Minerals and Rocks

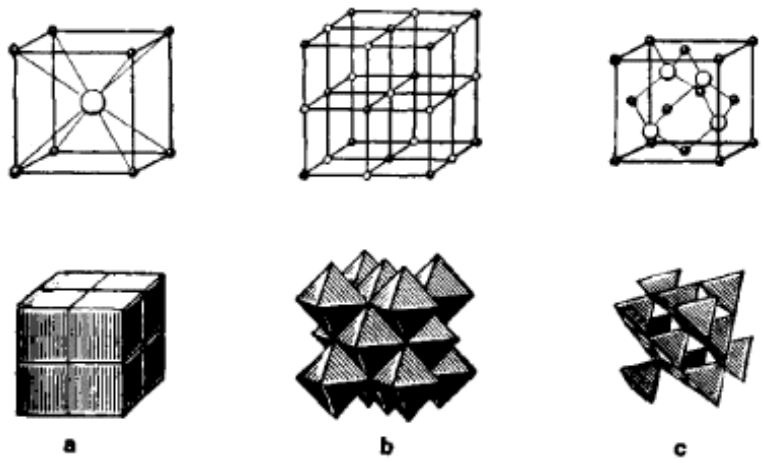
Definition of a Mineral

A mineral is a naturally occurring homogeneous solid, inorganically formed, with a definite chemical composition and a crystalline structure (ordered atomic arrangement).

- Naturally occurring
- Solid
- Inorganic
- Chemical composition
- Crystal structure

Definition of a Mineral

- **Naturally occurring**: not made by man or animals
- **Solid**: Has definite size, shape and volume
- **Inorganic**: the material is not formed from living things
- **Chemical Composition**: ex.: quartz = SiO_2
- **Crystal Structure**: atoms arranged in geometric patterns



PERIODIC TABLE OF THE ELEMENTS

http://www.ktf-split.hr/periodni/en/

PERIOD	GROUP 1 IA	2 IIA	3 IIIB	4 IVB	5 VB	6 VIB	7 VIIB	8	9 VIIIB	10	11 IB	12 IIB	13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	18 VIIIA
1	1 1.0079 **H** HYDROGEN																	2 4.0026 **He** HELIUM
2	3 6.941 **Li** LITHIUM	4 9.0122 **Be** BERYLLIUM											5 10.811 **B** BORON	6 12.011 **C** CARBON	7 14.007 **N** NITROGEN	8 15.999 **O** OXYGEN	9 18.998 **F** FLUORINE	10 20.180 **Ne** NEON
3	11 22.990 **Na** SODIUM	12 24.305 **Mg** MAGNESIUM											13 26.982 **Al** ALUMINIUM	14 28.086 **Si** SILICON	15 30.974 **P** PHOSPHORUS	16 32.065 **S** SULPHUR	17 35.453 **Cl** CHLORINE	18 39.948 **Ar** ARGON
4	19 39.098 **K** POTASSIUM	20 40.078 **Ca** CALCIUM	21 44.956 **Sc** SCANDIUM	22 47.867 **Ti** TITANIUM	23 50.942 **V** VANADIUM	24 51.996 **Cr** CHROMIUM	25 54.938 **Mn** MANGANESE	26 55.845 **Fe** IRON	27 58.933 **Co** COBALT	28 58.693 **Ni** NICKEL	29 63.546 **Cu** COPPER	30 65.39 **Zn** ZINC	31 69.723 **Ga** GALLIUM	32 72.64 **Ge** GERMANIUM	33 74.922 **As** ARSENIC	34 78.96 **Se** SELENIUM	35 79.904 **Br** BROMINE	36 83.80 **Kr** KRYPTON
5	37 85.468 **Rb** RUBIDIUM	38 87.62 **Sr** STRONTIUM	39 88.906 **Y** YTTRIUM	40 91.224 **Zr** ZIRCONIUM	41 92.906 **Nb** NIOBIUM	42 95.94 **Mo** MOLYBDENUM	43 (98) **Tc** TECHNETIUM	44 101.07 **Ru** RUTHENIUM	45 102.91 **Rh** RHODIUM	46 106.42 **Pd** PALLADIUM	47 107.87 **Ag** SILVER	48 112.41 **Cd** CADMIUM	49 114.82 **In** INDIUM	50 118.71 **Sn** TIN	51 121.76 **Sb** ANTIMONY	52 127.60 **Te** TELLURIUM	53 126.90 **I** IODINE	54 131.29 **Xe** XENON
6	55 132.91 **Cs** CAESIUM	56 137.33 **Ba** BARIUM	57-71 **La-Lu** Lanthanide	72 178.49 **Hf** HAFNIUM	73 180.95 **Ta** TANTALUM	74 183.84 **W** TUNGSTEN	75 186.21 **Re** RHENIUM	76 190.23 **Os** OSMIUM	77 192.22 **Ir** IRIDIUM	78 195.08 **Pt** PLATINUM	79 196.97 **Au** GOLD	80 200.59 **Hg** MERCURY	81 204.38 **Tl** THALLIUM	82 207.2 **Pb** LEAD	83 208.98 **Bi** BISMUTH	84 (209) **Po** POLONIUM	85 (210) **At** ASTATINE	86 (222) **Rn** RADON
7	87 (223) **Fr** FRANCIUM	88 (226) **Ra** RADIUM	89-103 **Ac-Lr** Actinide	104 (261) **Rf** RUTHERFORDIUM	105 (262) **Db** DUBNIUM	106 (266) **Sg** SEABORGIUM	107 (264) **Bh** BOHRIUM	108 (277) **Hs** HASSIUM	109 (268) **Mt** MEITNERIUM	110 (281) **Uun** UNUNNILIUM	111 (272) **Uuu** UNUNUNIUM	112 (285) **Uub** UNUNBIUM		114 (289) **Uuq** UNUNQUADIUM				

RELATIVE ATOMIC MASS (1)
GROUP IUPAC
GROUP CAS
ATOMIC NUMBER
SYMBOL
ELEMENT NAME
5 10.811 B BORON

Metal | Semimetal | Nonmetal
1 Alkali metal
2 Alkaline earth metal
Transition metals
Lanthanide
Actinide
16 Chalcogens element
17 Halogens element
18 Noble gas

STANDARD STATE (25 °C; 101 kPa)
Ne - gas
Fe - solid
Ga - liquid
Tc - synthetic

LANTHANIDE

57 138.91 **La** LANTHANUM	58 140.12 **Ce** CERIUM	59 140.91 **Pr** PRASEODYMIUM	60 144.24 **Nd** NEODYMIUM	61 (145) **Pm** PROMETHIUM	62 150.36 **Sm** SAMARIUM	63 151.96 **Eu** EUROPIUM	64 157.25 **Gd** GADOLINIUM	65 158.93 **Tb** TERBIUM	66 162.50 **Dy** DYSPROSIUM	67 164.93 **Ho** HOLMIUM	68 167.26 **Er** ERBIUM	69 168.93 **Tm** THULIUM	70 173.04 **Yb** YTTERBIUM	71 174.97 **Lu** LUTETIUM

ACTINIDE

89 (227) **Ac** ACTINIUM	90 232.04 **Th** THORIUM	91 231.04 **Pa** PROTACTINIUM	92 238.03 **U** URANIUM	93 (237) **Np** NEPTUNIUM	94 (244) **Pu** PLUTONIUM	95 (243) **Am** AMERICIUM	96 (247) **Cm** CURIUM	97 (247) **Bk** BERKELIUM	98 (251) **Cf** CALIFORNIUM	99 (252) **Es** EINSTEINIUM	100 (257) **Fm** FERMIUM	101 (258) **Md** MENDELEVIUM	102 (259) **No** NOBELIUM	103 (262) **Lr** LAWRENCIUM

(1) Pure Appl. Chem., 73, No. 4, 667-683 (2001)

Relative atomic mass is shown with five significant figures. For elements have no stable nuclides, the value enclosed in brackets indicates the mass number of the longest-lived isotope of the element.

However three such elements (Th, Pa, and U) do have a characteristic terrestrial isotopic composition, and for these an atomic weight is tabulated.

Editor: Aditya Vardhan (adivar@nettlinx.com)

Mineral Identification

Factors you must know:

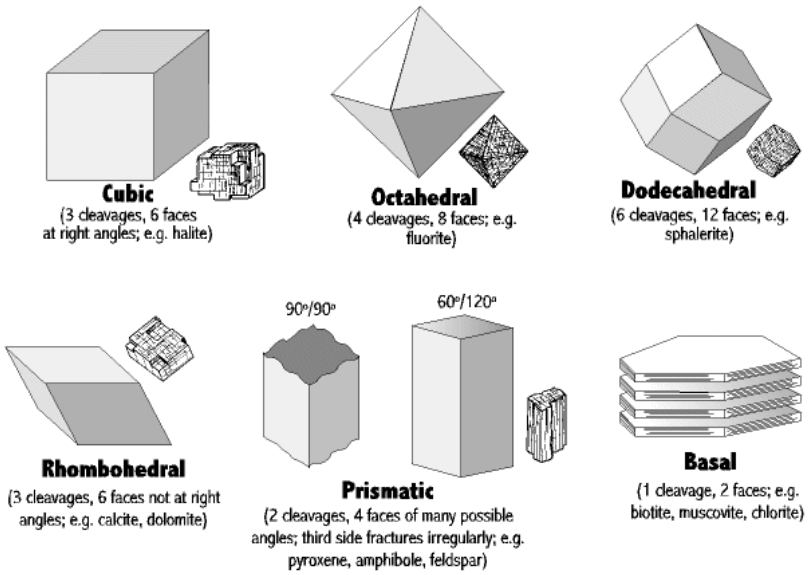
- Cleavage or fracture
- Streak: Light or Dark
- Hardness: can it scratch glass? Yes or no
- Luster: metallic or non-metallic

- Reference Table

Cleavage Vs. Fracture

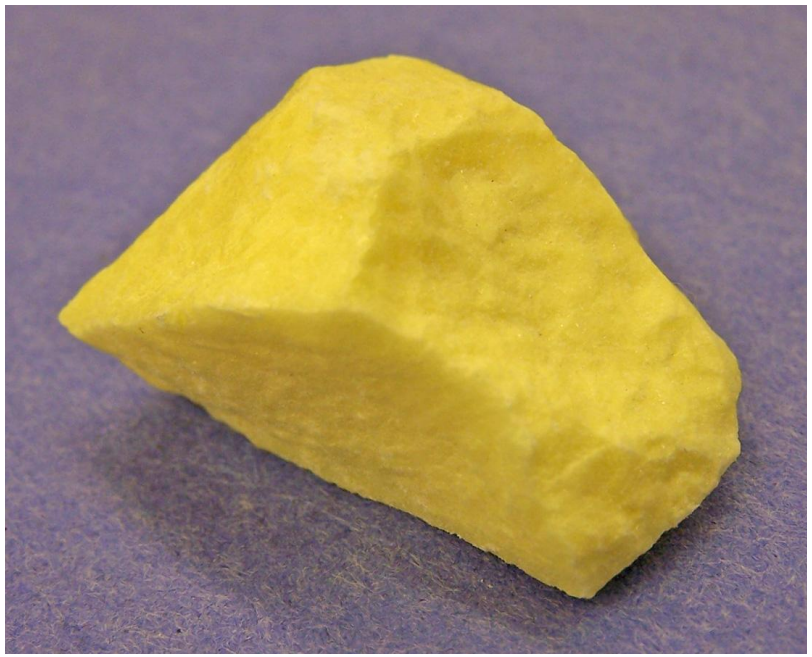
the mineral breaks in a predictable pattern because of its arrangement of atoms

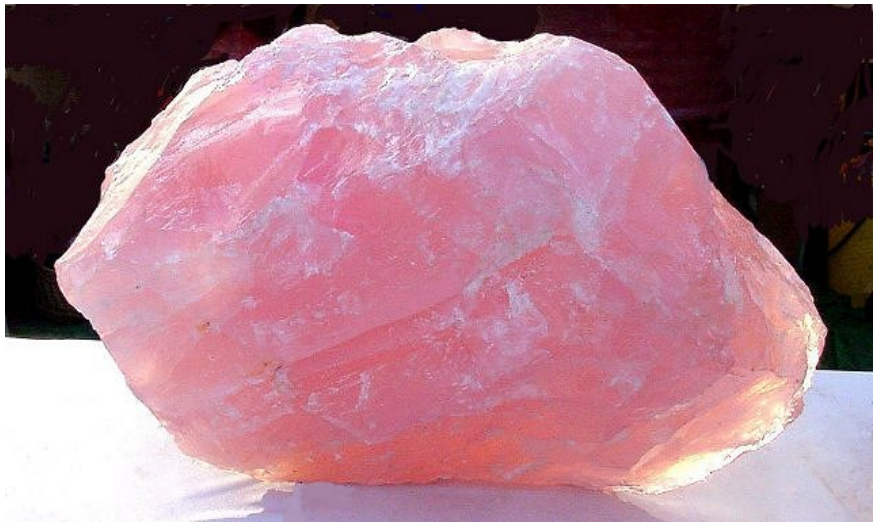
the mineral breaks randomly



Examples of Cleavage

Examples of Fracture





Luster

how light reflects off a mineral

metallic

looks like a metal

non-metallic

looks earthy, waxy, greasy or bright

Streak

The color of a mineral in powder form

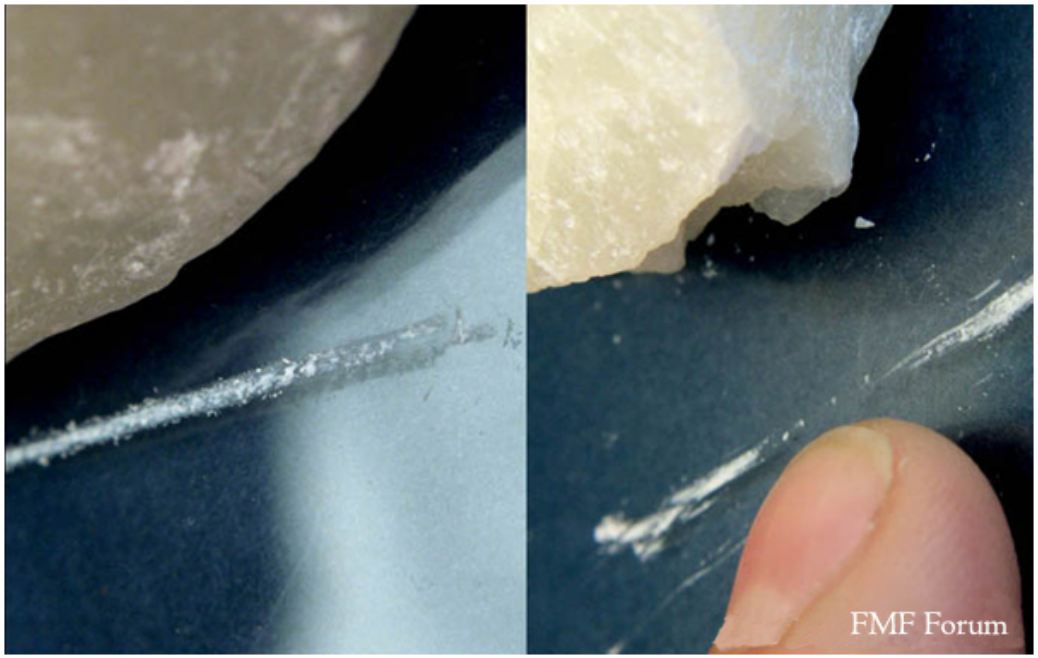


Hardness

Is it hard or soft?

If it can scratch glass it is HARD

If it cannot scratch glass its SOFT



Do Now

Go to page 16 of the ESRT. List the following information on the mineral **Graphite**:

1. What is the luster?
2. What is the hardness?
3. Does the mineral have cleavage or fracture?

Properties of Common Minerals

LUSTER	HARDNESS	CLEAVAGE	FRACTURE	COMMON COLORS	DISTINGUISHING CHARACTERISTICS	USE(S)	COMPOSITION*	MINERAL NAME
Metallic luster	1–2	✔		silver to gray	black streak, greasy feel	pencil lead, lubricants	C	**Graphite**
	2.5	✔		metallic silver	gray-black streak, cubic cleavage, density = 7.6 g/cm^3	ore of lead, batteries	PbS	**Galena**
	5.5–6.5		✔	black to silver	black streak, magnetic	ore of iron, steel	Fe_3O_4	**Magnetite**
	6.5		✔	brassy yellow	green-black streak, (fool's gold)	ore of sulfur	FeS_2	**Pyrite**
Either	5.5 – 6.5 or 1		✔	metallic silver or earthy red	red-brown streak	ore of iron, jewelry	Fe_2O_3	**Hematite**
Nonmetallic luster	1	✔		white to green	greasy feel	ceramics, paper	$Mg_3Si_4O_{10}(OH)_2$	**Talc**
	2		✔	yellow to amber	white-yellow streak	sulfuric acid	S	**Sulfur**
	2	✔		white to pink or gray	easily scratched by fingernail	plaster of paris, drywall	$CaSO_4 \cdot 2H_2O$	**Selenite gypsum**
	2–2.5	✔		colorless to yellow	flexible in thin sheets	paint, roofing	$KAl_3Si_3O_{10}(OH)_2$	**Muscovite mica**
	2.5	✔		colorless to white	cubic cleavage, salty taste	food additive, melts ice	NaCl	**Halite**
	2.5–3	✔		black to dark brown	flexible in thin sheets	construction materials	$K(Mg,Fe)_3 AlSi_3O_{10}(OH)_2$	**Biotite mica**
	3	✔		colorless or variable	bubbles with acid, rhombohedral cleavage	cement, lime	$CaCO_3$	**Calcite**
	3.5	✔		colorless or variable	bubbles with acid when powdered	building stones	$CaMg(CO_3)_2$	**Dolomite**
	4	✔		colorless or variable	cleaves in 4 directions	hydrofluoric acid	CaF_2	**Fluorite**
	5–6	✔		black to dark green	cleaves in 2 directions at 90°	mineral collections, jewelry	$(Ca,Na)(Mg,Fe,Al)(Si,Al)_2O_6$	**Pyroxene** (commonly augite)
	5.5	✔		black to dark green	cleaves at 56° and 124°	mineral collections, jewelry	$CaNa(Mg,Fe)_4(Al,Fe,Ti)_3Si_6O_{22}(O,OH)_2$	**Amphibole** (commonly hornblende)
	6	✔		white to pink	cleaves in 2 directions at 90°	ceramics, glass	$KAlSi_3O_8$	**Potassium feldspar** (commonly orthoclase)
	6	✔		white to gray	cleaves in 2 directions, striations visible	ceramics, glass	$(Na,Ca)AlSi_3O_8$	**Plagioclase feldspar**
	6.5		✔	green to gray or brown	commonly light green and granular	furnace bricks, jewelry	$(Fe,Mg)_2SiO_4$	**Olivine**
	7		✔	colorless or variable	glassy luster, may form hexagonal crystals	glass, jewelry, electronics	SiO_2	**Quartz**
	6.5–7.5		✔	dark red to green	often seen as red glassy grains in NYS metamorphic rocks	jewelry (NYS gem), abrasives	$Fe_3Al_2Si_3O_{12}$	**Garnet**

*Chemical symbols:

Al = aluminum	Cl = chlorine	H = hydrogen	Na = sodium	S = sulfur
C = carbon	F = fluorine	K = potassium	O = oxygen	Si = silicon
Ca = calcium	Fe = iron	Mg = magnesium	Pb = lead	Ti = titanium

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

Hardess: Moh's Hardness Scale

- Created by Friedrich Mohs in 1812
  - German Geologist and Minerologist

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

Hardess: Moh's Hardness Scale

- Created by Fredrick Mohs in 1812
- A scale based on scratch resistance.
- The ability of a harder mineral to scratch a softer mineral.

Talc

Talcum Powder

Other Mineral Characteristics

- Color
- Density
- Chemical
- Magnetic
- Taste
- Smell
- Double Refraction
- Radioactivity
- Fluorescence

PERIODIC TABLE OF THE ELEMENTS

http://www.ktf-split.hr/periodni/en/

PERIOD	GROUP 1 IA	2 IIA	3 IIIB	4 IVB	5 VB	6 VIB	7 VIIB	8	9 VIIIB	10	11 IB	12 IIB	13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	18 VIIIA
1	1 1.0079 **H** HYDROGEN																	2 4.0026 **He** HELIUM
2	3 6.941 **Li** LITHIUM	4 9.0122 **Be** BERYLLIUM											5 10.811 **B** BORON	6 12.011 **C** CARBON	7 14.007 **N** NITROGEN	8 15.999 **O** OXYGEN	9 18.998 **F** FLUORINE	10 20.180 **Ne** NEON
3	11 22.990 **Na** SODIUM	12 24.305 **Mg** MAGNESIUM											13 26.982 **Al** ALUMINIUM	14 28.086 **Si** SILICON	15 30.974 **P** PHOSPHORUS	16 32.065 **S** SULPHUR	17 35.453 **Cl** CHLORINE	18 39.948 **Ar** ARGON
4	19 39.098 **K** POTASSIUM	20 40.078 **Ca** CALCIUM	21 44.956 **Sc** SCANDIUM	22 47.867 **Ti** TITANIUM	23 50.942 **V** VANADIUM	24 51.996 **Cr** CHROMIUM	25 54.938 **Mn** MANGANESE	26 55.845 **Fe** IRON	27 58.933 **Co** COBALT	28 58.693 **Ni** NICKEL	29 63.546 **Cu** COPPER	30 65.39 **Zn** ZINC	31 69.723 **Ga** GALLIUM	32 72.64 **Ge** GERMANIUM	33 74.922 **As** ARSENIC	34 78.96 **Se** SELENIUM	35 79.904 **Br** BROMINE	36 83.80 **Kr** KRYPTON
5	37 85.468 **Rb** RUBIDIUM	38 87.62 **Sr** STRONTIUM	39 88.906 **Y** YTTRIUM	40 91.224 **Zr** ZIRCONIUM	41 92.906 **Nb** NIOBIUM	42 95.94 **Mo** MOLYBDENUM	43 (98) **Tc** TECHNETIUM	44 101.07 **Ru** RUTHENIUM	45 102.91 **Rh** RHODIUM	46 106.42 **Pd** PALLADIUM	47 107.87 **Ag** SILVER	48 112.41 **Cd** CADMIUM	49 114.82 **In** INDIUM	50 118.71 **Sn** TIN	51 121.76 **Sb** ANTIMONY	52 127.60 **Te** TELLURIUM	53 126.90 **I** IODINE	54 131.29 **Xe** XENON
6	55 132.91 **Cs** CAESIUM	56 137.33 **Ba** BARIUM	57-71 **La-Lu** Lanthanide	72 178.49 **Hf** HAFNIUM	73 180.95 **Ta** TANTALUM	74 183.84 **W** TUNGSTEN	75 186.21 **Re** RHENIUM	76 190.23 **Os** OSMIUM	77 192.22 **Ir** IRIDIUM	78 195.08 **Pt** PLATINUM	79 196.97 **Au** GOLD	80 200.59 **Hg** MERCURY	81 204.38 **Tl** THALLIUM	82 207.2 **Pb** LEAD	83 208.98 **Bi** BISMUTH	84 (209) **Po** POLONIUM	85 (210) **At** ASTATINE	86 (222) **Rn** RADON
7	87 (223) **Fr** FRANCIUM	88 (226) **Ra** RADIUM	89-103 **Ac-Lr** Actinide	104 (261) **Rf** RUTHERFORDIUM	105 (262) **Db** DUBNIUM	106 (266) **Sg** SEABORGIUM	107 (264) **Bh** BOHRIUM	108 (277) **Hs** HASSIUM	109 (268) **Mt** MEITNERIUM	110 (281) **Uun** UNUNNILIUM	111 (272) **Uuu** UNUNUNIUM	112 (285) **Uub** UNUNBIUM		114 (289) **Uuq** UNUNQUADIUM				

RELATIVE ATOMIC MASS (1)
GROUP IUPAC
GROUP CAS
ATOMIC NUMBER
SYMBOL
ELEMENT NAME
5 10.811 B BORON

Metal | Semimetal | Nonmetal
1 Alkali metal
2 Alkaline earth metal
Transition metals
Lanthanide
Actinide
16 Chalcogens element
17 Halogens element
18 Noble gas

STANDARD STATE (25 °C; 101 kPa)
Ne - gas
Fe - solid
Ga - liquid
Tc - synthetic

LANTHANIDE

57 138.91 **La** LANTHANUM	58 140.12 **Ce** CERIUM	59 140.91 **Pr** PRASEODYMIUM	60 144.24 **Nd** NEODYMIUM	61 (145) **Pm** PROMETHIUM	62 150.36 **Sm** SAMARIUM	63 151.96 **Eu** EUROPIUM	64 157.25 **Gd** GADOLINIUM	65 158.93 **Tb** TERBIUM	66 162.50 **Dy** DYSPROSIUM	67 164.93 **Ho** HOLMIUM	68 167.26 **Er** ERBIUM	69 168.93 **Tm** THULIUM	70 173.04 **Yb** YTTERBIUM	71 174.97 **Lu** LUTETIUM

ACTINIDE

89 (227) **Ac** ACTINIUM	90 232.04 **Th** THORIUM	91 231.04 **Pa** PROTACTINIUM	92 238.03 **U** URANIUM	93 (237) **Np** NEPTUNIUM	94 (244) **Pu** PLUTONIUM	95 (243) **Am** AMERICIUM	96 (247) **Cm** CURIUM	97 (247) **Bk** BERKELIUM	98 (251) **Cf** CALIFORNIUM	99 (252) **Es** EINSTEINIUM	100 (257) **Fm** FERMIUM	101 (258) **Md** MENDELEVIUM	102 (259) **No** NOBELIUM	103 (262) **Lr** LAWRENCIUM

(1) Pure Appl. Chem., 73, No. 4, 667-683 (2001)

Relative atomic mass is shown with five significant figures. For elements have no stable nuclides, the value enclosed in brackets indicates the mass number of the longest-lived isotope of the element.

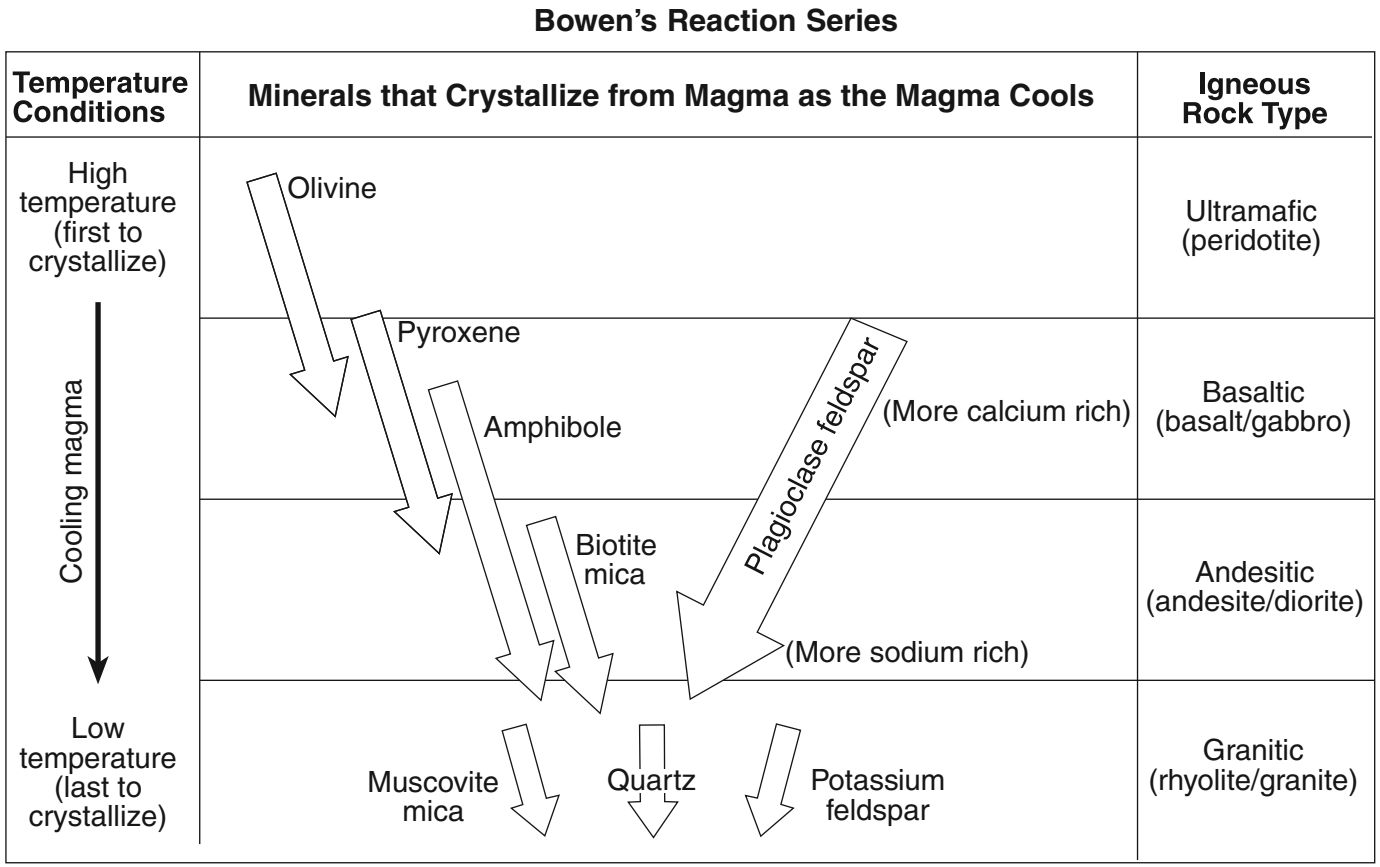
However three such elements (Th, Pa, and U) do have a characteristic terrestrial isotopic composition, and for these an atomic weight is tabulated.

Editor: Aditya Vardhan (adivar@nettlinx.com)

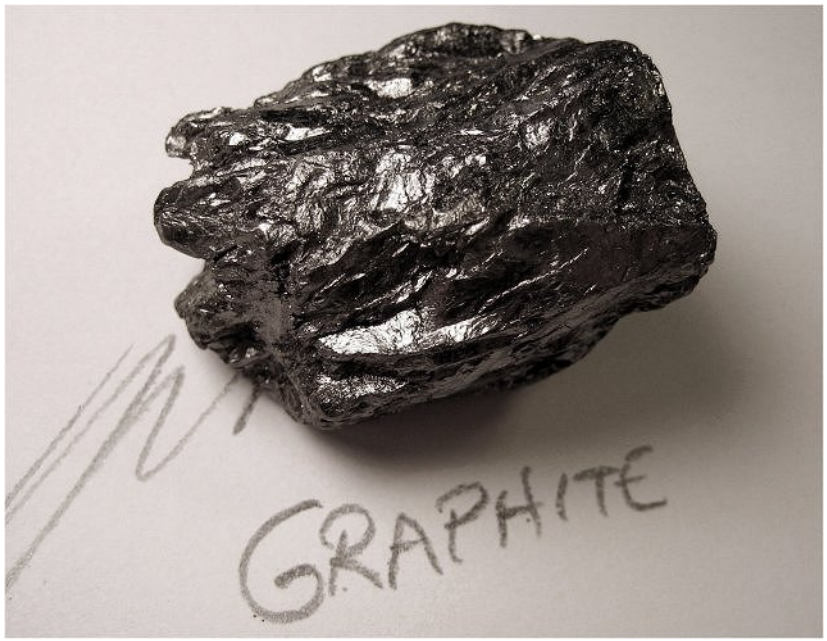
Mineral Formation

- Minerals form by two process…
  1. Cooling underneath the surface of the Earth.
  2. Through evaporation or precipitation.

Cooling Under the Earth's Surface

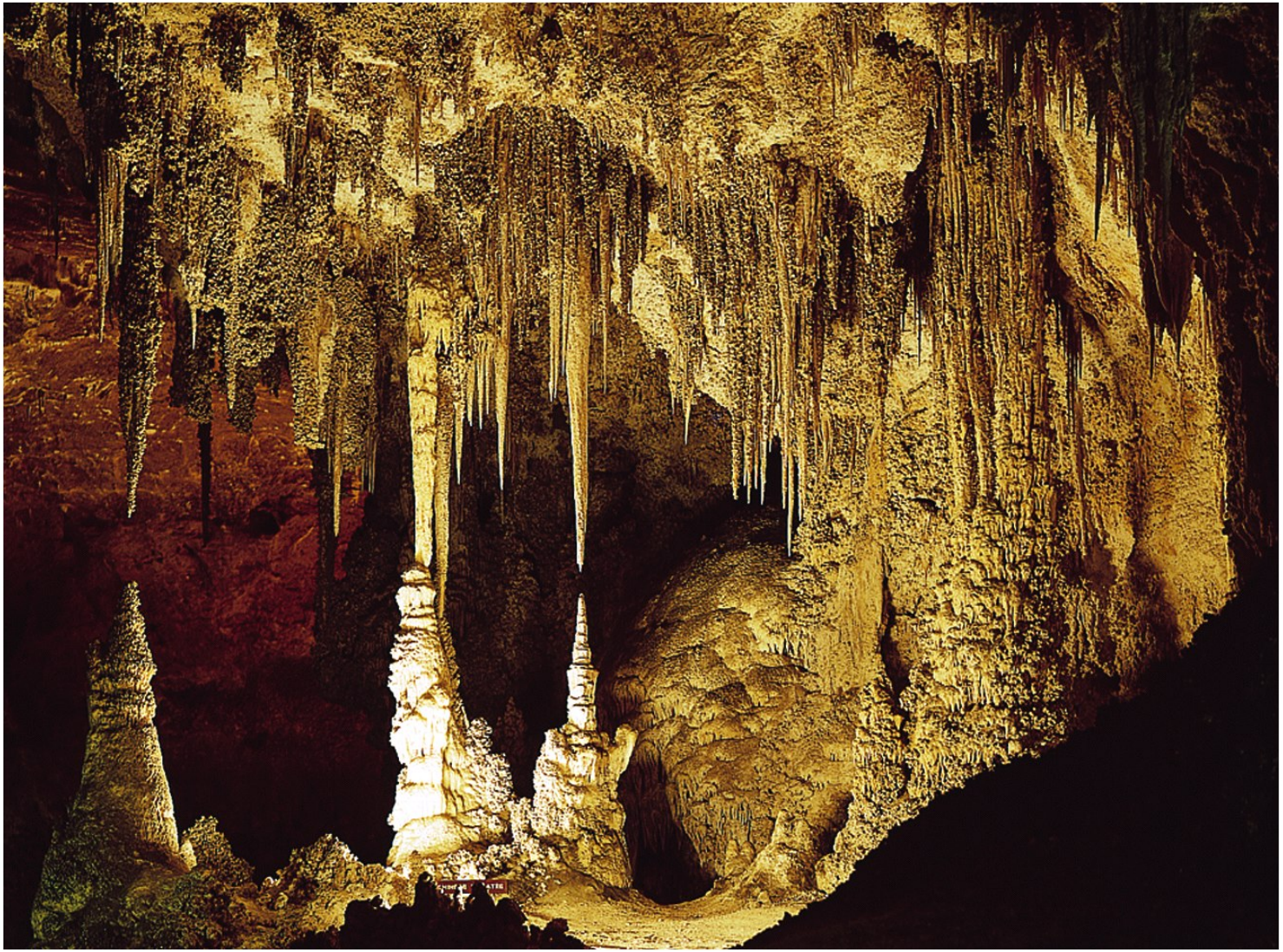


Diamond vs. Graphite



Evaporation

Precipitation



Minerals To Know

- Graphite
  - Cleavage
  - Streak: black
  - Hardness: 1 – 2, Cannot scratch glass
  - Luster: Metallic

Minerals To Know

- Galena
  - Cleavage
  - Streak: silver
  - Hardness: 2.5, Cannot scratch glass
  - Luster: Metallic

Minerals To Know

- Magnetite
  - Fracture
  - Streak: black
  - Hardness: 5.5-6.5, scratch glass
  - Luster: Metallic

Minerals To Know

- Pyrite
  - Fracture
  - Streak: green-black
  - Hardness: 6.5, Scratches glass
  - Luster: Metallic

Minerals To Know

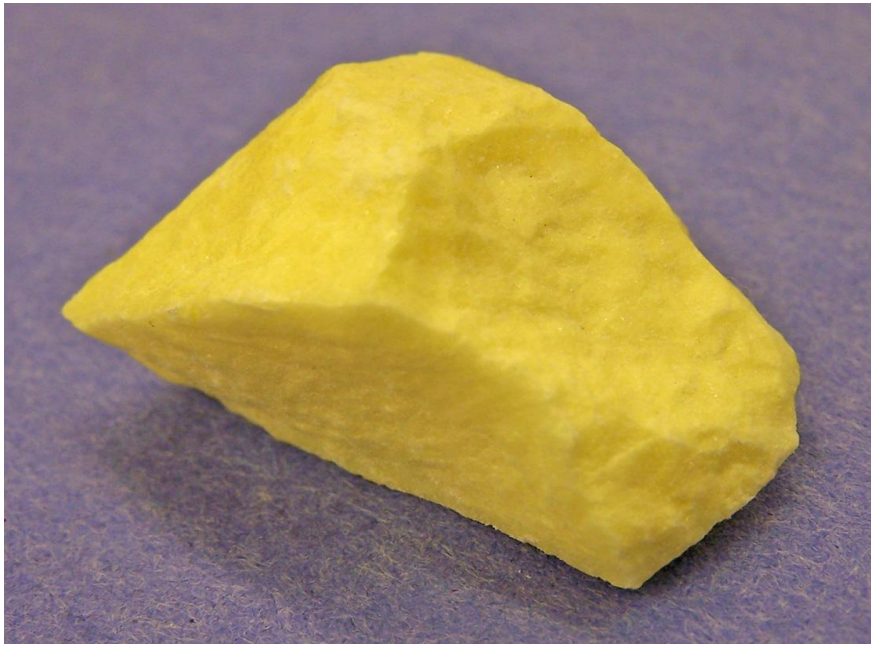
- Hematite
  - Fracture
  - Streak: red or silver
  - Hardness: 5.5-6.5 or 1
  - Luster: Metallic or Non-Metallic

Minerals To Know

- Talc
  - Cleavage
  - Streak: White
  - Hardness: 1, Cannot scratch glass
  - Luster: non-Metallic

Minerals To Know

- Sulfur
  - Fracture
  - Streak: White-yellow
  - Hardness: 2, Cannot scratch glass
  - Luster: non-Metallic



Minerals To Know

- Halite
  - Cleavage
  - Streak: White
  - Hardness: 2.5,
    Cannot scratch glass
  - Luster: non-Metallic

Minerals To Know

- Biotite Mica
  - Cleavage
  - Streak: grey
  - Hardness: 2.5 – 3, Cannot scratch glass
  - Luster: non-Metallic

Muscovite Mica

Minerals To Know

- Calcite
  - Cleavage
  - Streak: White
  - Hardness: 3,
    Cannot scratch glass
  - Luster: non-Metallic

Minerals To Know

- Fluorite
  - Cleavage
  - Streak: White
  - Hardness: 4,
    Cannot scratch glass
  - Luster: non-Metallic

Minerals To Know

- Feldspar (Orthoclase)
  - Cleavage
  - Streak: White
  - Hardness: 6,
    Cannot scratch glass
  - Luster: non-Metallic

Minerals To Know

- Quartz
  - Fracture
  - Streak: White
  - Hardness: 7, Scratches glass
  - Luster: non-Metallic

Do Now

- Copy the question below and write down an answer…

Look at the Igneous Rock Identification table on page 6 of your ESRT.

List all the information this table gives on Igneous Rocks.

ROCKS

Rocks

If a mineral is a naturally occurring homogeneous solid, inorganically formed, with a definite chemical composition and a crystalline structure …

… then what is a rock?

Rocks

- Rocks are composed of 1 or more minerals.
- Rocks are classified based on how they formed (origin).
- 3 classes of rocks:
  - Igneous
  - Sedimentary
  - Metamorphic

Igneous Rocks

- Form from the cooling and solidification (crystallization) of molten lava and magma

- **Intrusive (Plutonic)**: slow cooling of magma deep within the Earth
- Characteristics:
  - Large crystals
  - Coarse, rough texture
  - Inter-grown crystals

Obsidian

Rhyolite

- **Extrusive (Volcanic)**: fast cooling lava at Earth's surface
- Characteristics:
  - Small crystals
  - No crystals/Glassy
  - Fine/smooth texture
  - Vesicular: contains air/gas pockets

- **Intrusive**: slow cooling of magma deep within the Earth
- Characteristics:
  - Large crystals
  - Coarse, rough texture
  - Inter-grown crystals

- **Extrusive**: fast cooling lava at Earth's surface
- Characteristics:
  - Small/no crystals
  - Glassy
  - Fine/smooth texture
  - Vesicular: contains air/ gas pockets

Comparison

Granite

Rhyolite

Igneous Rocks

Textures to look for:

- Crystals
- Gas pockets
- Glass Surface

Igneous Rocks

Rocks to know:

- **Pumice**: look for gas pockets
- **Obsidian**: black and glassy
- **Basalt**: black and FINE (small) grained
- **Gabbro**: dark and large crystals
- **Granite**: dark or light, large crystals

Pumice: look for empty gas pockets

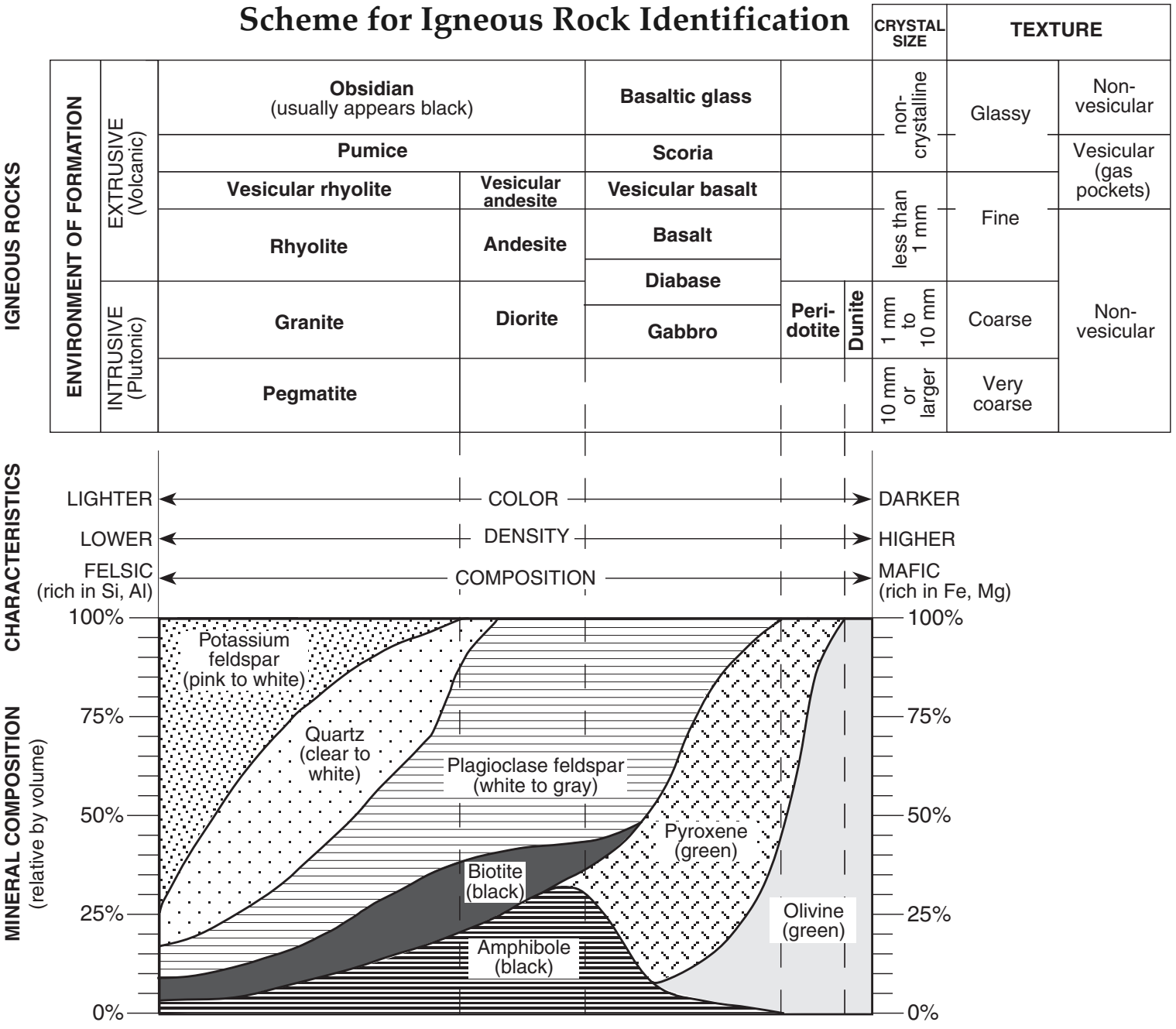
Obsidian: black and glassy

Basalt : black and fine (small) grained

Gabbro

Granite

Scheme for Igneous Rock Identification



Do Now

- Write down an answer in handout…

Summarize the difference between the igneous rocks Granite and Rhyolite.

Granite

Rhyolite

Do Now

- Copy the question below and write down an answer…

What is the mineral composition of the igneous rock:

- *Rhyolite*
- *Andesite*
- *Gabbro*

Sedimentary Rocks

- Form from pieces of other rocks, animals or plants.
- The pieces get compacted and glued together
  - Cementation, lithification

Sedimentary Rocks

- **Clastic**: made from other pieces of rocks
- Characteristics
  - Visible fragments/pieces (pebbles, sand, mud/clay)

Sedimentary Rocks

- **Crystalline**: Form from the evaporation and precipitation of dissolved minerals.
  - Crystals
  - Fine to coarse

Sedimentary Rocks

- **Bioclastic**: Made from once living plants or animals
  - Fossils
  - Black coal

Sedimentary Rocks

- Look for SEDIMENT!
  - (pebbles, sand)
- Look for FOSSILS!
  - (shells, plant imprints, animals)

Sedimentary Rocks

Rocks to know:

- **Conglomerate**: look for pebbles
- **Sandstone**: look for sand particles
- **Shale**: compact silt or clay, can have fossils
- **Limestone**: look for sea shells
- **Coal**: black

Conglomerate

Sandstone

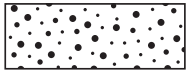
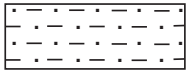
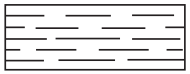
Shale

Limestone

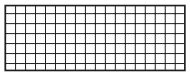
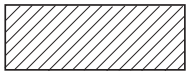
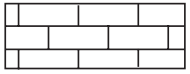
Coal

Scheme for Sedimentary Rock Identification

INORGANIC LAND-DERIVED SEDIMENTARY ROCKS

TEXTURE	GRAIN SIZE	COMPOSITION	COMMENTS	ROCK NAME	MAP SYMBOL
Clastic (fragmental)	Pebbles, cobbles, and/or boulders embedded in sand, silt, and/or clay	Mostly quartz, feldspar, and clay minerals; may contain fragments of other rocks and minerals	Rounded fragments	**Conglomerate**	
			Angular fragments	**Breccia**	
	Sand (0.006 to 0.2 cm)		Fine to coarse	**Sandstone**	
	Silt (0.0004 to 0.006 cm)		Very fine grain	**Siltstone**	
	Clay (less than 0.0004 cm)		Compact; may split easily	**Shale**	

CHEMICALLY AND/OR ORGANICALLY FORMED SEDIMENTARY ROCKS

TEXTURE	GRAIN SIZE	COMPOSITION	COMMENTS	ROCK NAME	MAP SYMBOL
Crystalline	Fine to coarse crystals	Halite	Crystals from chemical precipitates and evaporites	**Rock salt**	
		Gypsum		**Rock gypsum**	
		Dolomite		**Dolostone**	
Crystalline or bioclastic	Microscopic to very coarse	Calcite	Precipitates of biologic origin or cemented shell fragments	**Limestone**	
Bioclastic		Carbon	Compacted plant remains	**Bituminous coal**	

Do Now

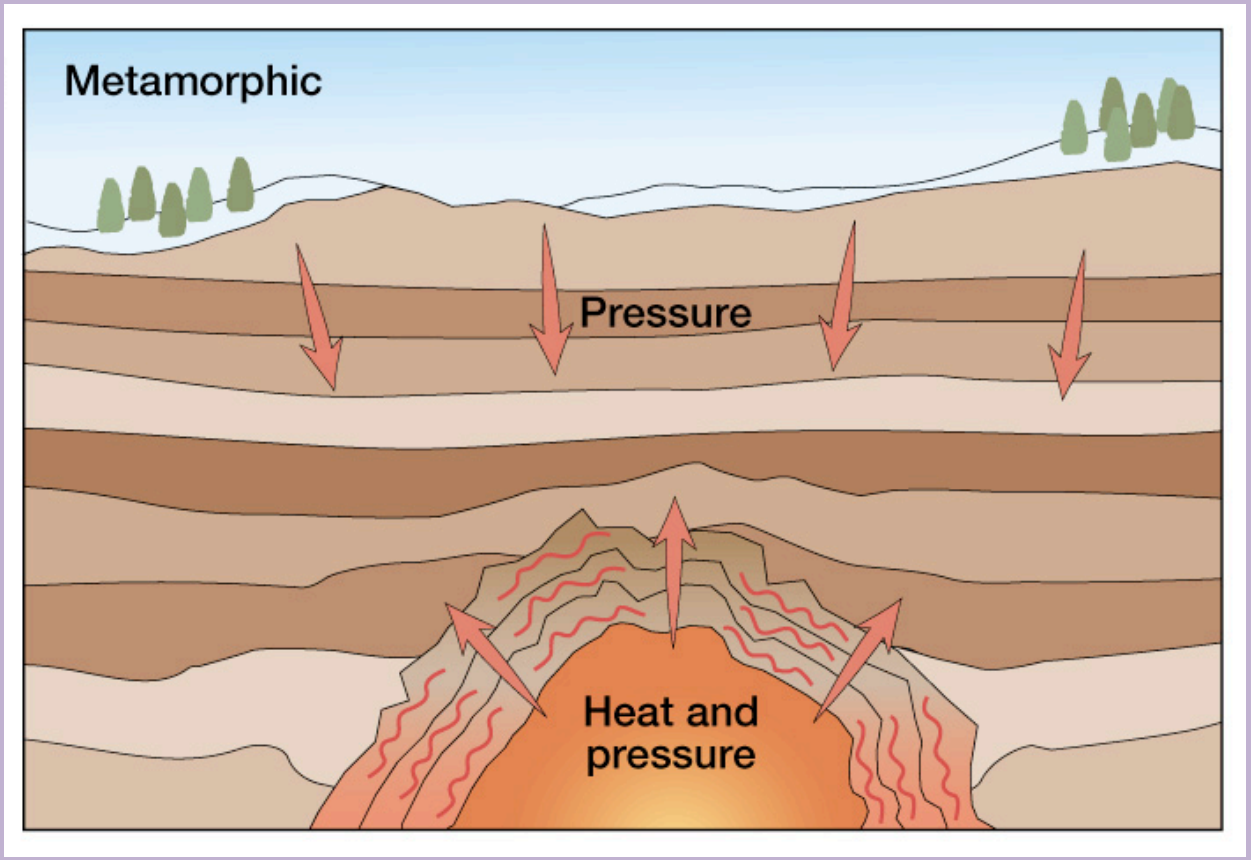
- Copy the question below and write down an answer…

What mineral is limestone and rock salt made from.

List the hardness of both minerals.

Metamorphic Rocks

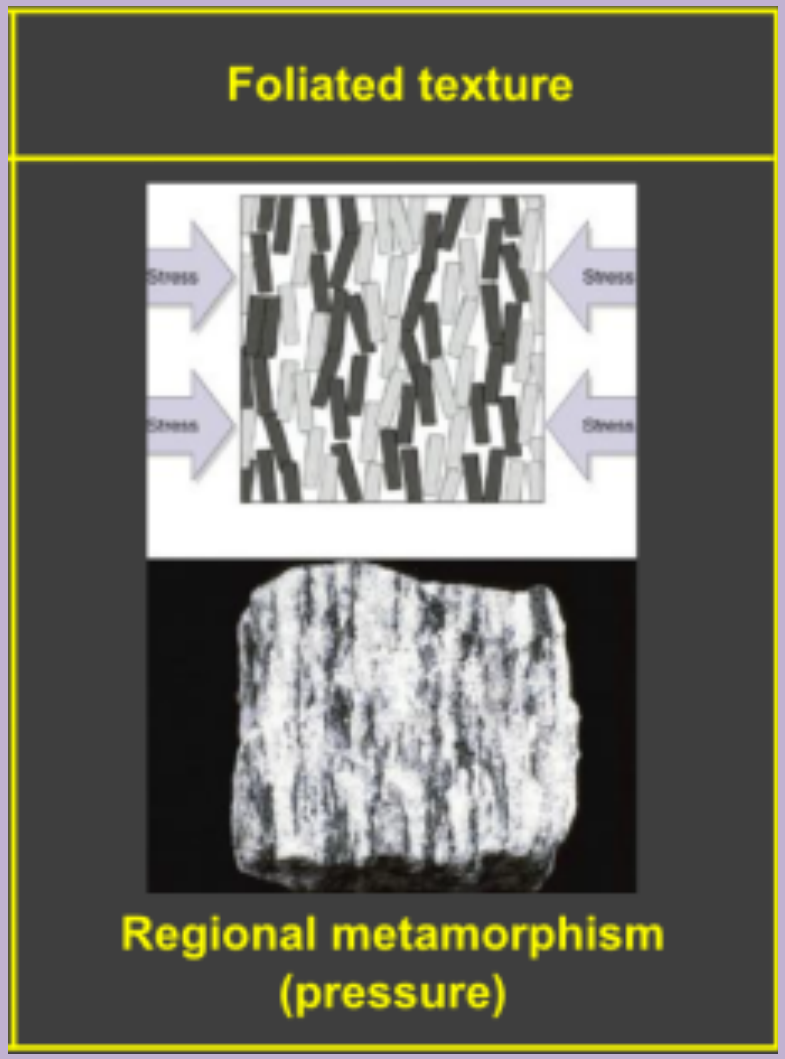
- Form from intense heat and pressure.
- There is no melting!



Metamorphosis

- The process of transformation
- A change into something completely different

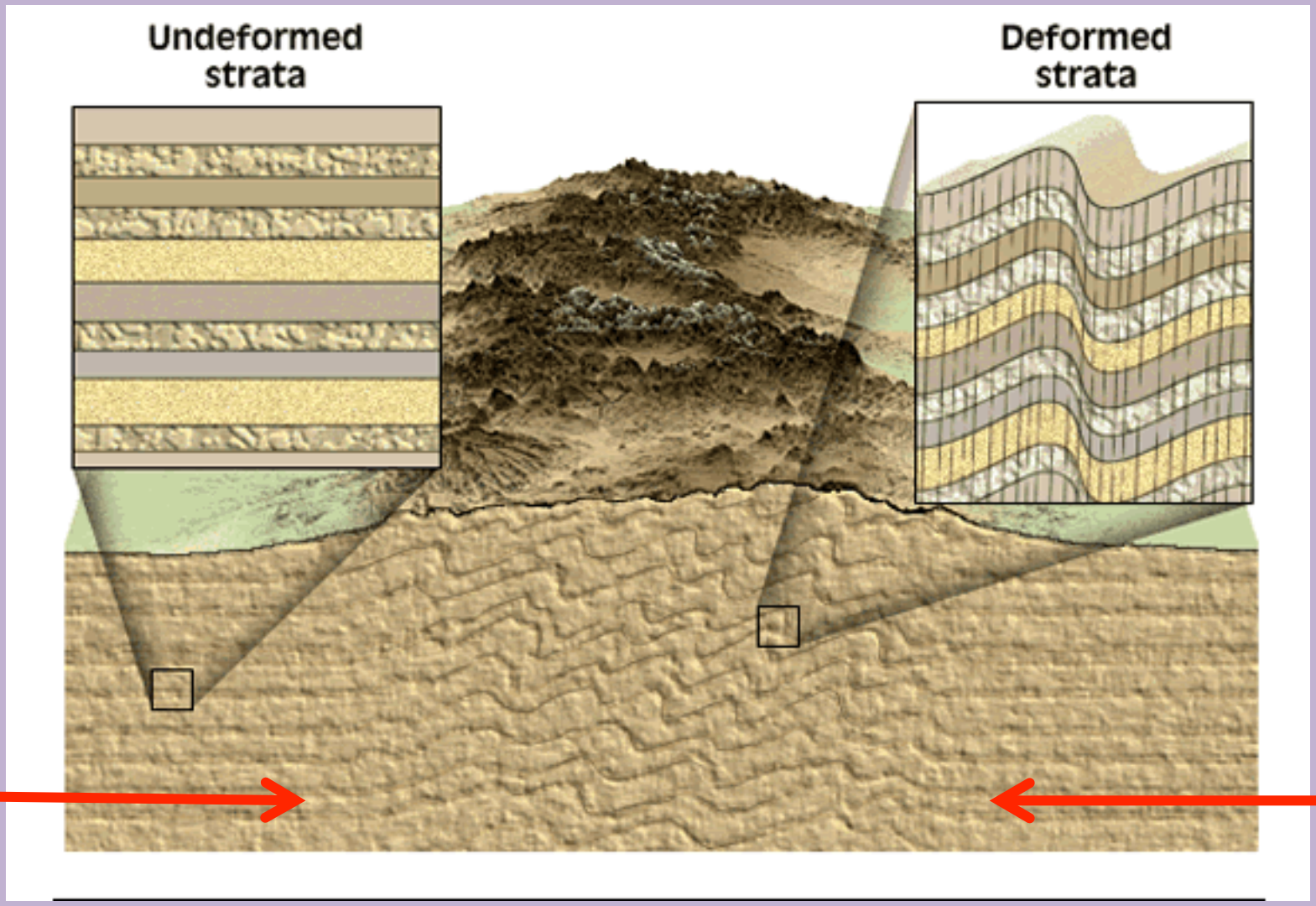
Metamorphic

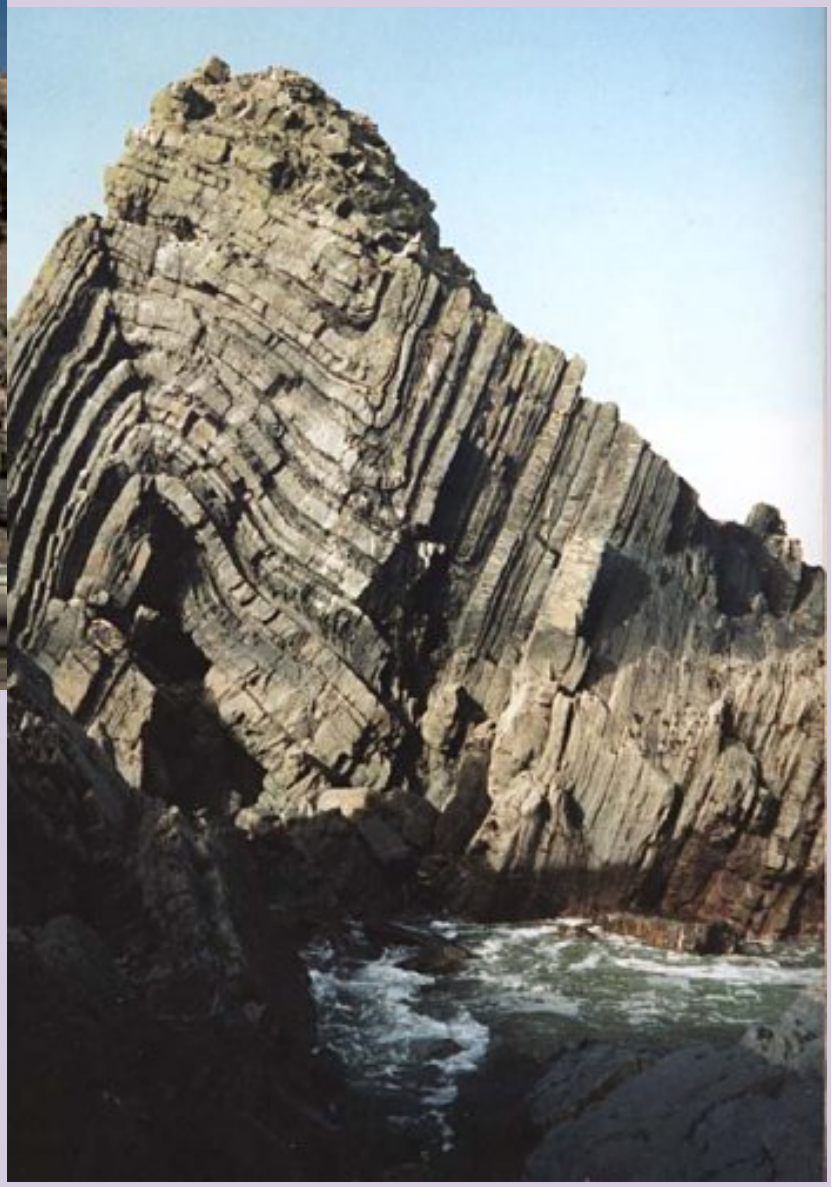


FOLIATED

- Regional metamorphism where applied pressure produces layers.
  - Mineral Alignment
  - Layering
  - Banding

Regional Metamorphism



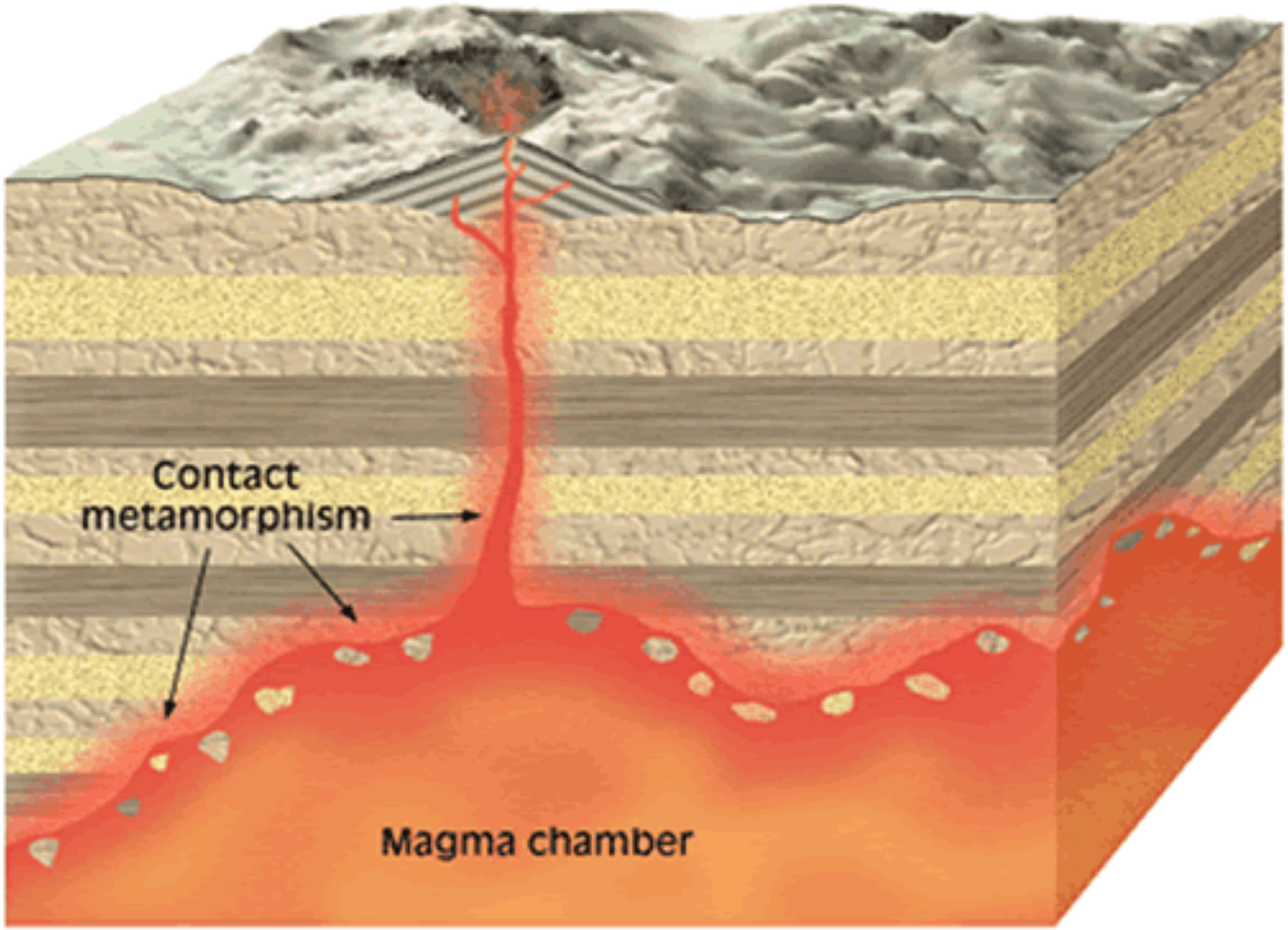


Metamorphic

NON-FOLIATED

- Contact metamorphism where applied heat recrystallizes the minerals.
  - Shiny Flakes
  - Crystals Mashed Together
  - Granular

Contact Metamorphism



Metamorphic Rocks

- **New minerals** due to recrystallization
  - The growth of new mineral crystals without melting
- **Increased density**
  - Rock is squeezed under pressure
- **Banding**
  - Layered arrangement of inter-grown crystals due to pressure

Metamorphic Rock

What to look for:

- Shiny flakes (mica)
- Crystals all mashed together
- Layering (banding) with crystals!

Metamorphic Rock

Rocks to know:

- Slate: black and flat with foliation *(Shale)*
- Schist: flakey, shiny crystals *(Shale)*
- Gneiss: banded, flat, folded crystals *(Granite)*
- Marble: crystals mashed together *(Limestone)*




Slate: black, flat with foliation (cleavage)

Schist: flakey, shiny crystals

Gneiss: layering and folding of crystals

Marble: crystals mashed together

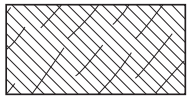
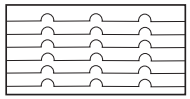
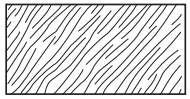
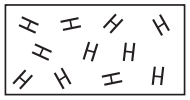
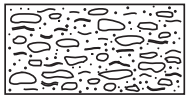
Sandstone

Sedimentary

Quartzite

Metamorphic

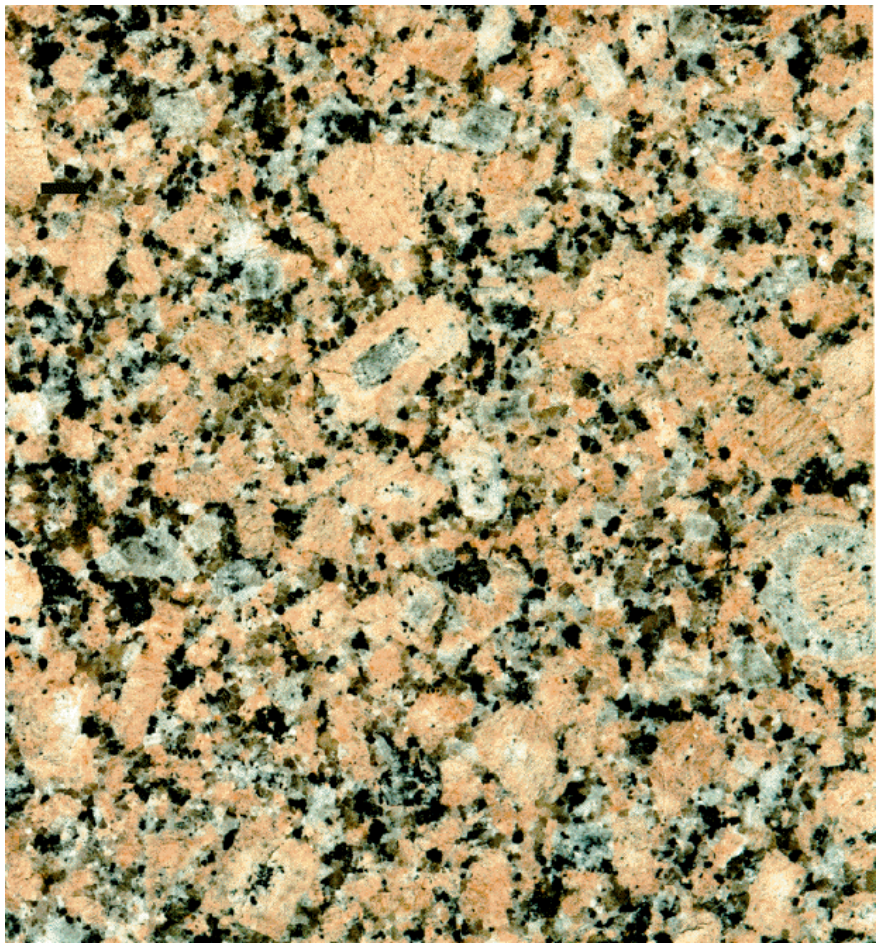
Scheme for Metamorphic Rock Identification

TEXTURE		GRAIN SIZE	COMPOSITION	TYPE OF METAMORPHISM	COMMENTS	ROCK NAME	MAP SYMBOL
FOLIATED	MINERAL ALIGNMENT	Fine	MICA, QUARTZ, FELDSPAR, AMPHIBOLE, GARNET, PYROXENE	Regional (Heat and pressure increases) ↓	Low-grade metamorphism of shale	**Slate**	
		Fine to medium			Foliation surfaces shiny from microscopic mica crystals	**Phyllite**	
					Platy mica crystals visible from metamorphism of clay or feldspars	**Schist**	
	BAND-ING	Medium to coarse			High-grade metamorphism; mineral types segregated into bands	**Gneiss**	
NONFOLIATED		Fine	Carbon	Regional	Metamorphism of bituminous coal	**Anthracite coal**	
		Fine	Various minerals	Contact (heat)	Various rocks changed by heat from nearby magma/lava	**Hornfels**	
		Fine to coarse	Quartz	Regional or contact	Metamorphism of quartz sandstone	**Quartzite**	
			Calcite and/or dolomite		Metamorphism of limestone or dolostone	**Marble**	
		Coarse	Various minerals		Pebbles may be distorted or stretched	**Metaconglomerate**	

Coal Vs. Obsidian

Gneiss Vs. Sandstone

Granite Vs. Gneiss



Do Now

- Copy the question below and write down an answer…

  Describe the main difference between each rock class:

  Igneous, sedimentary and metamorphic

Do Now

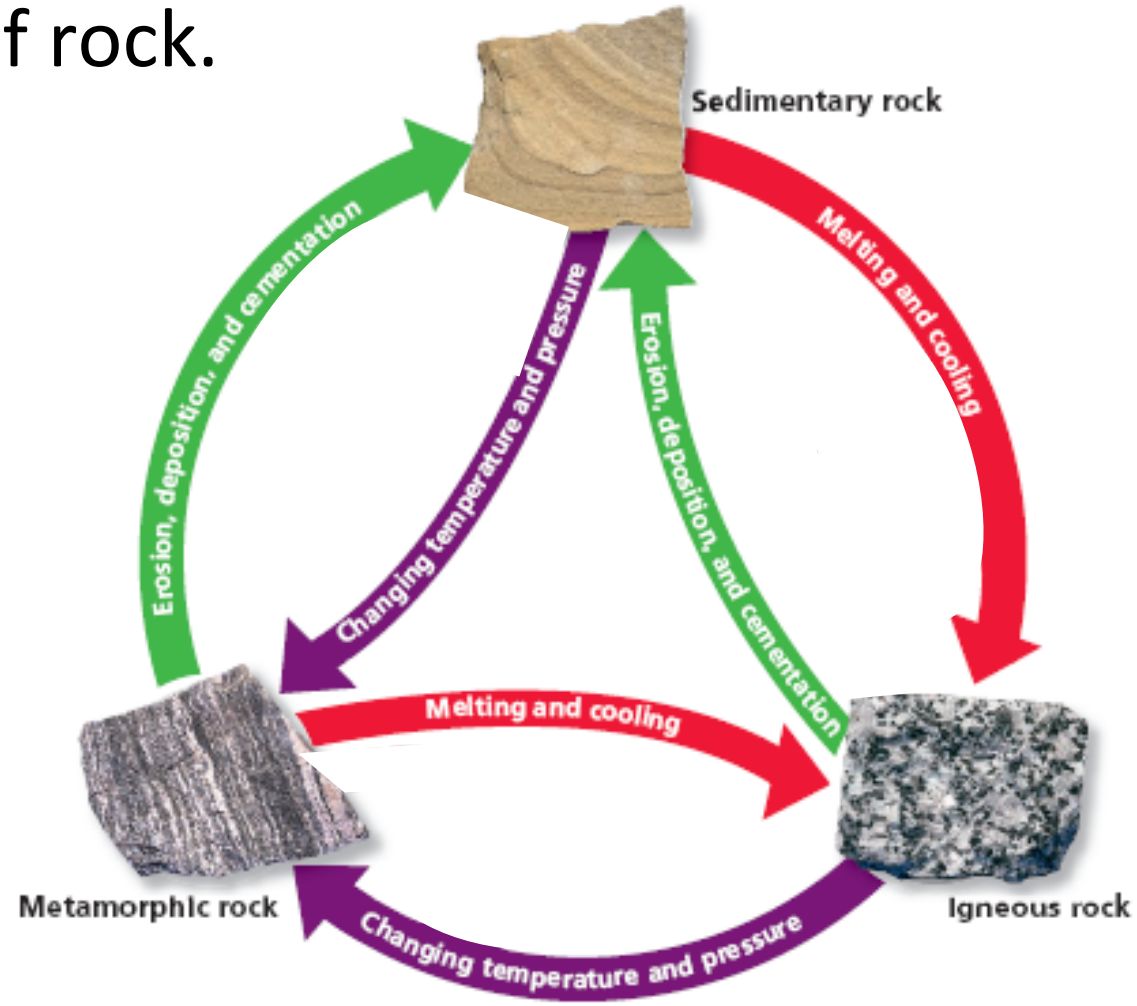
- Copy the question below and write down an answer…

What is the difference between regional and contact metamorphism?

What characteristic does the rock show for each?

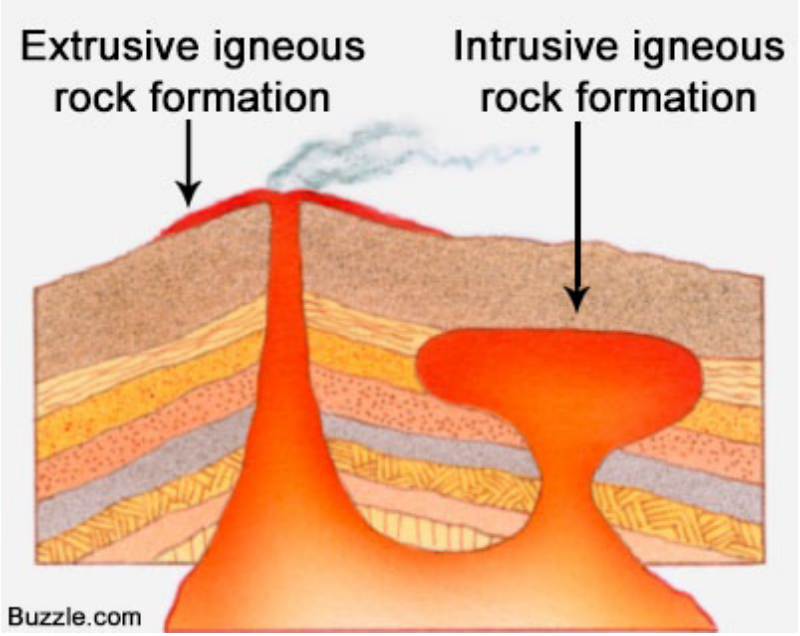
The Rock Cycle

- Any class of rock can change and form into another class of rock.



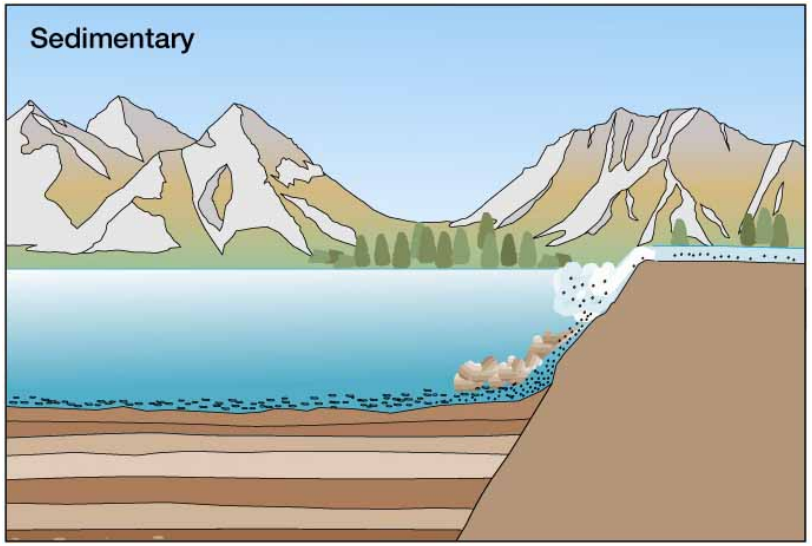
Igneous Rock

- Melting
  - Igneous Rock
- Weathering and Erosion
  - Sedimentary
- Heat and Pressure
  - Metamorphic Rock



Sedimentary Rock

- Melting
  - Igneous Rock
- Weathering and Erosion
  - Sedimentary Rock
- Heat and Pressure
  - Metamorphic Rock

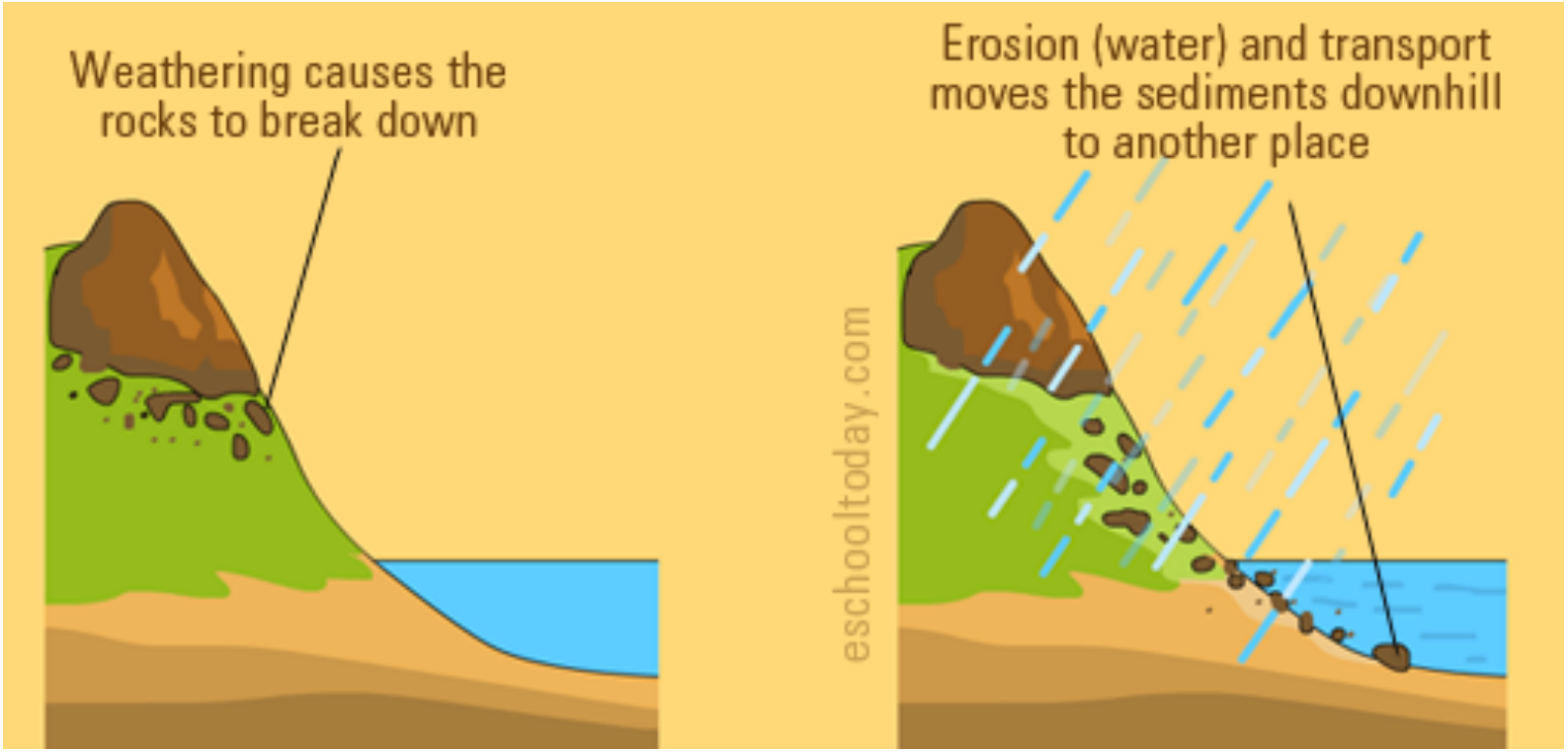


Weathering

- The breakdown of rocks when exposed to conditions at Earth's surface.

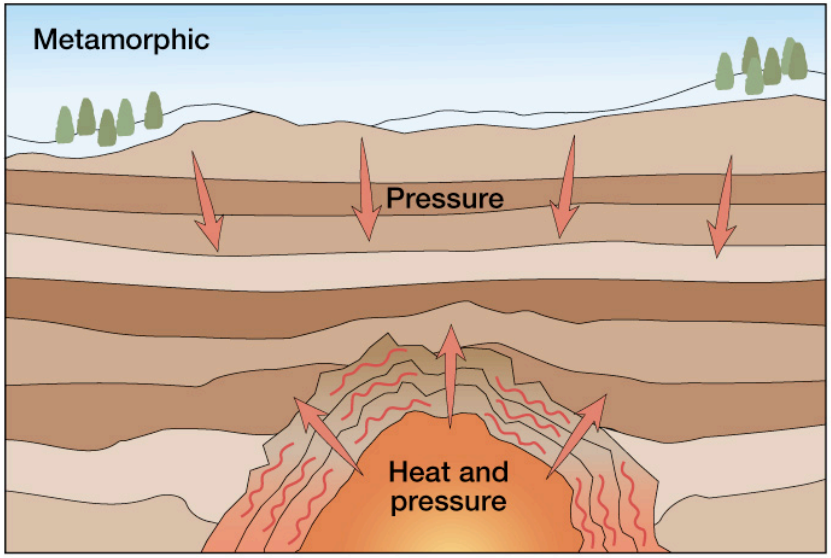
Erosion

- The movement of broken down rock by water, air, glacier, or by gravity.

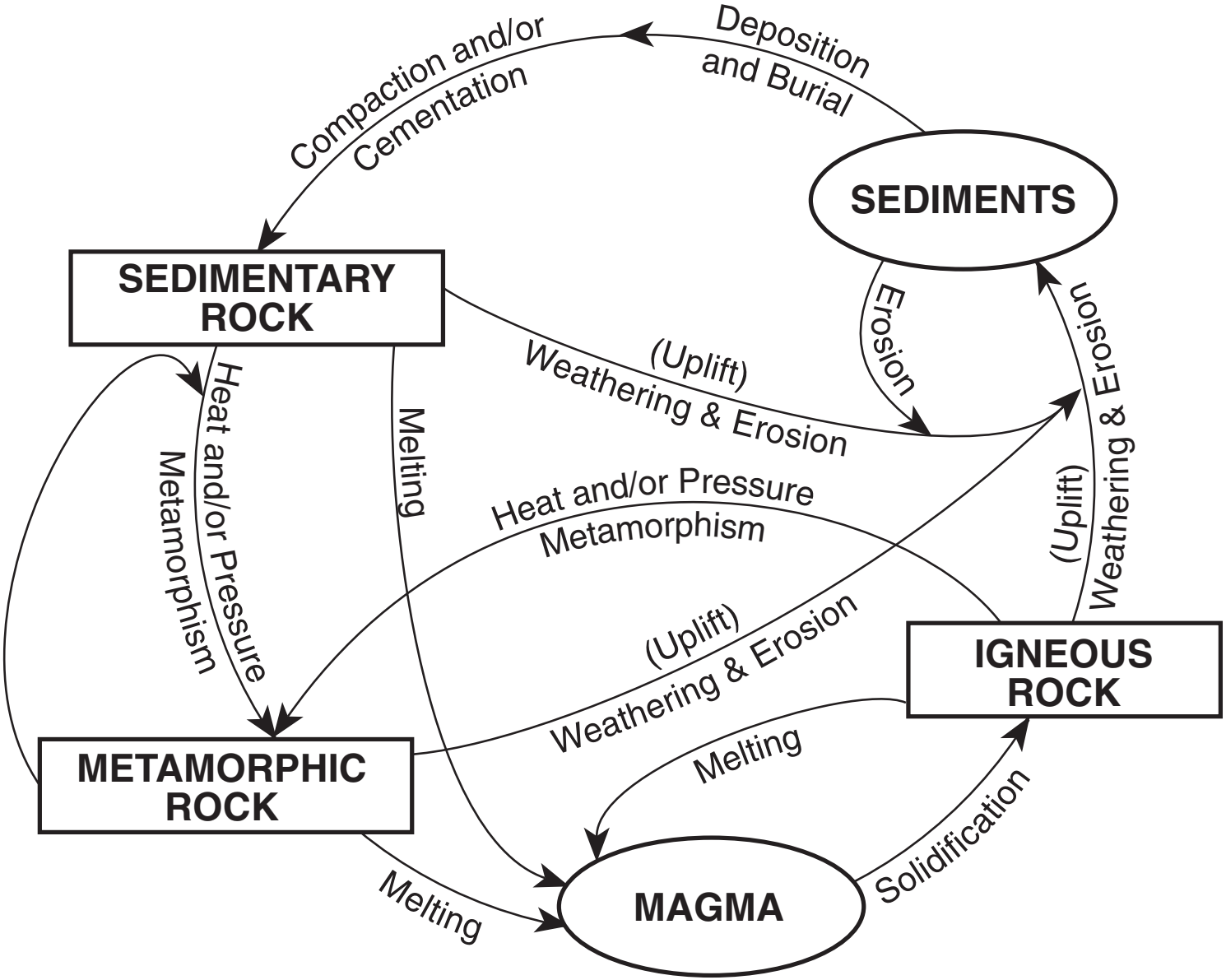


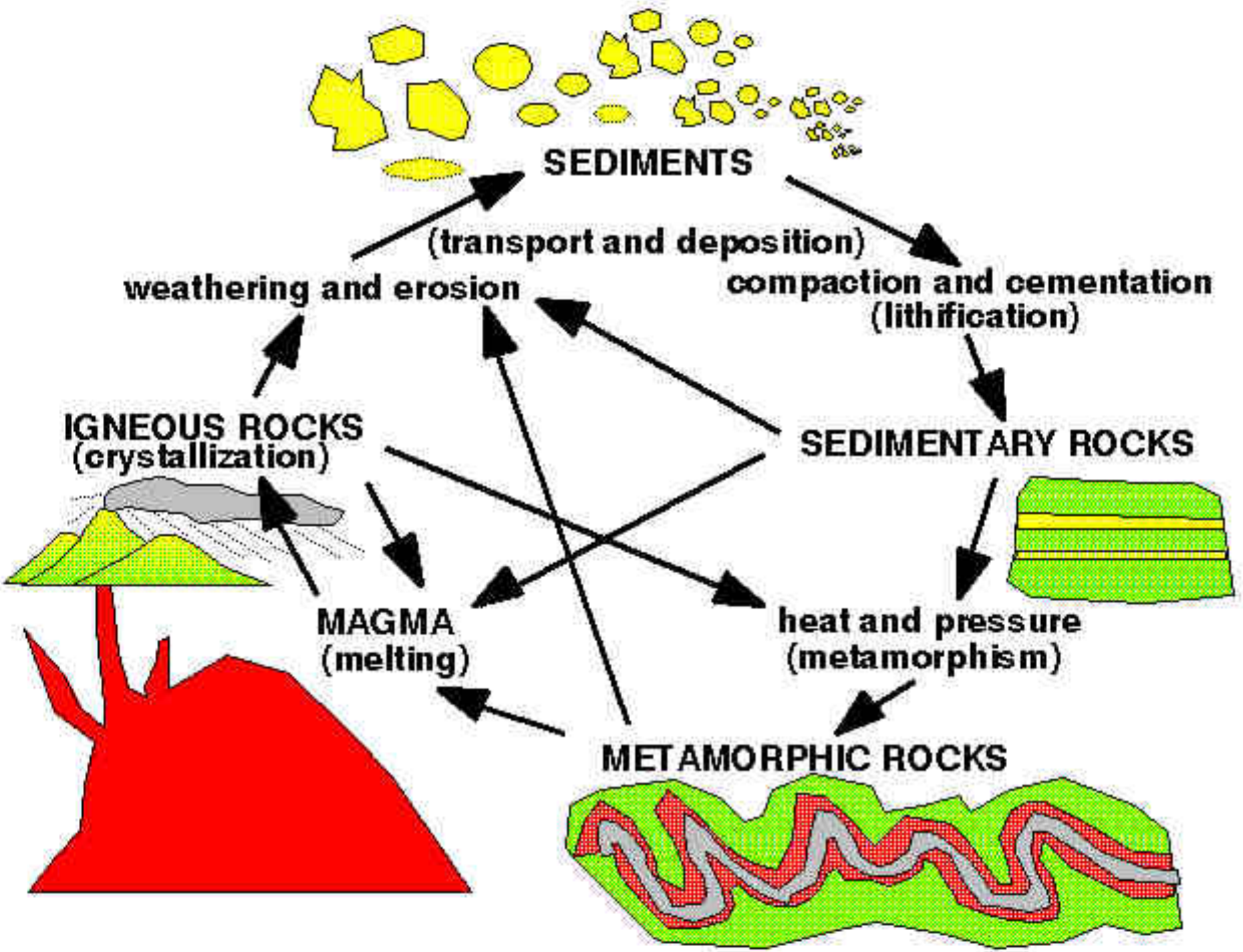
Metamorphic Rock

- Melting
  - Igneous Rock
- Weathering and Erosion
  - Sedimentary
- Heat and Pressure
  - Metamorphic Rock

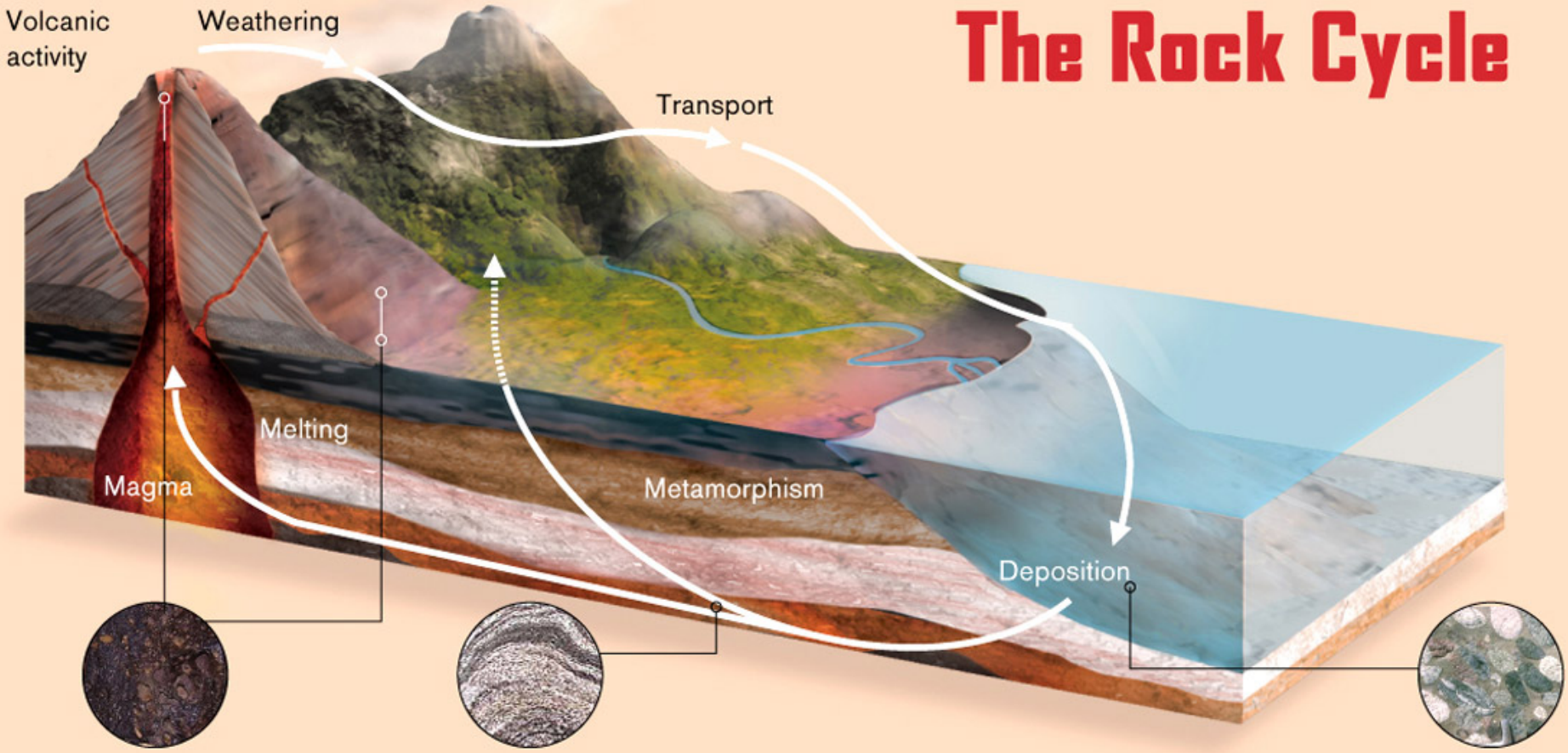


Rock Cycle in Earth's Crust




SEDIMENTS
(transport and deposition)
weathering and erosion
compaction and cementation
(lithification)
IGNEOUS ROCKS
(crystallization)
SEDIMENTARY ROCKS
MAGMA
(melting)
heat and pressure
(metamorphism)
METAMORPHIC ROCKS

The Rock Cycle



Igneous rock

These rocks are formed when magma (molten rock) from the Earth's interior cools and solidifies.

Metamorphic rock

The heat and pressure of the Earth's interior transform igneous and sedimentary rocks into metamorphic rocks.

Sedimentary rock

Atmospheric agents erode and transport igneous rocks to the seabed, where they are compressed and merged with others into sedimentary rocks.

THE ROCK CYCLE

Sandstone
(Clastic)

Sedimentary Rock

Fossiliferous
Limestone
(Organic)

Changed by Heat, Pressure and/or Chemical Action

Deposition, Compaction & Lithification

Weathering & Erosion

Gneiss
(Foliated)

Basalt
(Extrusive)

Weathering & Erosion

Metamorphic Rock

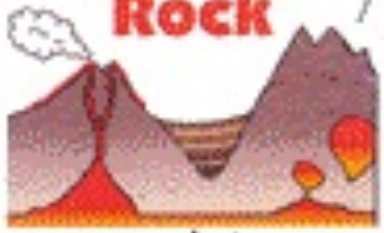
Changed by Heat, Pressure and/or Chemical Action

Igneous Rock

Pressure

Pressure

Heating



melting

Marble
(Non-Foliated)

melting

Magma

solidification

Granite
(Intrusive)