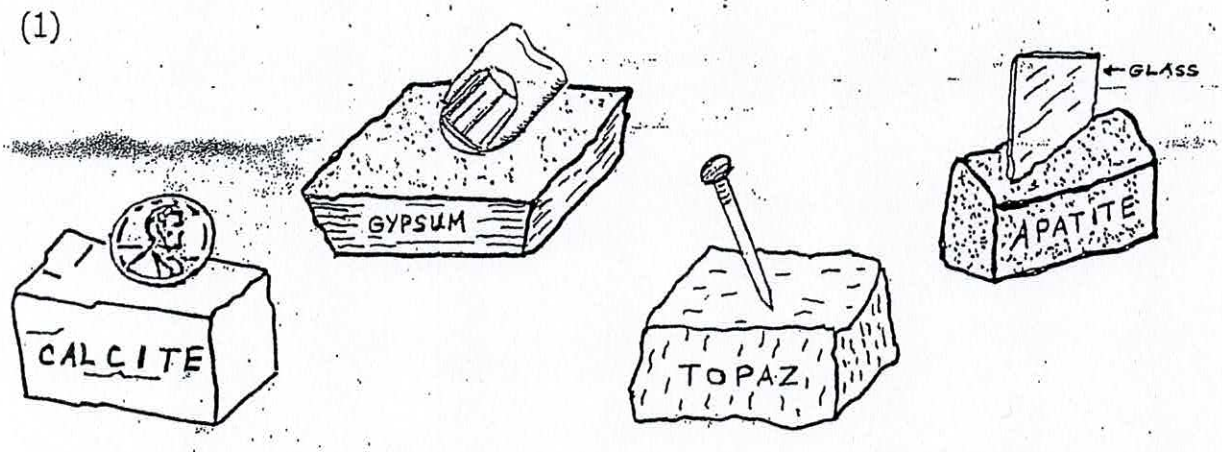
6.5 Steel file

7 streak plate



d. Testing Hardness (yes/no)

(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

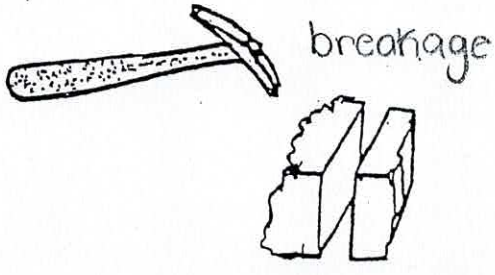
a copper penny? no

a steel file? no

e. What determines Hardness? - internal arrangement of atoms

5. Cleavage and Fracture –

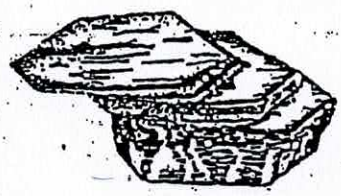
no cleavage



a. Cleavage - when a mineral splits along smooth flat structures

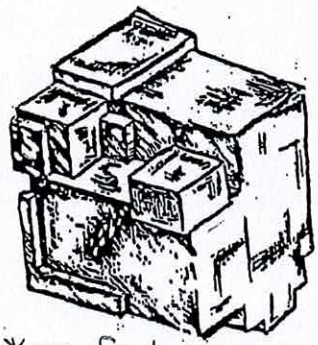
(1) examples of cleavage:

(a)The mineral mica cleaves in one direction(s).



(b)The mineral galena cleaves in three direction(s).

(halite also breaks in 3 direction(s))



*on friday

(2) What determines cleavage?

Internal arrangment of atoms

(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 unevenly into curved or irregular pieces with rough jagged surfaces

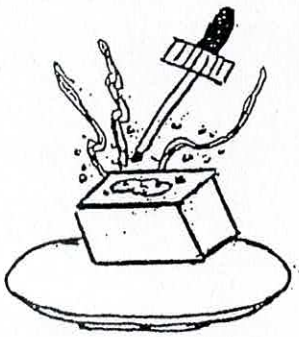
(no cleavage)

(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

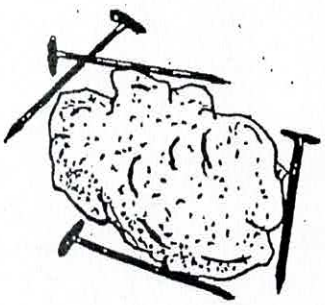


calcite reacts with hydrochloric acid. It forms bubbles of carbon dioxide gas.

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

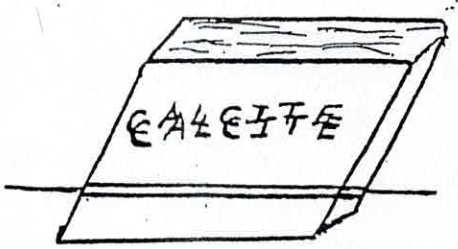
calcite + hydrochloric acid → calcium chloride + water + carbon dioxide

C. Special Properties –

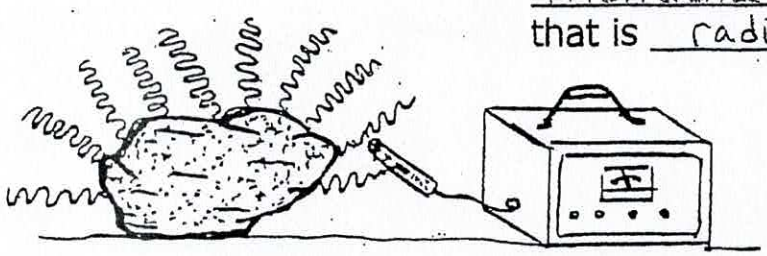


Lodestone, a form of the mineral magnetite, is naturally magnetic

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



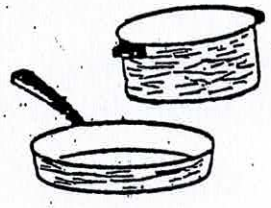
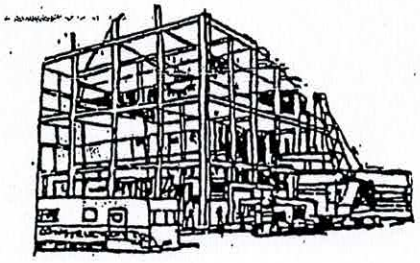
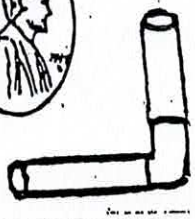
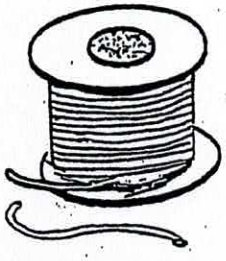
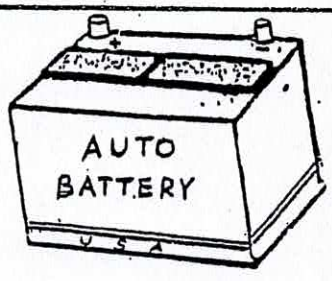
Pitchblende is an example of a mineral that is radioactive.



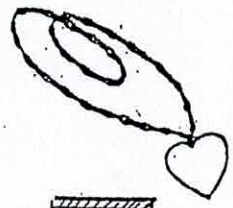
II. Uses of Minerals

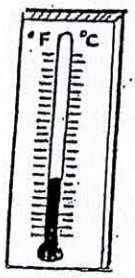
A. Ore – a mineral that contains metal and nonmetals that can be mined and removed in usuable amounts for a profit

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 $Al(OH)_3$ $AlO(OH)$ $HAlO_2$	 
3. Copper	Chalcopyrite $CaFeS_2$ malachite $Cu_2CO_3(OH)_2$	  
4. lead	galena PbS	

METAL	MINERAL(S)	USE
5. Silver	Argenite Ag_2S	
6. gold	Gold Au	
7. mercury	Cinnabar HgS	



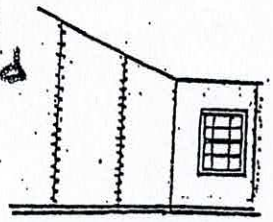
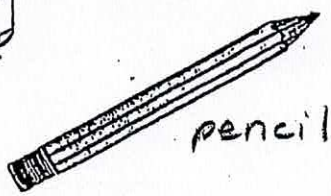
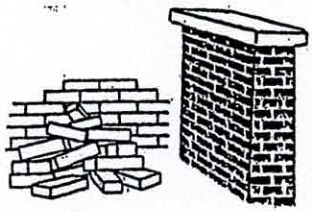
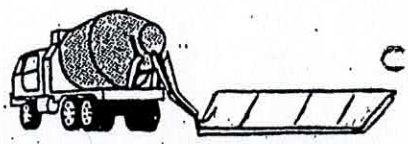


b. alloy - a mixture of two or more metals or a mixture of metals and nonmetals.

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

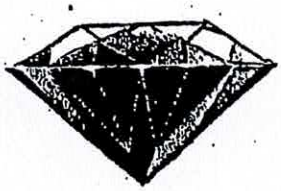
2. Nonmetals – elements that have dull surfaces and are poor conductors of heat and electricity.

	MINERAL(S)	USE
a.	Halite	table salt

MINERAL(S)	USE
b. gypsum	Wallboard 
c. Sulfur	 matches
d. talc	 powder
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

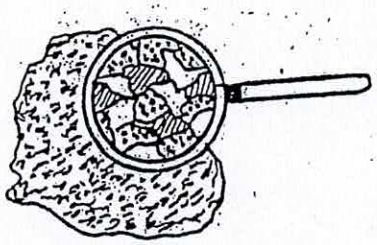
Petrology - the branch of science that studies rocks.

I. CLASSIFICATION OF ROCKS

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

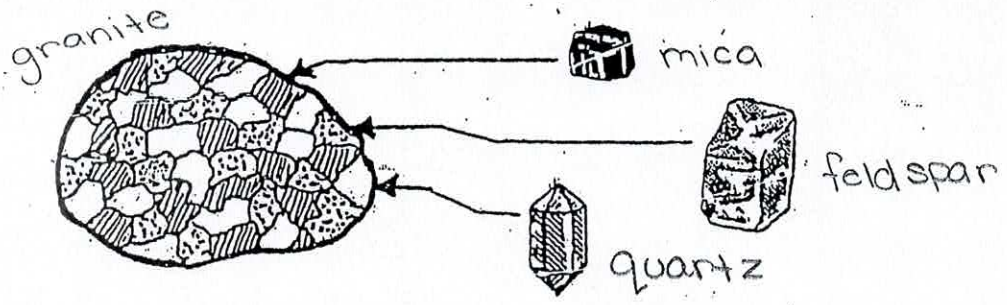
B. The three groups of rocks are:

1. Sedimentary
2. igneous
3. metamorphic



II. ROCKS IN RELATION TO MINERALS

A. Many kinds of rocks are composed of minerals



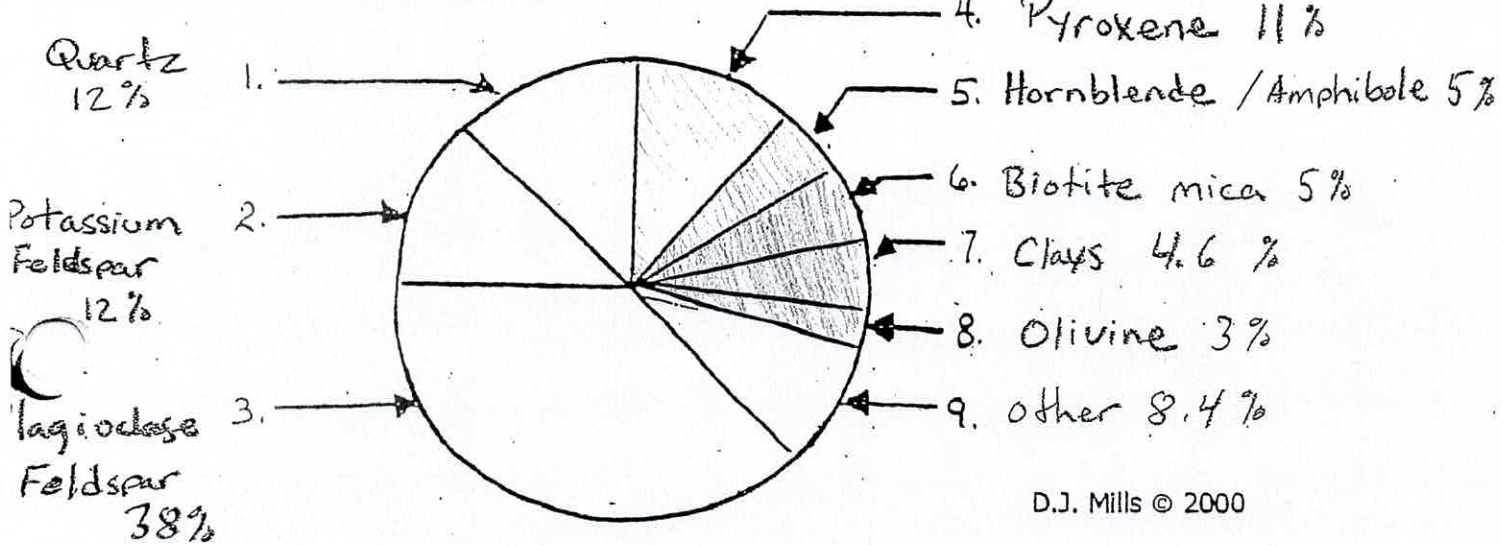
B. Some rocks are monomineralic - composed of only one (limestone → calcite) example: calcite (mineral) → Limestone (rock)

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.

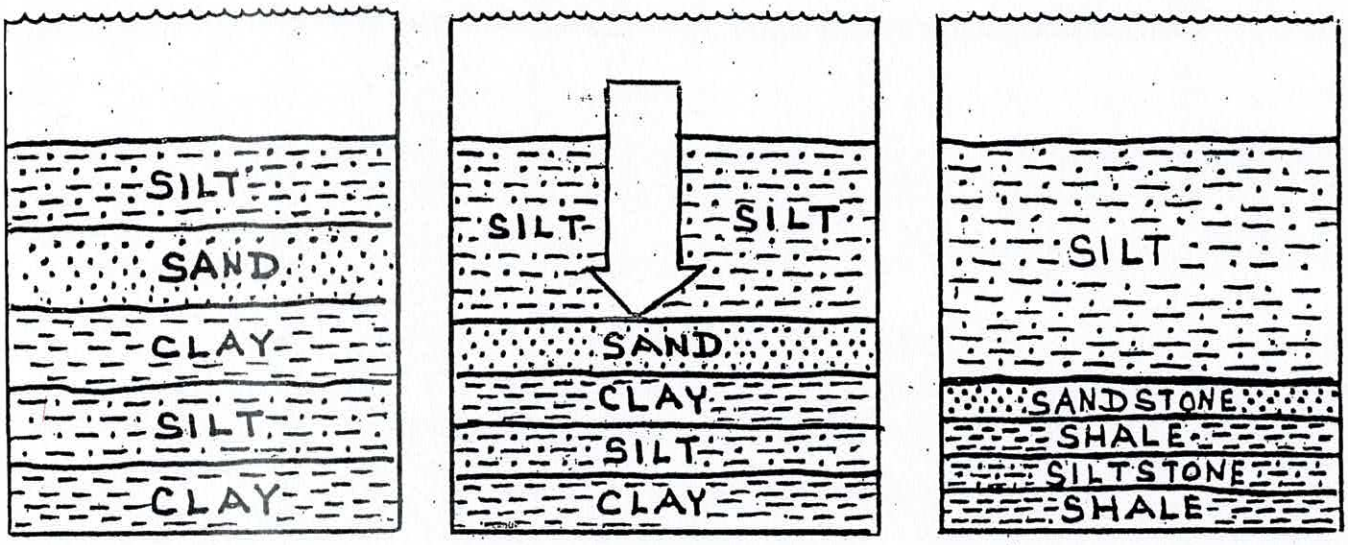
F. Common rock-forming minerals:



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 accumulated

Pressure/weight squeezes lower layers

Sediment completed

B. Types of Sediments

Type — 1. Clastic (land-derived) - form from rock particles/sediments that are pressed and cemented together

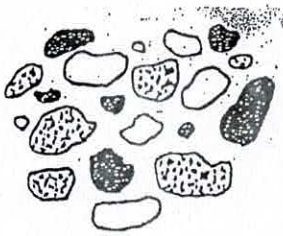
a. Compaction - pressed by weight of overlying rock.

b. Cementation - glued by natural cement in water (calcite).

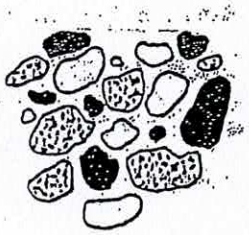
individual particles of rock – sediment

pressure

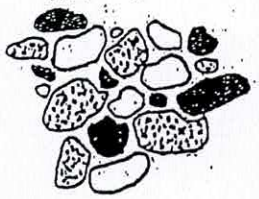
natural sediments dissolved in water



after deposition

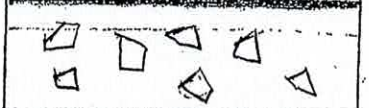
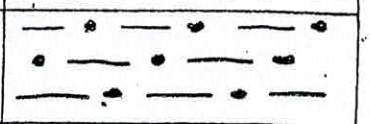
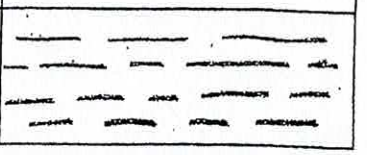


Compaction

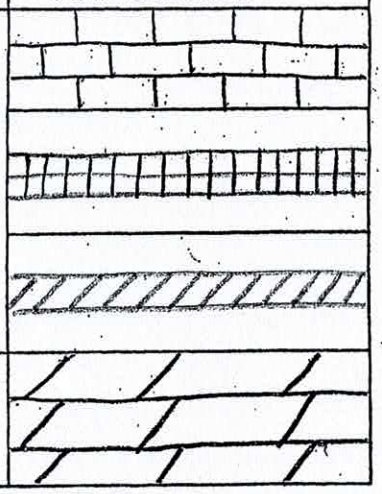


Cementation

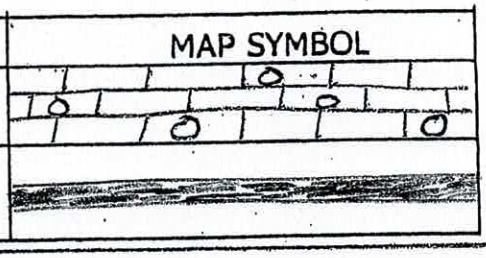
c.

ROCK NAME	GRAIN SIZE (CM)	COMMENT	MAP SYMBOL
Conglomerate	boulders 25.6	Various size rock Particles and mud	
Breccia	cobbles 6.4 pebbles 0.2	Silt and sand cemented together	
Sandstone	Sand .006	Fine to coarse grains cemented together	
Siltstone	Silt .004	very fine grained	
Shale	Clay	compact, may split easily	

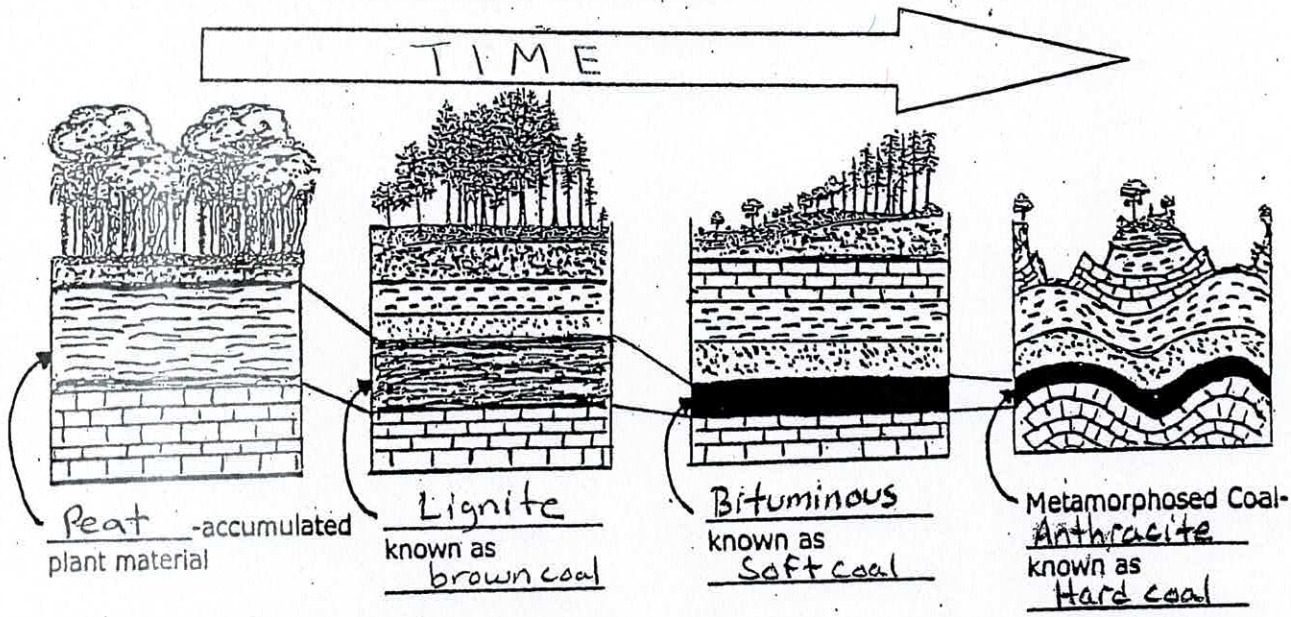
2nd Type — 2. Chemical Sedimentary - form from dissolved minerals in water that settle-out / precipate. Dissolved minerals left behind when water evaporates

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	

-d. Type — 3. Organic Sedimentary - form from the accumulation of plant/animal matter that undergoes a transformation into rock
(Bioclastic)

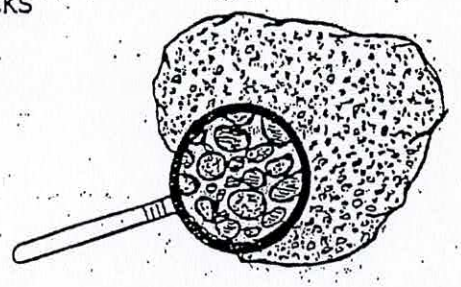
ROCK NAME	COMPOSITION/COMMENT	MAP SYMBOL
limestone	Cemented shell fragments	
coal	Carbon from plant remains	

Formation of Coal



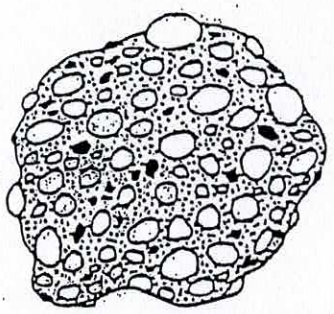
C. Important characteristics of sedimentary rocks

1. They are composed of rock fragments or organic particles.



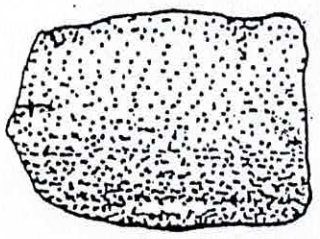
a. Some have a range of particle or sediment size

Conglomerate



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

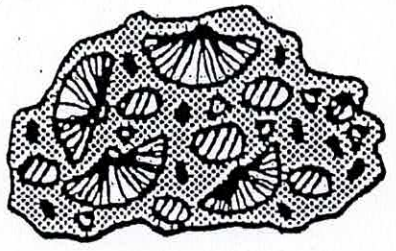
Sandstone



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

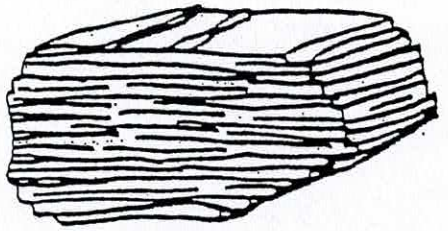
fossils

Fossil limestone



3. Split easily

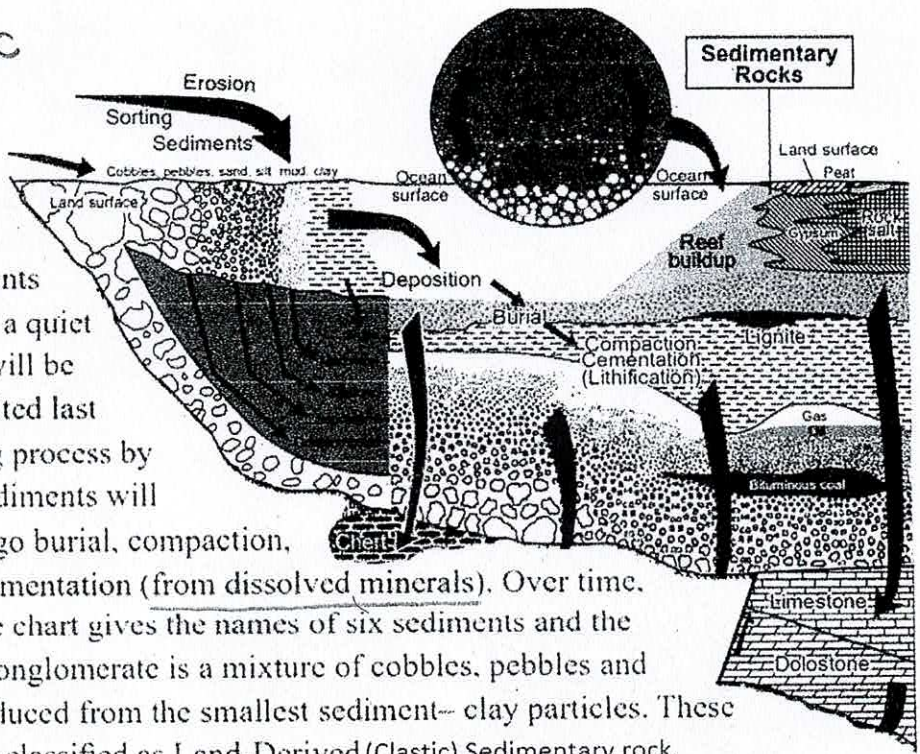
Shale



Sedimentary Rock E.S.S.R.T PG 14

clastic

Sedimentary Rock Section:



Mechanical (physical) and chemical weathering forces act on rocks at or near the surface. These forces break down solid bedrock to smaller sediments that can be eroded away. If they enter a quiet body of water, the largest sediments will be deposited first and the smallest deposited last and farthest out. This creates a sorting process by size and density. The different size sediments will produce different rocks as they undergo burial, compaction, (from the weight above them), and cementation (from dissolved minerals). Over time, different sedimentary rocks form. The chart gives the names of six sediments and the resulting rocks they form. The rock conglomerate is a mixture of cobbles, pebbles and other smaller sediments. Shale is produced from the smallest sediment– clay particles. These six rocks formed from sediments are classified as Land-Derived (Clastic) Sedimentary rock.

Other classifications of sedimentary rocks are the following:

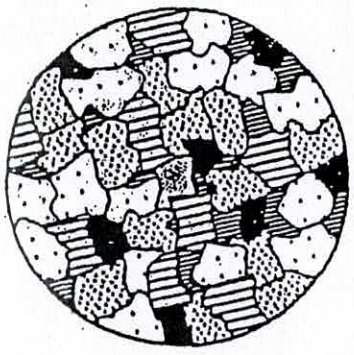
Chemically formed sedimentary rocks – Limestone and dolostone are chemically formed sedimentary rocks. Both contain the mineral calcite, which reacts with acid. Concentrated dissolved minerals can be released of precipitated out of a solution and accumulate on the bottom of the water source. When these "released" minerals become cemented. This process can form rocks rock gypsum and rock salt.

Organic sedimentary Rocks - Limestone containing pieces of seashells is organic. Another organic rock is coal. Organic Material can accumulate in bogs or swamps. Overtime this material gets compressed to form first peat, then lignite and then bituminous coal-all are different grades of coal. At the upper right side of the chart shows "Reef buildup." Coral is a type of organic biochemical rock produced by coral polyps secreting layers of calcium carbonate. Oil and natural gas are trapped and now contain these resources.

IV. IGNEOUS ROCKS

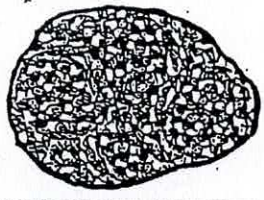
A. forms from the cooling and solidification/ crystalization of molten lava and magma

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.

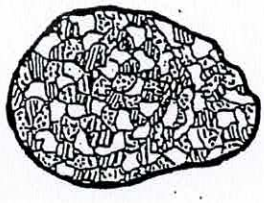


B. Types of Igneous Rocks

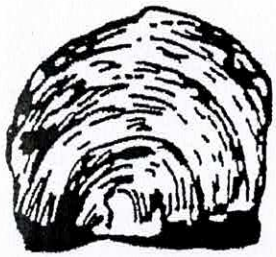
1st Type -1. extrusive / volcanic -
forms from the fast cooling of lava on or near Earth's surface. Fast cooling does NOT allow time for crystals to grow. Rocks have small or no crystals - therefore a smooth/fine texture.

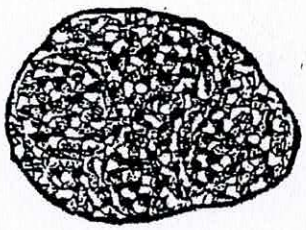


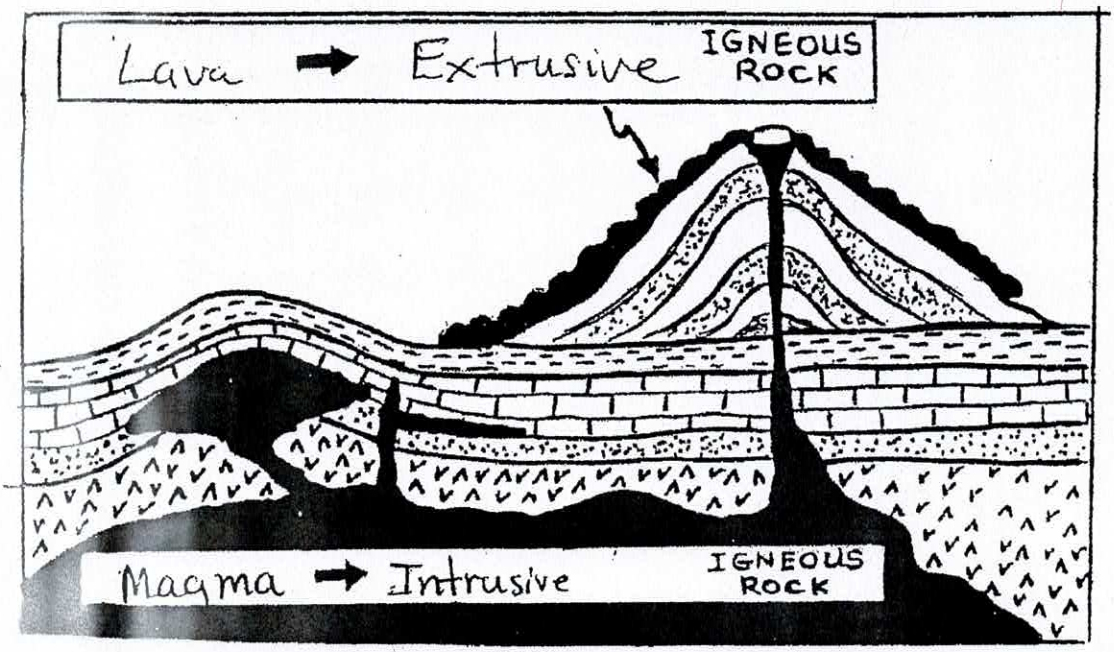
2nd Type -2. intrusive / plutonic -
forms from slow cooling of magma within the Earth. Slow cooling allows time for large crystals to grow. Rocks have large crystals - therefore a course/ rough texture

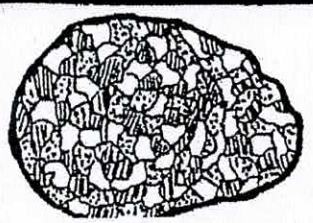


3.









Names — Igneous rocks

Scheme for Igneous Rock Identification

IGNEOUS ROCKS		Obsidian (usually appears black)		Basaltic glass			CRYSTAL SIZE	Texture
ENVIRONMENT OF FORMATION	EXTRUSIVE (Volcanic)	Pumice		Scoria			non-crystalline	Glassy
		Vesicular rhyolite	Vesicular andesite	Vesicular basalt				Vesicular (gas pockets)
		Rhyolite	Andesite	Basalt			less than 1 mm	Fine
				Diabase				
	INTRUSIVE (Plutonic)	Granite	Diorite	Gabbro	Peri-dotite	Dunite	1 mm to 10 mm	Coarse
		Pegmatite					10 mm or larger	Very coarse
CHARACTERISTICS		LIGHTER ←		COLOR		→ DARKER		
		LOWER ←		DENSITY		→ HIGHER		
		FELSIC (rich in Si, Al) ←		COMPOSITION		→ MAFIC (rich in Fe, Mg)		

Mafic igneous rocks -
The magma reaches very high temp (can still cool down fast or slow depending on environment) when crystallization occurs the minerals rich in mafic which mean the minerals have more iron , magnesium and calcium.

Felsic igneous rocks -
The magma is lower in temp (can still cool down fast or slow depending on environment) when crystallization occurs the minerals are rich in Felsic which mean the minerals have more silica , potassium and sodium.

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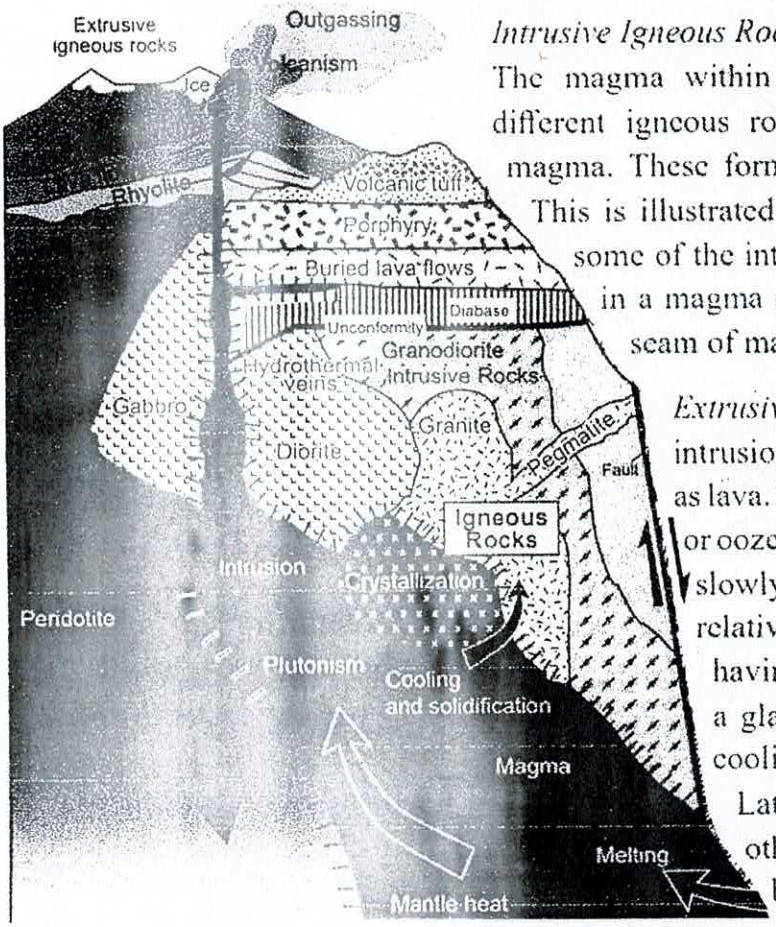
Igneous Rock E.S.S.R.T PG 14

Igneous Rock Section:

Igneous rocks formed from as melted molten rock cooled and solidified. Magma produces intrusive rocks, while lava produces extrusive igneous rocks.



Intrusive Igneous Rocks – A magma chamber is a large pool of magma. The magma within cools very slowly and eventually may form different igneous rocks based on the mineral composition of the magma. These formed intrusive rocks will exhibit visible crystals. This is illustrated around the word crystallization. Above this are some of the intrusive rocks (granite, diorite, etc.) that may form in a magma chamber. The diagrammed igneous intrusion is a seam of magma that cuts through existing rocks.

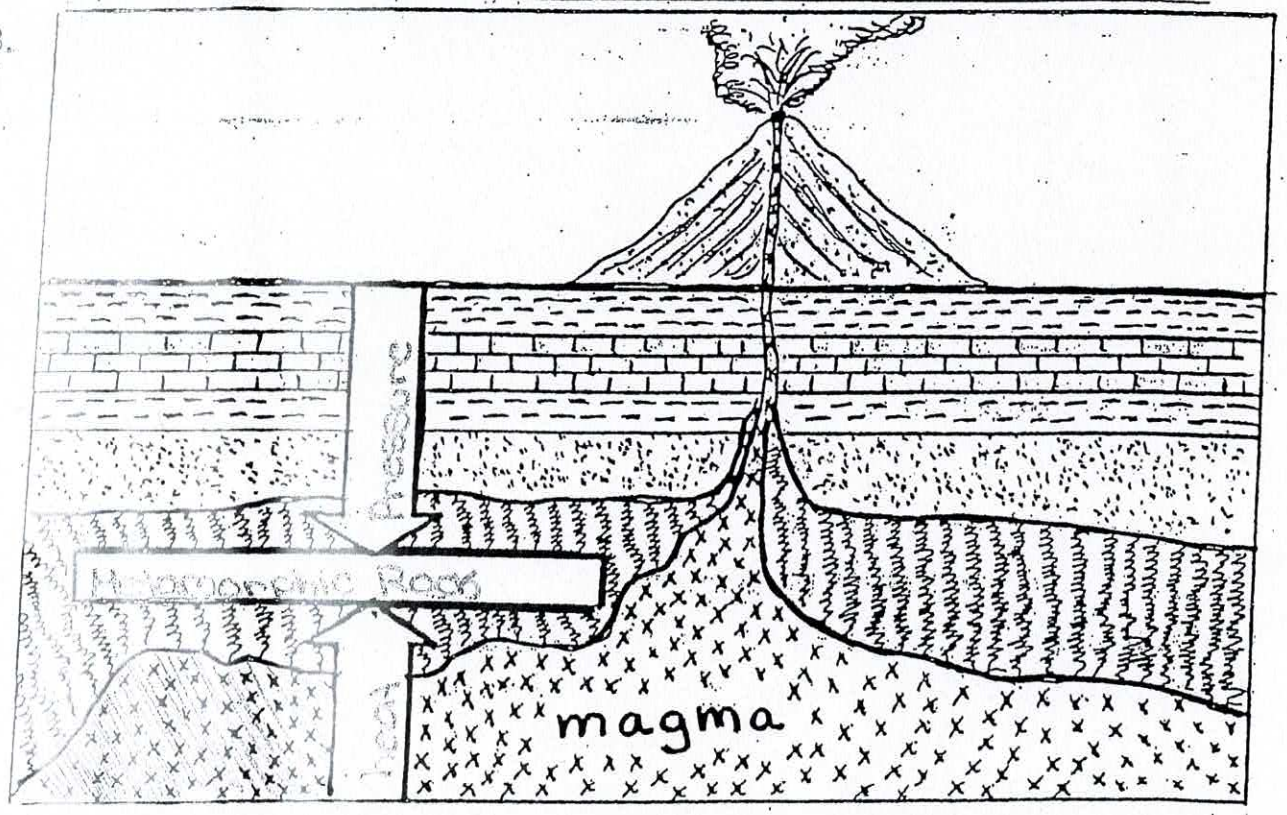
Extrusive Igneous Rocks – As shown in the diagram, intrusions bring magma to the surface, and now it's known as lava. Lava can be violently ejected by volcanic eruptions or ooze out of a deep crustal opening producing a lava flow, slowly spreading outward. In all cases, lava cools relatively quickly, either producing very small crystals, having a fine texture, or lacking any crystals, having a glassy texture. The composition of the lava and its cooling rate can form different extrusive igneous rocks. Later volcanic eruptions can cover lava flows and other extrusive rock layers. The diagram shows two buried lava flows and four extrusive igneous rocks.

V. METAMORPHIC ROCKS

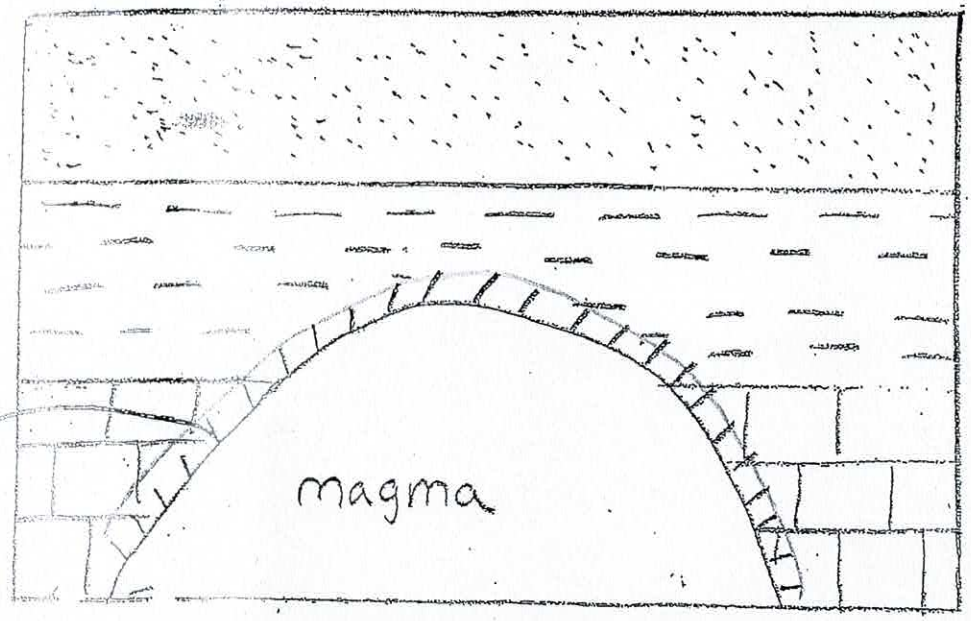
A. form from other preexisting rock (Sedimentary, igneous, metamorphic) that have been changed

B.

Regional



Contact



C. Conditions that cause rocks to undergo metamorphism include:

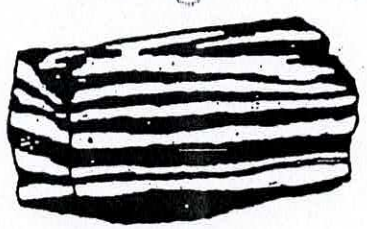
1. exposure to heat
2. pressure
3. chemical activity

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.

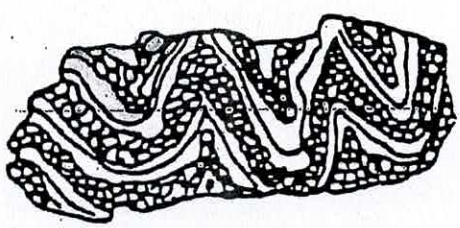
Under conditions of high temperature and high pressure, many metamorphic rocks form by the process of recrystallization. This is the growth of new mineral crystals from the sediments of a sedimentary rock or the growth of new mineral crystals from the crystals of an igneous or metamorphic rock. Recrystallization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

D. Changes in a rock caused by metamorphism:

1. increased density
2. chemical change / new minerals
3. foliated - is a (banding, mineral alignment) 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 - mineral crystals arranged in 'bands' or 'mineral alignment'
2. Nonfoliated - do not have mineral crystals in 'bands' or 'mineral alignment'

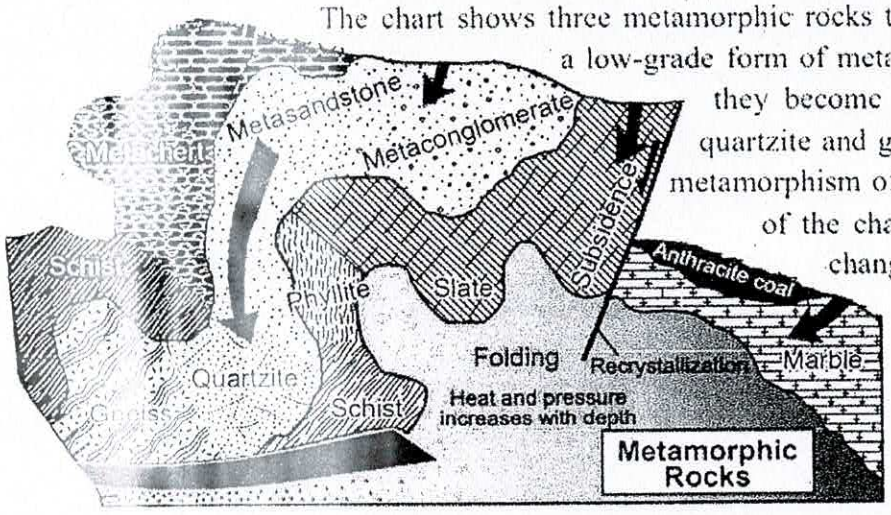
F.

	METAMORPHIC ROCK		ORIGINAL ROCK	ORIGINAL TYPE
Foliated	slate	←	shale	sedimentary
	Schist	←	slate	Metamorphic
	Gneiss	←	granite	igneous
Non-foliated	marble	←	limestone	sedimentary
	quartzite	←	sandstone	sedimentary
	anthracite coal	←	bituminous coal	sedimentary

Metamorphic Rock E.S.S.R.T PG 14

Metamorphic Rock Section:

Rocks can be subjected to heat and pressure from Earth's forces. If these forces do not melt the rocks, they can alter them, changing the original rock into a metamorphic rock. Thus, all metamorphic rocks are made from preexisting rocks. The metamorphism of limestone and/or dolostone produces marble. The chart shows three metamorphic rocks that have the prefix meta, indicating a low-grade form of metamorphism. With more heat/pressure they become true metamorphic rocks, producing quartzite and gneiss. Locate slate. It is a low-grade metamorphism of shale. Following this curvy section of the chart, under more heat/pressure it will change to phyllite and then to schist. The sedimentary coal—bituminous coal can be changed into metamorphic anthracite coal. This is the preferred coal for use.



Types of metamorphism

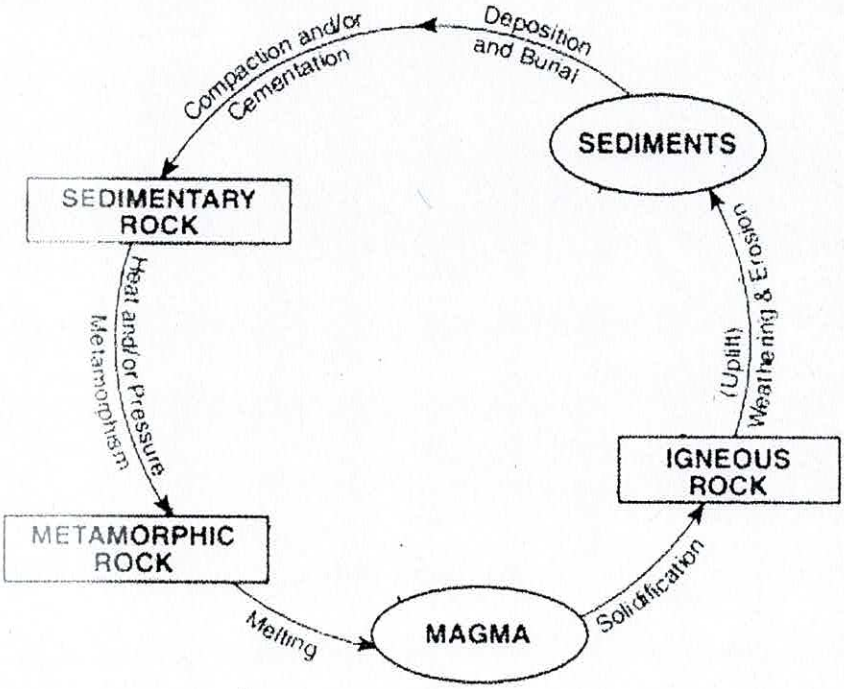
Regional Metamorphism – This is a very large area that has undergone metamorphism. Plate collisions produces regional metamorphism, forming folded mountains.

Usually results in Foliation

Contact Metamorphism – The heat of an igneous intrusion can cause the surrounding rocks to metamorphose. This is called contact metamorphism. In the igneous section, this is diagrammed by hash-marks on the edges of the intrusion as it comes into contact with preexisting rocks.

Usually results in Non-foliation

Rock Cycle in Earth's Crust



Rock Cycle in Earth's Crust

The arrows are the Process