Rocks and Minerals

Goal: Students will be able to describe the characteristics an object must possess to be classified as a mineral.

Goal: Students will be able to describe the characteristics an object must possess to be classified as a mineral.

Goal: Students will be able to describe the characteristics an object must possess to be classified as a mineral.

Goal: Students will be able to describe the characteristics an object must possess to be classified as a mineral.

Goal: Students will be able to describe the characteristics an object must possess to be classified as a mineral.

Goal: Students will be able to describe the characteristics an object must possess to be classified as a mineral.

Goal: Students will be able to describe the characteristics an object must possess to be classified as a mineral.

Goal: Students will be able to describe the characteristics an object must possess to be classified as a mineral.

Goal: Students will be able to describe the characteristics an object must possess to be classified as a mineral.

What makes up an environment?

- Living - plants, animals, bacteria, etc.
- Non-living - rocks, minerals, man-made materials.

Goal: Students will be able to describe the characteristics an object must possess to be classified as a mineral.

Goal: Students will be able to describe the characteristics an object must possess to be classified as a mineral.

Goal: Students will be able to describe the characteristics an object must possess to be classified as a mineral.

Goal: Students will be able to describe the characteristics an object must possess to be classified as a mineral.

Goal: Students will be able to describe the characteristics an object must possess to be classified as a mineral.

Goal: Students will be able to describe the characteristics an object must possess to be classified as a mineral.

Goal: Students will be able to describe the characteristics an object must possess to be classified as a mineral.

Goal: Students will be able to describe the characteristics an object must possess to be classified as a mineral.

Goal: Students will be able to describe the characteristics an object must possess to be classified as a mineral.

Goal: Students will be able to describe the characteristics an object must possess to be classified as a mineral.

January
Garnet

February
Amethyst

March
Aquamarine

April
Crystal

May
Emerald

June
Alexandrite

July
Ruby

August
Peridot

September
Sapphire

October
Rose Zircon

November
Topaz

December
Blue Zircon

Goal: Students will be able to describe the characteristics an object must possess to be classified as a mineral.

Goal: Students will be able to describe the characteristics an object must possess to be classified as a mineral.

Minerals

- Natural (not man-made).
- Non-living (inorganic).
- Solid, with a crystalline atomic structure. (Atoms are arranged.)
- Definite composition. (Certain elements or compounds.)

Goal: Students will be able to describe the characteristics an object must possess to be classified as a mineral.

Periodic Table of the Elements

1 1IA 11A	2 IIA 2A	3 IIIB 3B	4 IVB 4B	5 VB 5B	6 VIB 6B	7 VIIB 7B	8	9 VIII 8	10	11 IB 1B	12 IIB 2B	13 IIIA 3A	14 IVA 4A	15 VA 5A	16 VIA 6A	17 VIIA 7A	18 VIIIA 8A
1 H Hydrogen 1.0079																	2 He Helium 4.00260
3 Li Lithium 6.941	4 Be Beryllium 9.01218											5 B Boron 10.811	6 C Carbon 12.011	7 N Nitrogen 14.00674	8 O Oxygen 15.9994	9 F Fluorine 18.998403	10 Ne Neon 20.1797
11 Na Sodium 22.989768	12 Mg Magnesium 24.305											13 Al Aluminum 26.981539	14 Si Silicon 28.0855	15 P Phosphorus 30.973762	16 S Sulfur 32.066	17 Cl Chlorine 35.4527	18 Ar Argon 39.948
19 K Potassium 39.0983	20 Ca Calcium 40.078	21 Sc Scandium 44.95591	22 Ti Titanium 47.88	23 V Vanadium 50.9415	24 Cr Chromium 51.9961	25 Mn Manganese 54.938	26 Fe Iron 55.847	27 Co Cobalt 58.9332	28 Ni Nickel 58.6934	29 Cu Copper 63.546	30 Zn Zinc 65.39	31 Ga Gallium 69.732	32 Ge Germanium 72.64	33 As Arsenic 74.92159	34 Se Selenium 78.96	35 Br Bromine 79.904	36 Kr Krypton 83.80
37 Rb Rubidium 85.4678	38 Sr Strontium 87.62	39 Y Yttrium 88.90585	40 Zr Zirconium 91.224	41 Nb Niobium 92.90638	42 Mo Molybdenum 95.94	43 Tc Technetium 98.9072	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.9055	46 Pd Palladium 106.42	47 Ag Silver 107.8682	48 Cd Cadmium 112.411	49 In Indium 114.818	50 Sn Tin 118.71	51 Sb Antimony 121.760	52 Te Tellurium 127.6	53 I Iodine 126.90447	54 Xe Xenon 131.29
55 Cs Cesium 132.90543	56 Ba Barium 137.327	57-71	72 Hf Hafnium 178.49	73 Ta Tantalum 180.9479	74 W Tungsten 183.85	75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.22	78 Pt Platinum 195.08	79 Au Gold 196.9665	80 Hg Mercury 200.59	81 Tl Thallium 204.3833	82 Pb Lead 207.2	83 Bi Bismuth 208.98037	84 Po Polonium [208.9824]	85 At Astatine 209.9871	86 Rn Radon 222.0176
87 Fr Francium 223.0197	88 Ra Radium 226.0254	89-103	104 Rf Rutherfordium [261]	105 Db Dubnium [262]	106 Sg Seaborgium [266]	107 Bh Bohrium [264]	108 Hs Hassium [269]	109 Mt Meitnerium [268]	110 Ds Darmstadtium [269]	111 Rg Roentgenium [272]	112 Cn Copernicium [277]	113 Uut Ununtrium unknown	114 Uuq Ununquadium [289]	115 Uup Ununpentium unknown	116 Uuh Ununhexium [298]	117 Uus Ununseptium unknown	118 Uuo Ununoctium unknown

Lanthanide Series	57 La Lanthanum 138.9055	58 Ce Cerium 140.115	59 Pr Praseodymium 140.90765	60 Nd Neodymium 144.24	61 Pm Promethium 144.9127	62 Sm Samarium 150.36	63 Eu Europium 151.9655	64 Gd Gadolinium 157.25	65 Tb Terbium 158.92534	66 Dy Dysprosium 162.50	67 Ho Holmium 164.93032	68 Er Erbium 167.26	69 Tm Thulium 168.93421	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.967
Actinide Series	89 Ac Actinium 227.0278	90 Th Thorium 232.0381	91 Pa Protactinium 231.03588	92 U Uranium 238.0289	93 Np Neptunium 237.0482	94 Pu Plutonium 244.0642	95 Am Americium 243.0614	96 Cm Curium 247.0703	97 Bk Berkelium 247.0703	98 Cf Californium 251.0796	99 Es Einsteinium [254]	100 Fm Fermium 257.0951	101 Md Mendelevium 258.1	102 No Nobelium 259.1009	103 Lr Lawrencium [262]

Alkali Metal | Alkaline Earth | Transition Metal | Basic Metal | Semimetals | Nonmetals | Halogens | Noble Gas | Lanthanides | Actinides

Goal: Students will be able to describe the characteristics an object must possess to be classified as a mineral.

Goal: Students will be able to describe the characteristics an object must possess to be classified as a mineral.

Goal: Students will be able to use different properties of minerals.

Properties of Minerals

Goal: Students will be able to use different properties of minerals.

Goal: Students will be able to use different properties of minerals.

Color

Goal: Students will be able to use different properties of minerals.

Streak

Goal: Students will be able to use different properties of minerals.

Luster

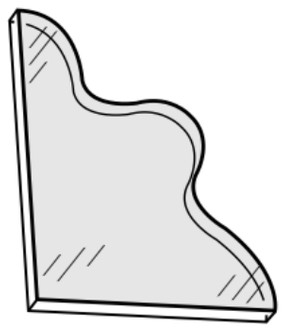
- Metallic - reflect light only from their outer surface. Looks like a metal.
- Non-metallic - can be glassy, dull, pearly, waxy, etc.

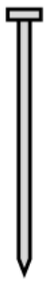
Goal: Students will be able to use different properties of minerals.

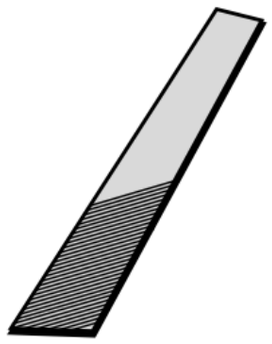
Hardness - resistance to being scratched.

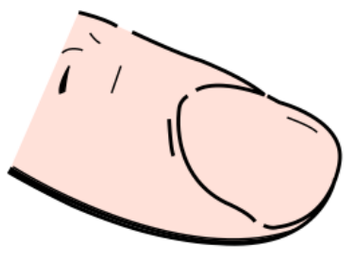
Moh's Hardness Scale - ranges from 1 (softest) to 10 (hardest).

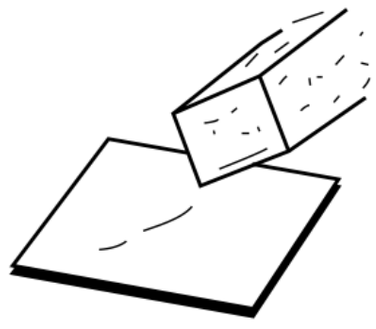
Copper Penny

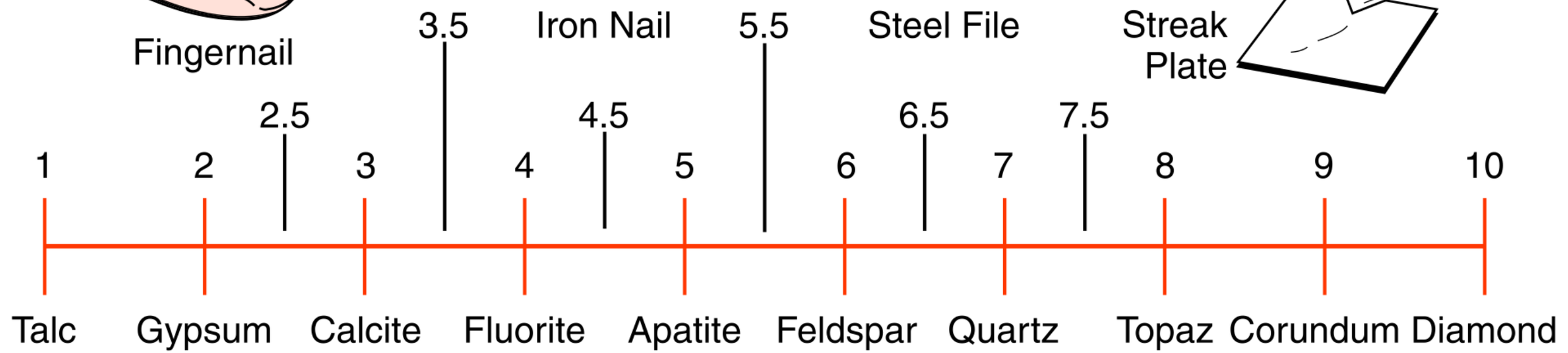

Window Glass


Iron Nail

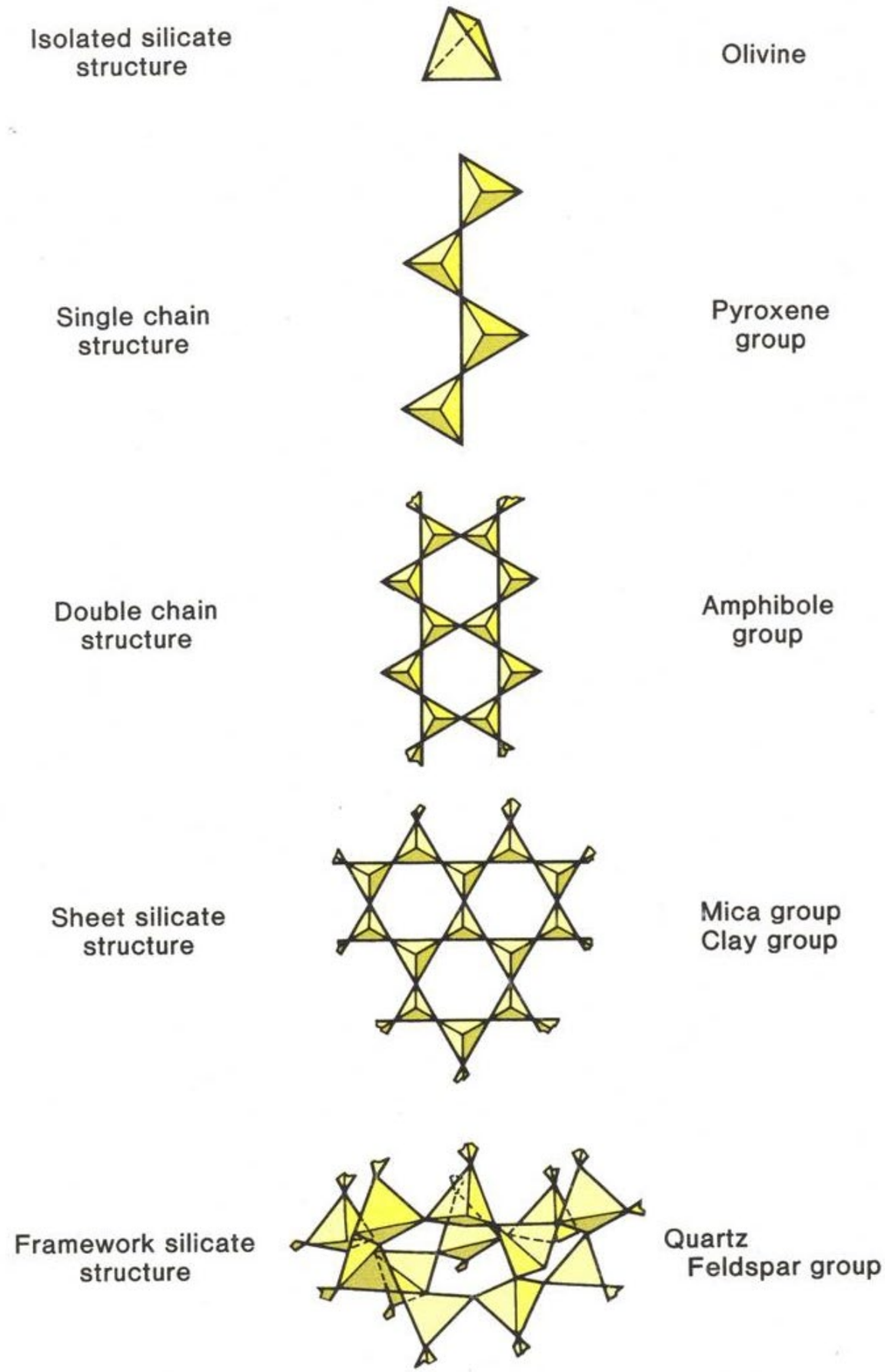

Steel File


Fingernail


Porcelain Streak Plate



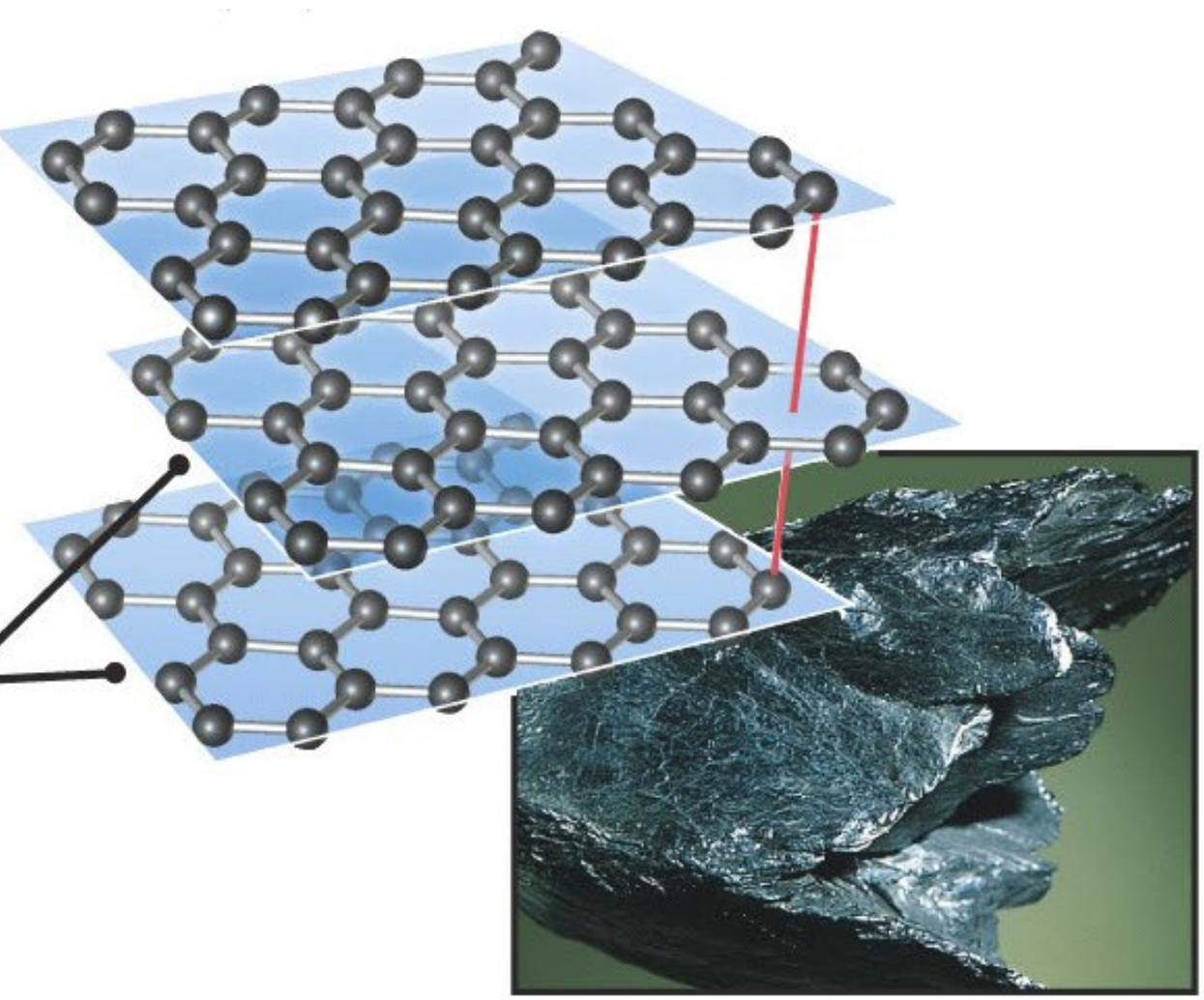
Goal: Students will be able to use different properties of minerals.



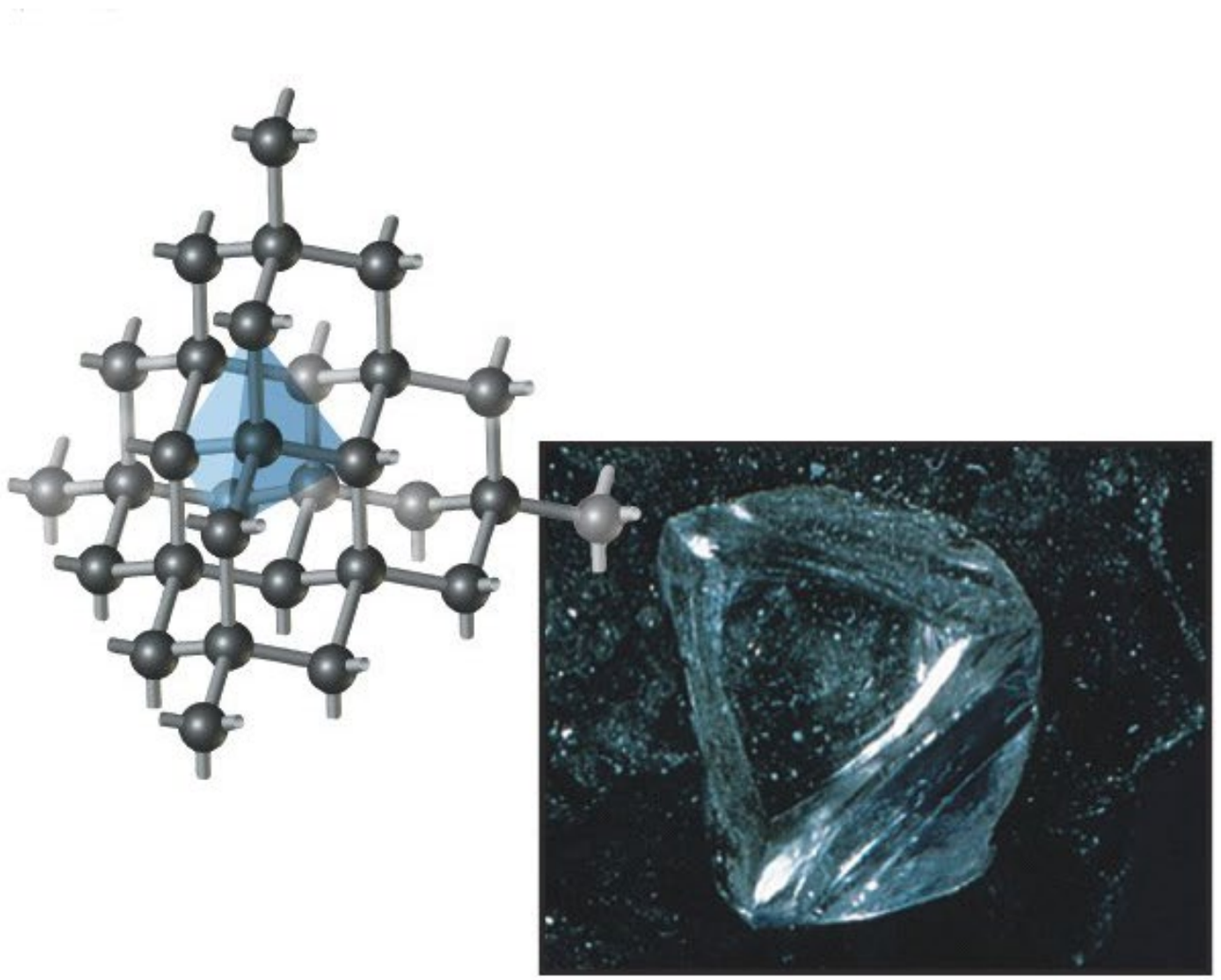
Crystal Shape

- The way atoms arrange controls the shape and properties of the mineral.
- Crystal shape is very specific to a mineral.
- Substances that share the same composition can still be different minerals because of their crystal structure.

Goal: Students will be able to use different properties of minerals.



Graphite

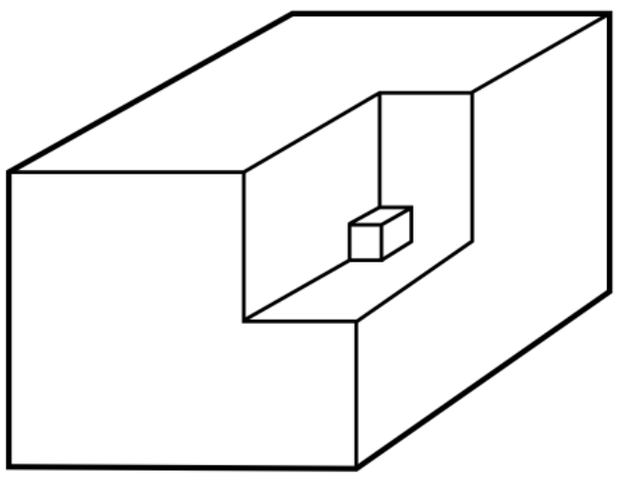


Diamond

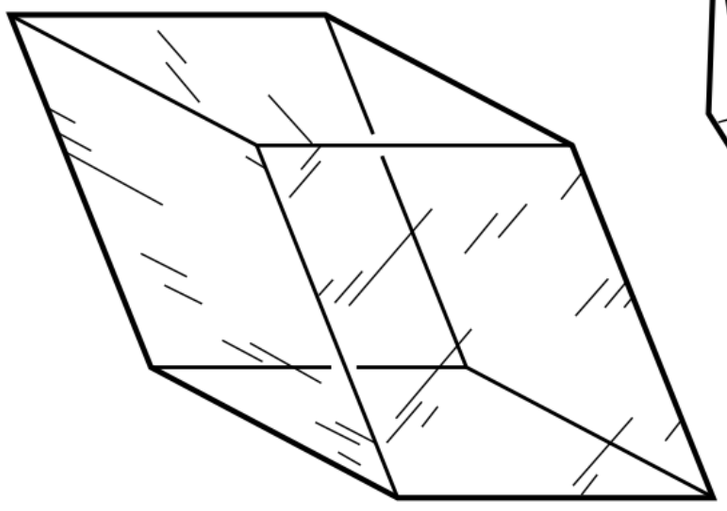
Goal: Students will be able to use different properties of minerals.

Cleavage and Fracture

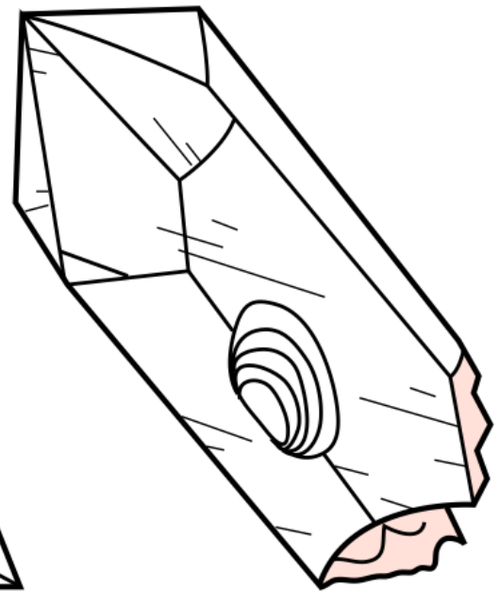
- Cleavage - the tendency of some minerals to break along smooth, flat planes.
- Fracture - breakage along curved surfaces or surfaces that are not parallel.



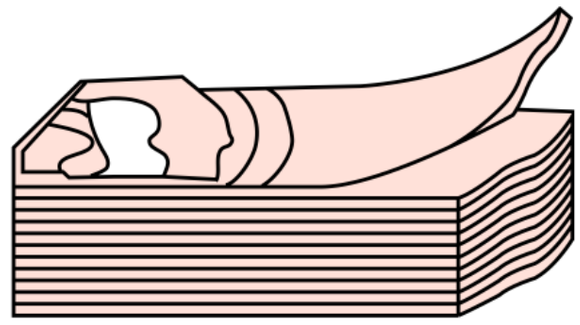
Halite forms cubic crystals that cleave parallel to the crystal faces.



Calcite crystals are rhombohedral and cleave parallel to the crystal faces.

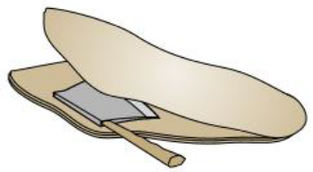


Quartz crystals are hexagonal but fracture along curved surfaces.

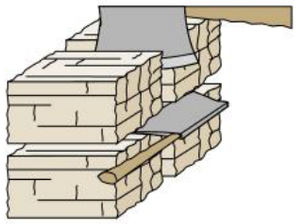


Minerals in the mica family split into thin, flexible sheets.

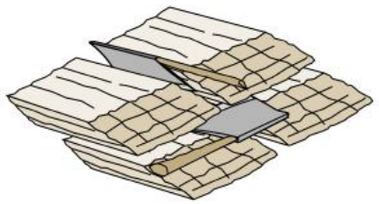
Goal: Students will be able to use different properties of minerals.



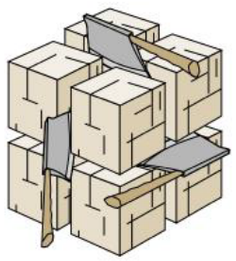
Biotite and muscovite micas exhibit one excellent direction of cleavage.



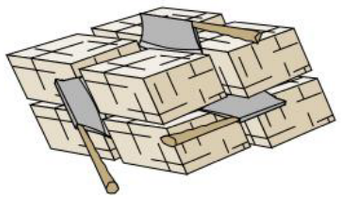
Orthoclase and plagioclase feldspars exhibit two good directions of cleavage at approximately 90deg from each other



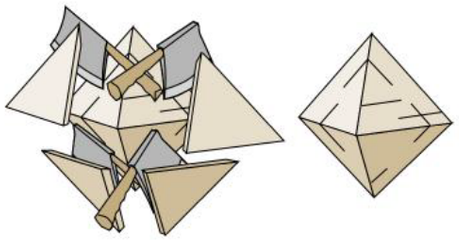
Hornblende (an amphibole) has two good directions of cleavage at 124 deg. from each other.



Galena has three good directions of cleavage that form two 90deg. angles (cubic cleavage)



Calcite has three good directions of cleavage that form angles of 105 deg. in one plane and 75 deg. in another

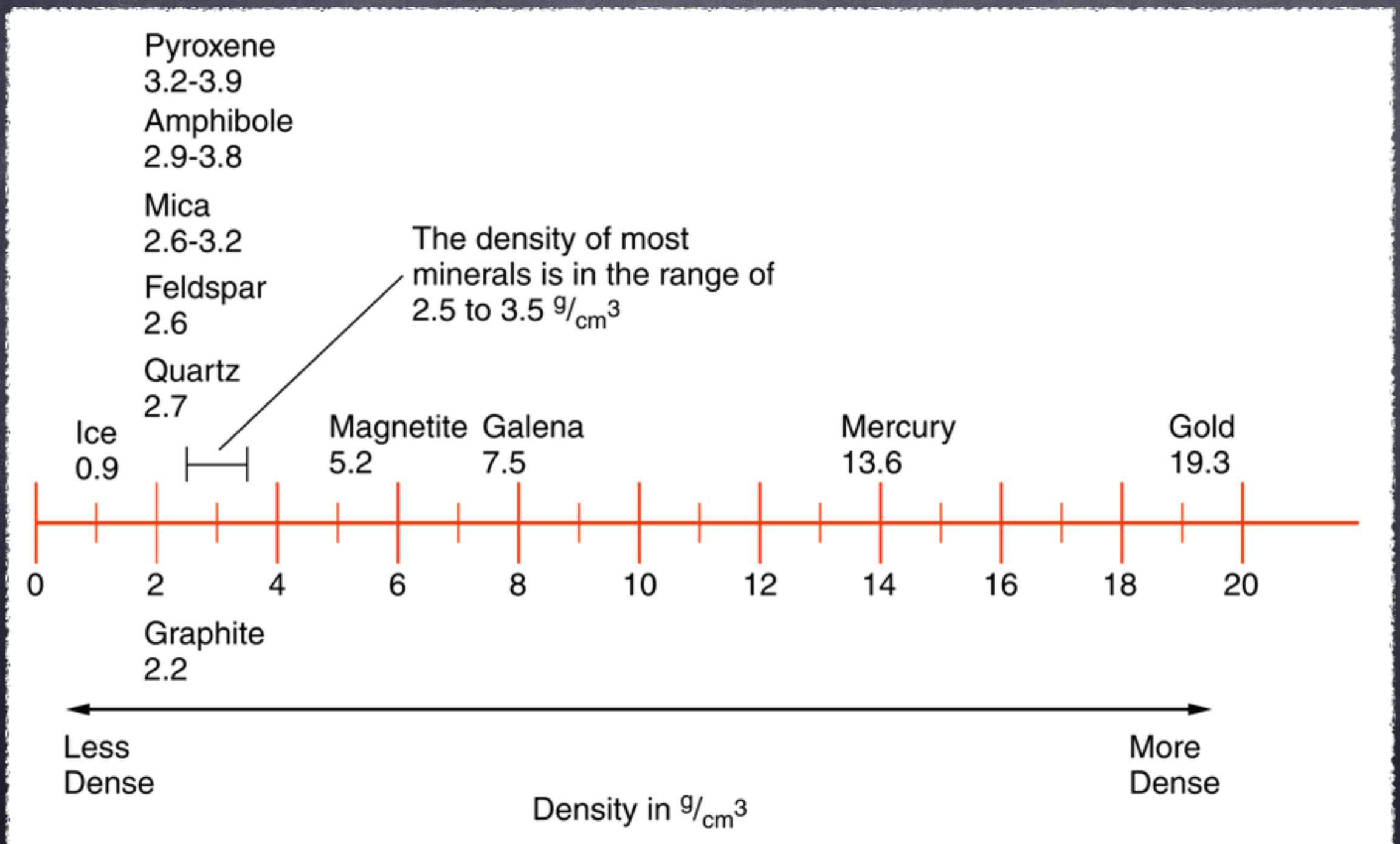


Fluorite has four good directions of cleavage (octahedral cleavage)

Goal: Students will be able to use different properties of minerals.

Density

Density = Mass/Volume



Goal: Students will be able to use different properties of minerals.

Other Special Properties

- Magnetism
- Taste
- Feel (greasy or slippery)
- Reacts with acids

Goal: Students will be able to use different properties of minerals.

Properties of Common Minerals

LUSTER	HARD-NESS	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	$CaNa(Mg,Fe)_4(Al,Fe,Ti)_3$ $Si_6O_{22}(O,OH)_2$	**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

✔ = dominant form of breakage

Goal: Students will be able to use different properties of minerals.

Mineral Groups

- Minerals are broken up into groups based on their composition (what they are made of).

Goal: Students will be able to use different properties of minerals.

What are minerals at Earth's surface made of?

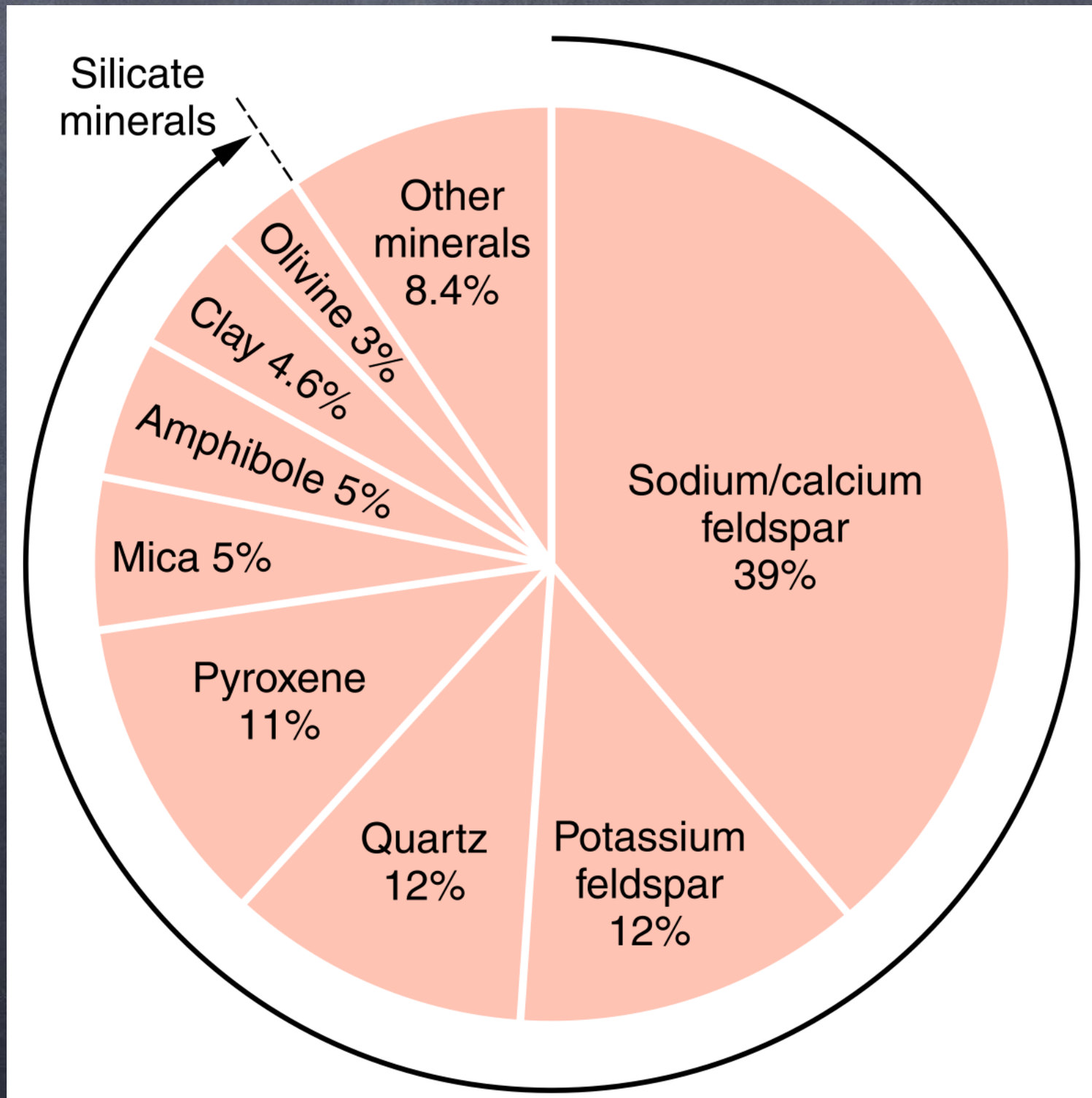
Average Chemical Composition of Earth's Crust, Hydrosphere, and Troposphere

ELEMENT (symbol)	CRUST		HYDROSPHERE	TROPOSPHERE
	Percent by mass	Percent by volume	Percent by volume	Percent by volume
Oxygen (O)	46.10	94.04	33.0	21.0
Silicon (Si)	28.20	0.88		
Aluminum (Al)	8.23	0.48		
Iron (Fe)	5.63	0.49		
Calcium (Ca)	4.15	1.18		
Sodium (Na)	2.36	1.11		
Magnesium (Mg)	2.33	0.33		
Potassium (K)	2.09	1.42		
Nitrogen (N)				78.0
Hydrogen (H)			66.0	
Other	0.91	0.07	1.0	1.0

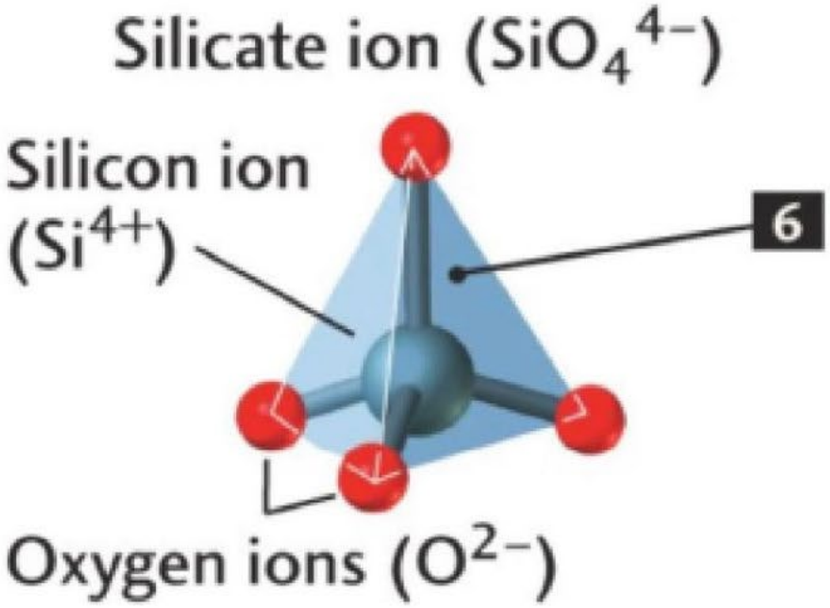
Goal: Students will be able to use different properties of minerals.

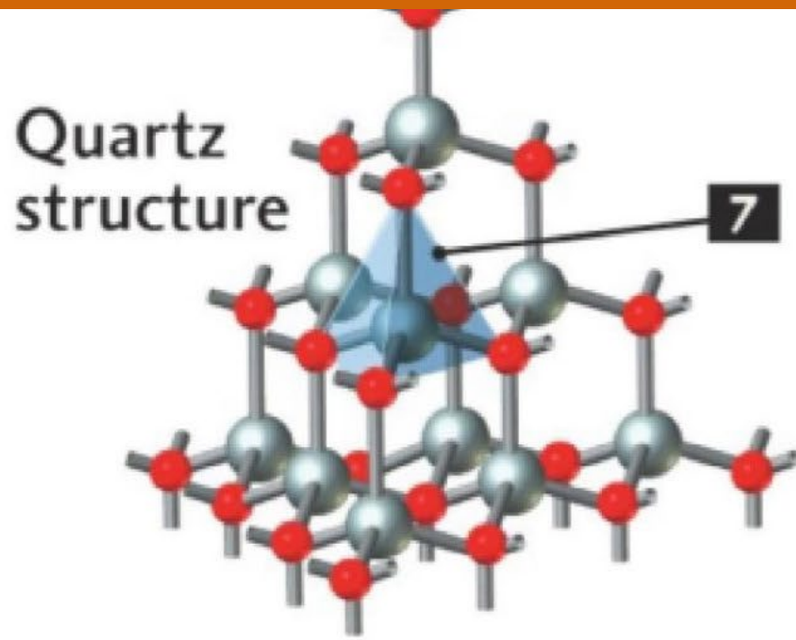
Silicates

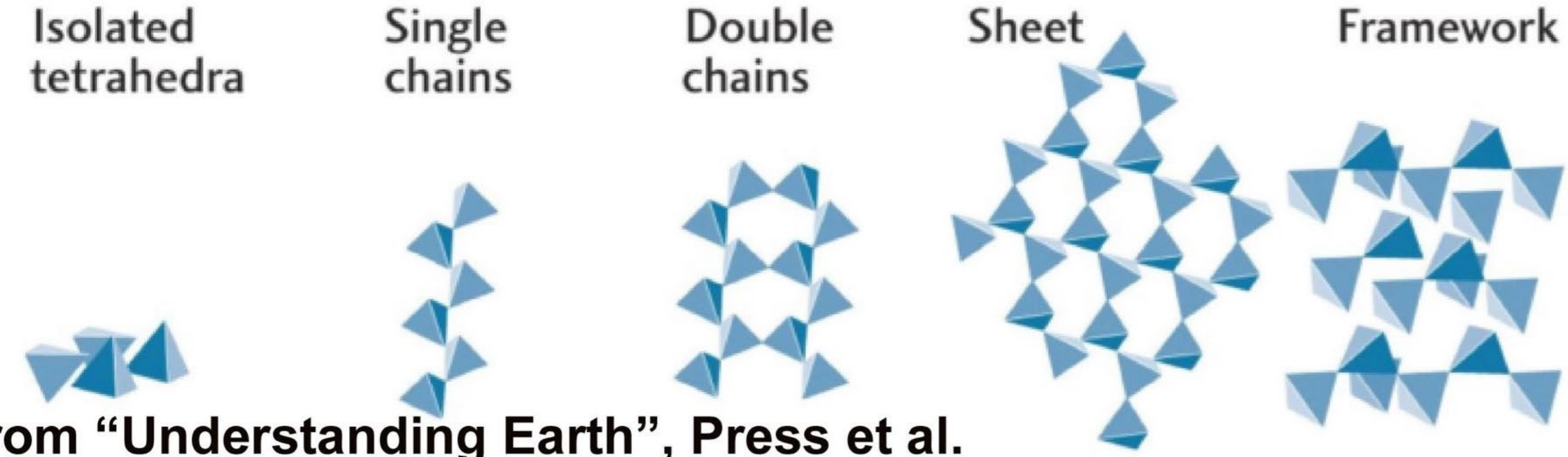
- The most common mineral group is the Silicates. They are made up of mostly silicon and oxygen.



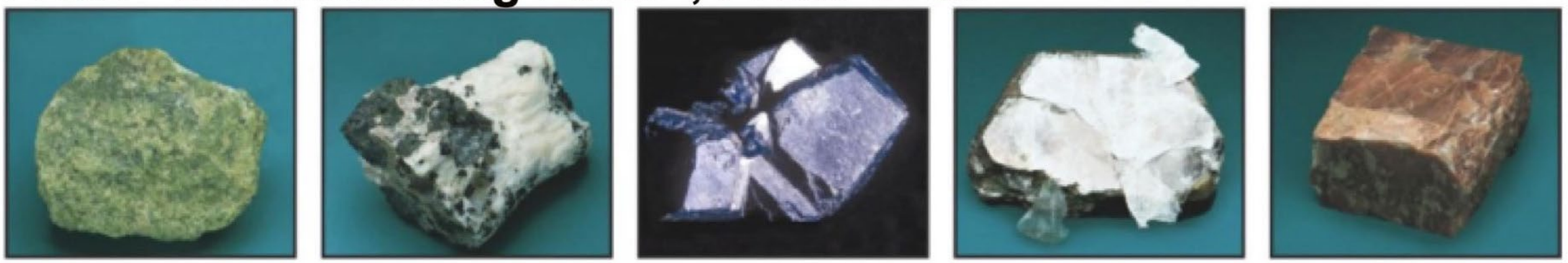
Goal: Students will be able to use different properties of minerals.



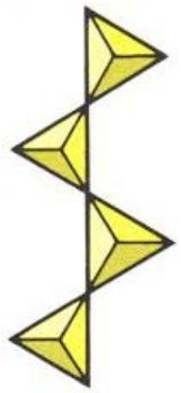
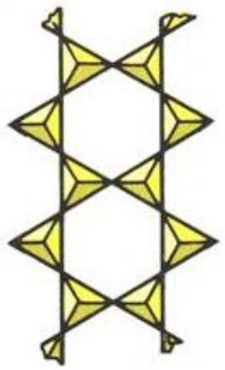
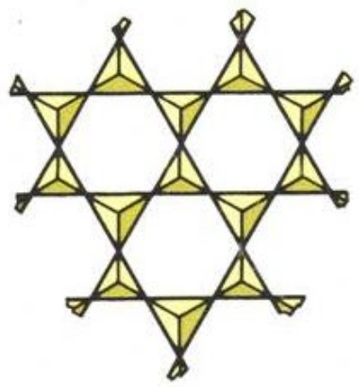
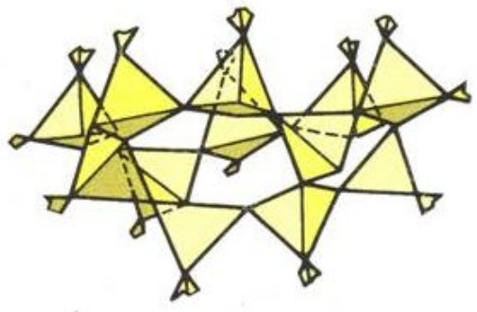




From "Understanding Earth", Press et al.



Goal: Students will be able to use different properties of minerals.

Isolated silicate structure		Olivine
Single chain structure		Pyroxene group
Double chain structure		Amphibole group
Sheet silicate structure		Mica group Clay group
Framework silicate structure		Quartz Feldspar group

Goal: Students will be able to identify each step of the rock cycle, and use the rock cycle chart in the ESRT.

Rocks

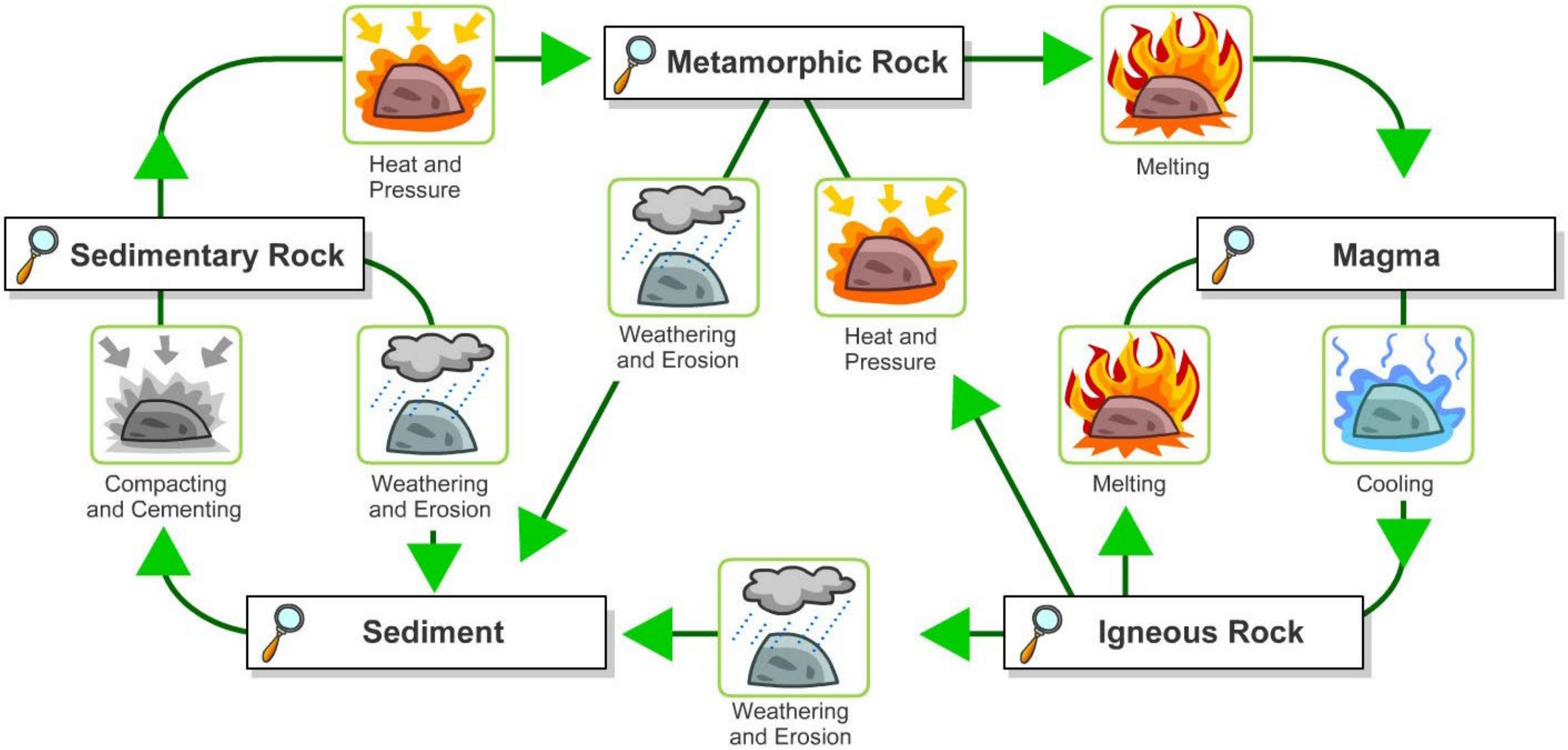
Goal: Students will be able to identify each step of the rock cycle, and use the rock cycle chart in the ESRT.

What are rocks?

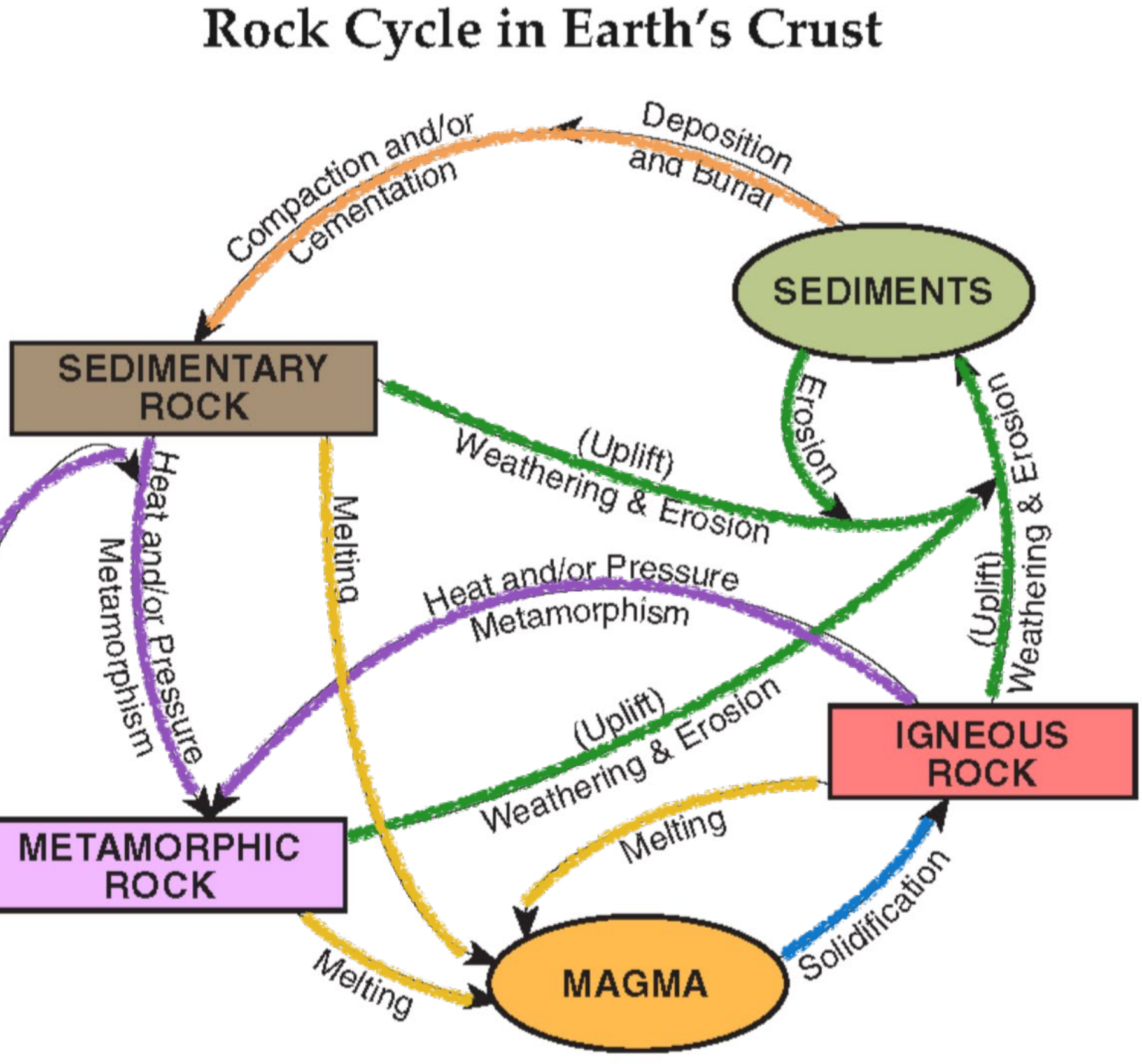
- A substance that is or was a natural part of the solid Earth, or lithosphere. Rocks are made up of a variety of minerals.
- Rocks are broken up into three groups based on how they formed.
  - Igneous
  - Sedimentary
  - Metamorphic

Goal: Students will be able to identify each step of the rock cycle, and use the rock cycle chart in the ESRT.

The Rock Cycle



Goal: Students will be able to identify each step of the rock cycle, and use the rock cycle chart in the ESRT.



Goal: Students will observe how rate of cooling affects mineral crystallization.

Igneous Rocks

Goal: Students will observe how rate of cooling affects mineral crystallization.

Igneous Rocks

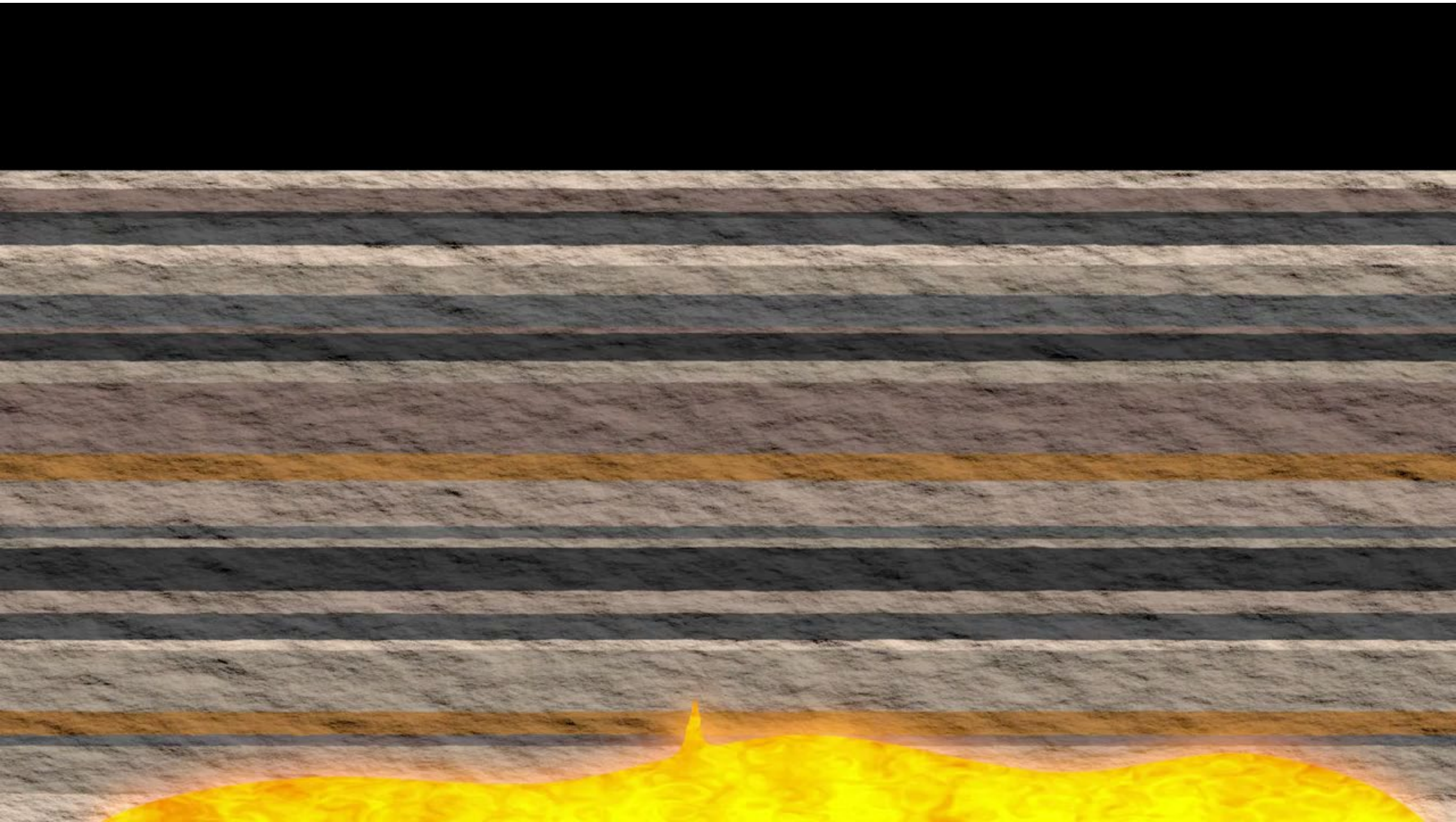
- Igneous rocks - form from hot, molten (liquid) rock material that originated deep within Earth.
- Liquid rock within the Earth is called magma.
- Liquid rock at Earth's surface is called lava.

Goal: Students will observe how rate of cooling affects mineral crystallization.

Igneous Rocks

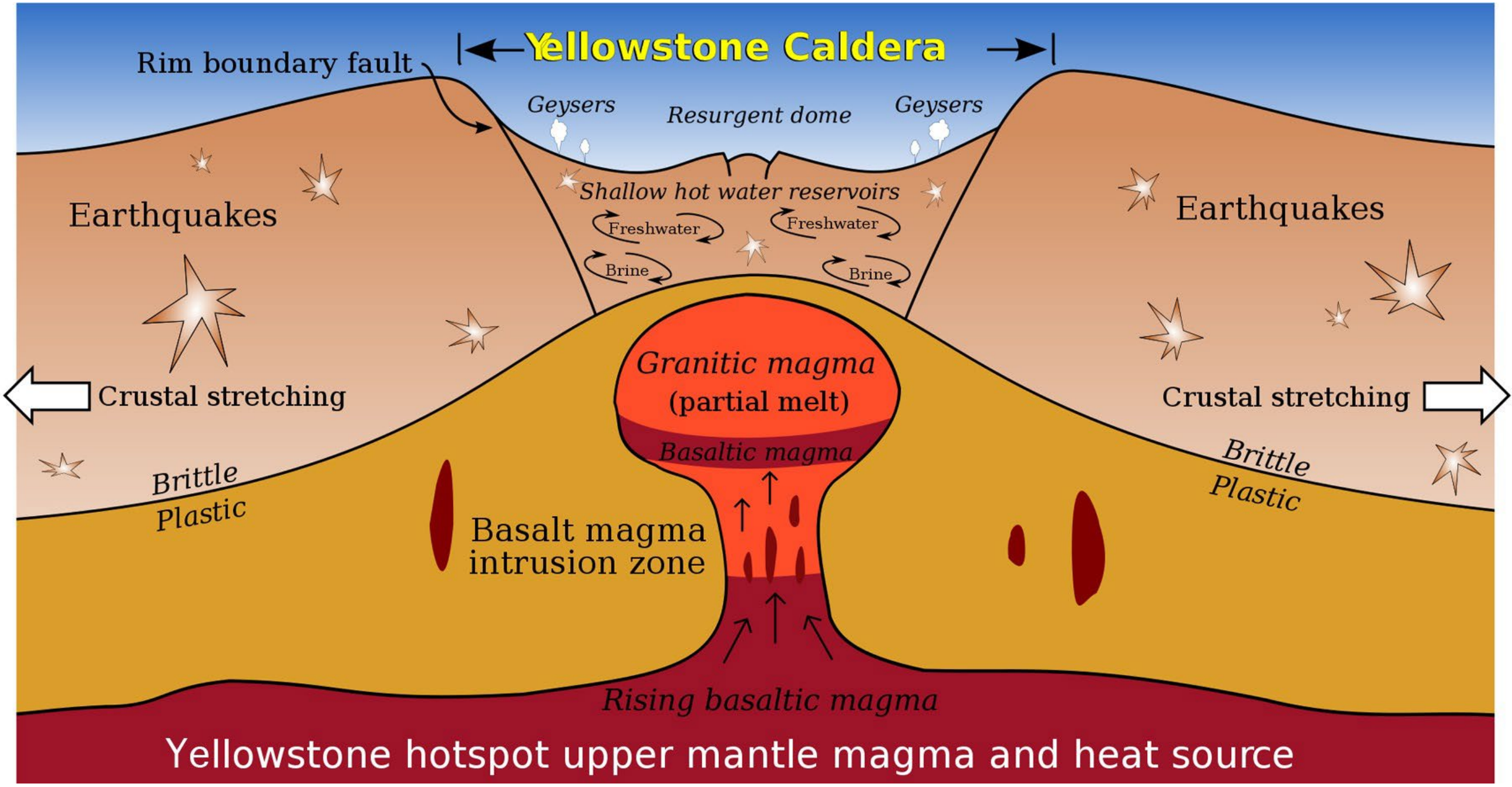
- Igneous rocks are broken up into two groups based on where they formed and what they are made of.
  - Intrusive - formed inside the Earth from magma.
  - Extrusive - formed on the Earth's crust from lava.

Creates Intrusive Igneous Rock since rock material never reached surface.



Creates Extrusive Igneous Rock since rock material reached surface.

Goal: Students will observe how rate of cooling affects mineral crystallization.



Goal: Students will observe how rate of cooling affects mineral crystallization.


NO
Chef
BOYARDEE
Beef
Ravioli
in Tomato
& Meat Sauce

U.S. Geological Survey (USGS)
Page Liked · 57 mins ·

Kanaga Volcano — Here's a photo from Kanaga Volcano, one of the most southerly members of the Aleutian Islands chain. In the foreground is a stunning view of a lava flow from a 1906 event. According to records, a trapper living on the island in 1906 experienced several earthquakes and witnessed lava pouring down both east and west sides of the cone.

You can learn more about Kanaga Volcano, see images, and read about current past activity at http://on.doi.gov/Kanaga. Photo credit: Michelle Combs, USGS.

You can also follow USGS Volcanoes on Facebook (https://fb.com/USGSVolcanoes/) to learn about volcanic events, eruption anniversaries, and more.

#USGS #science #volcanoes #Alaska #Aleutians #landscape #lava

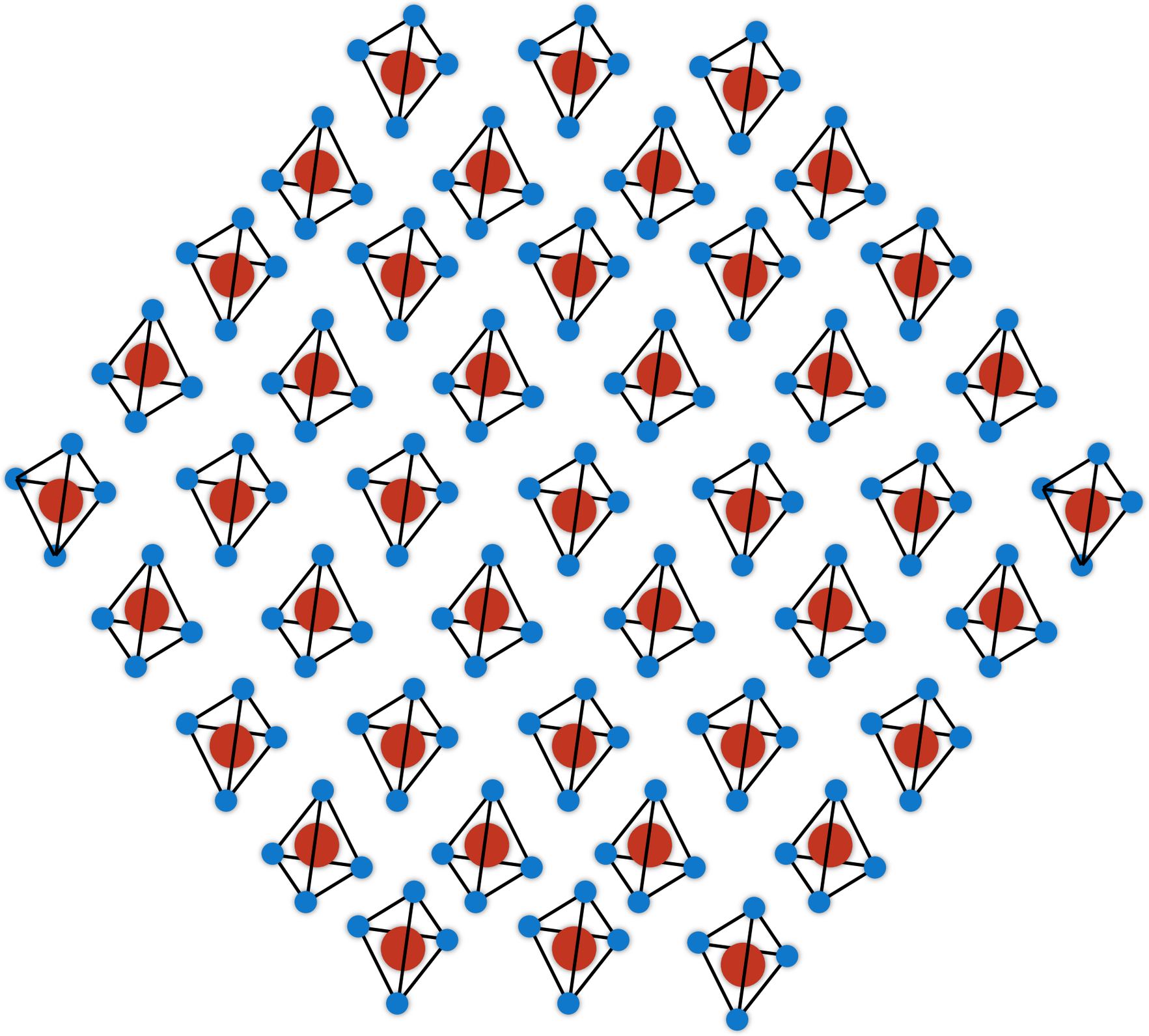
Goal: Students will observe how rate of cooling affects mineral crystallization.

Igneous Rocks

- Igneous rocks are broken up into two groups based on where they formed and what they are made of.

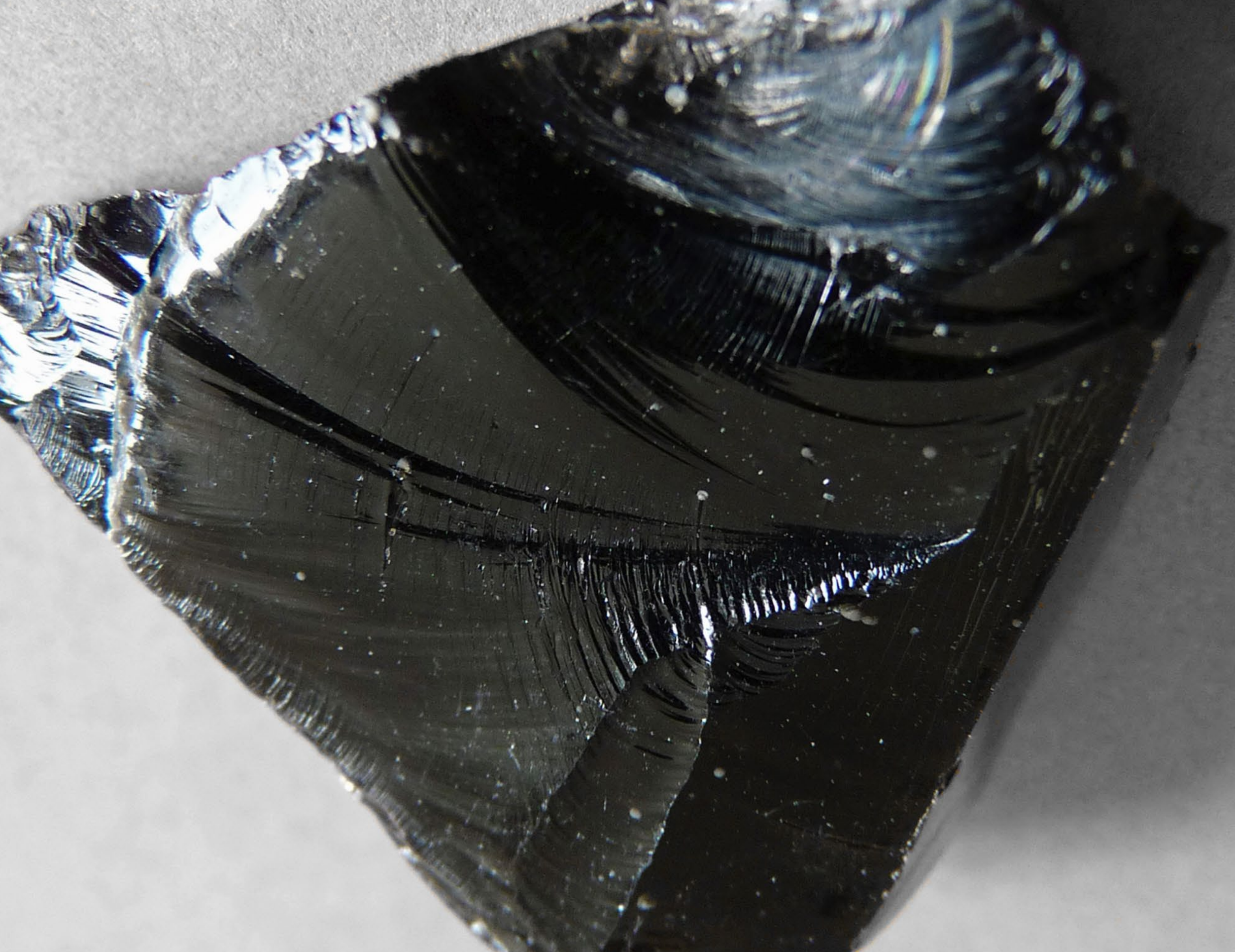
- Intrusive - formed inside the Earth from magma. Took a long time to cool, and therefore have large crystals.

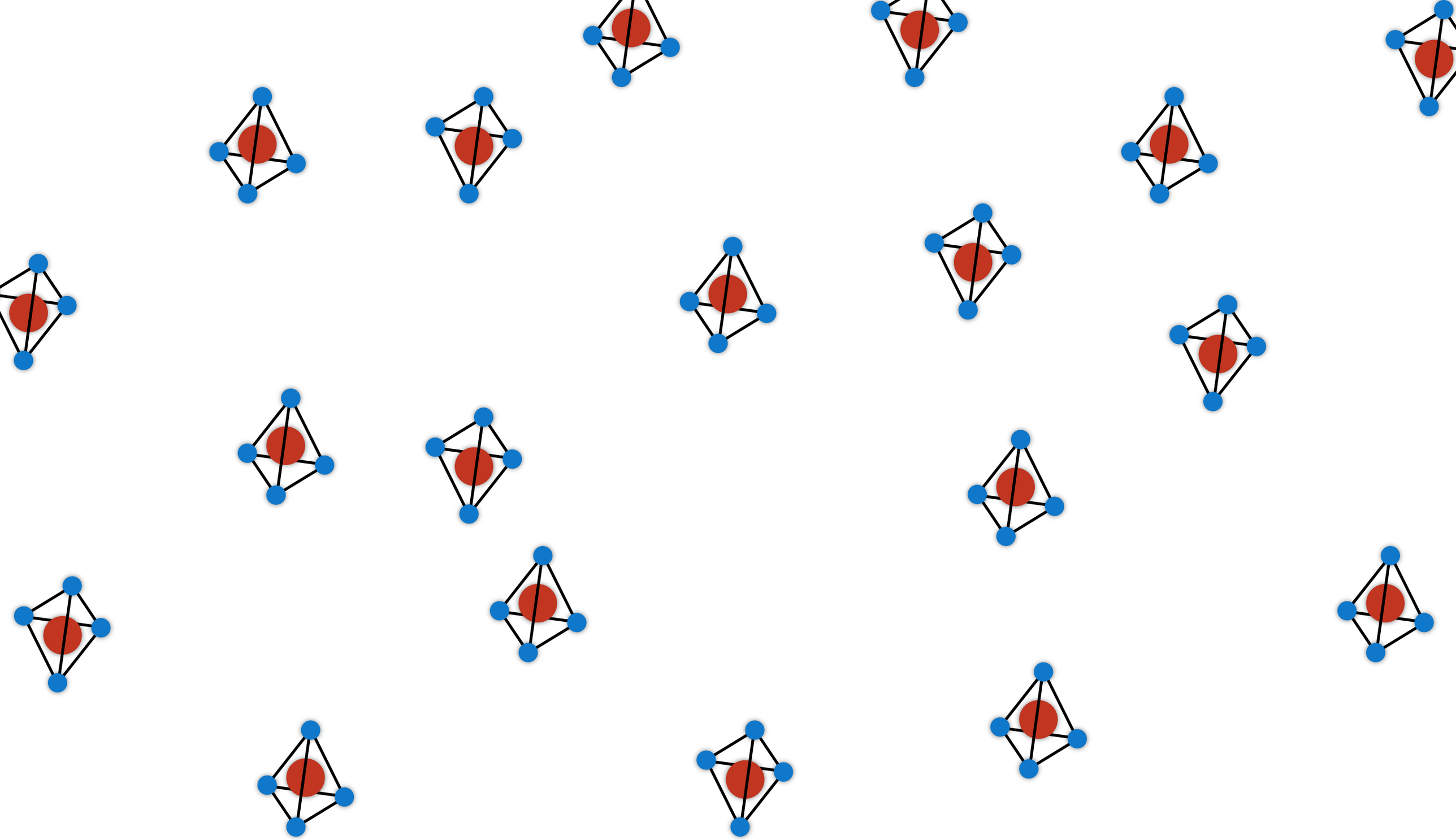
- Extrusive - formed on the Earth's crust from lava. Cooled quickly, and therefore have small crystals.



1 Million Years... 2 Million Years... 3 Million Years... 4 Million Years... 5 Million Years...

Rock took a long time to cool, therefore formed big crystals.





A couple minutes…

Rock cooled very rapidly, therefore did not form crystals.

Goal: Students will be able to use the "Igneous Rock Chart" in the ESRT.

Scheme for Igneous Rock Identification

IGNEOUS ROCKS — ENVIRONMENT OF FORMATION	CRYSTAL SIZE	TEXTURE				
EXTRUSIVE (Volcanic)	non-crystalline	Glassy	Non-vesicular	Obsidian (usually appears black)		Basaltic glass
			Vesicular (gas pockets)	Pumice		Scoria
	less than 1 mm	Fine		Vesicular rhyolite	Vesicular andesite	Vesicular basalt
			Non-vesicular	Rhyolite	Andesite	Basalt
INTRUSIVE (Plutonic)	1 mm to 10 mm	Coarse		Granite	Diorite	Diabase / Gabbro
	10 mm or larger	Very coarse		Pegmatite		

Peridotite, Dunite

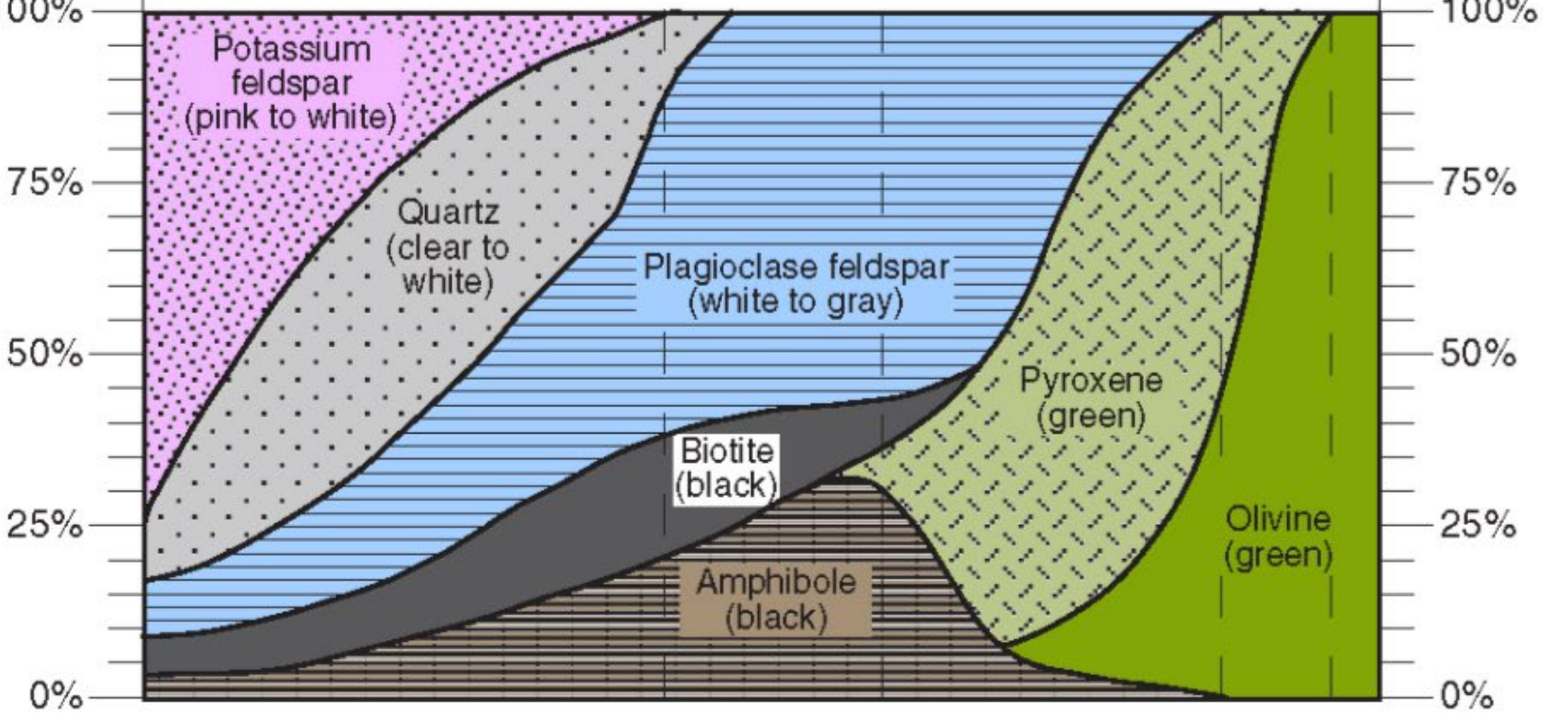
CHARACTERISTICS

LIGHTER ← COLOR → DARKER

LOWER ← DENSITY → HIGHER

FELSIC (rich in Si, Al) ← COMPOSITION → MAFIC (rich in Fe, Mg)

MINERAL COMPOSITION (relative by volume)

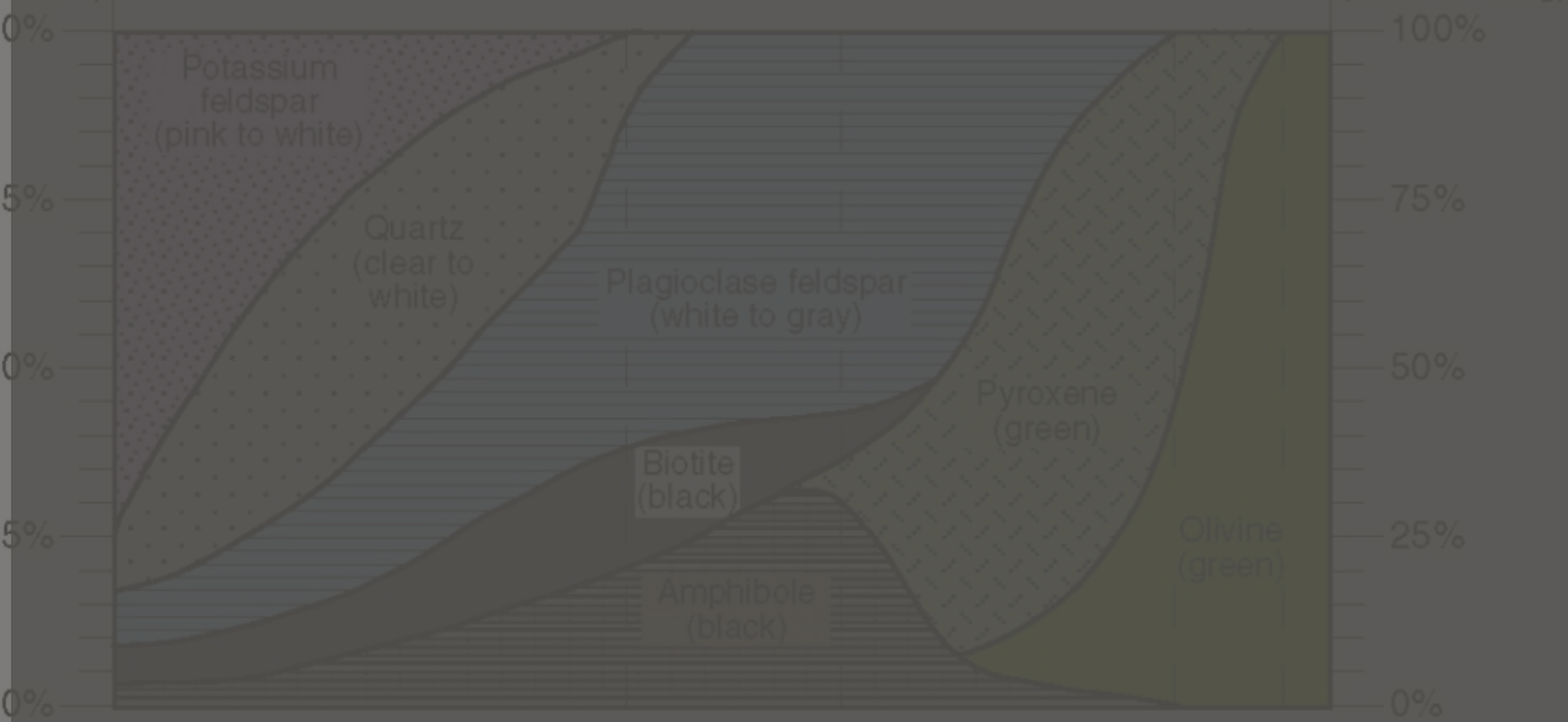


Goal: Students will be able to use the "Igneous Rock Chart" in the ESRT.

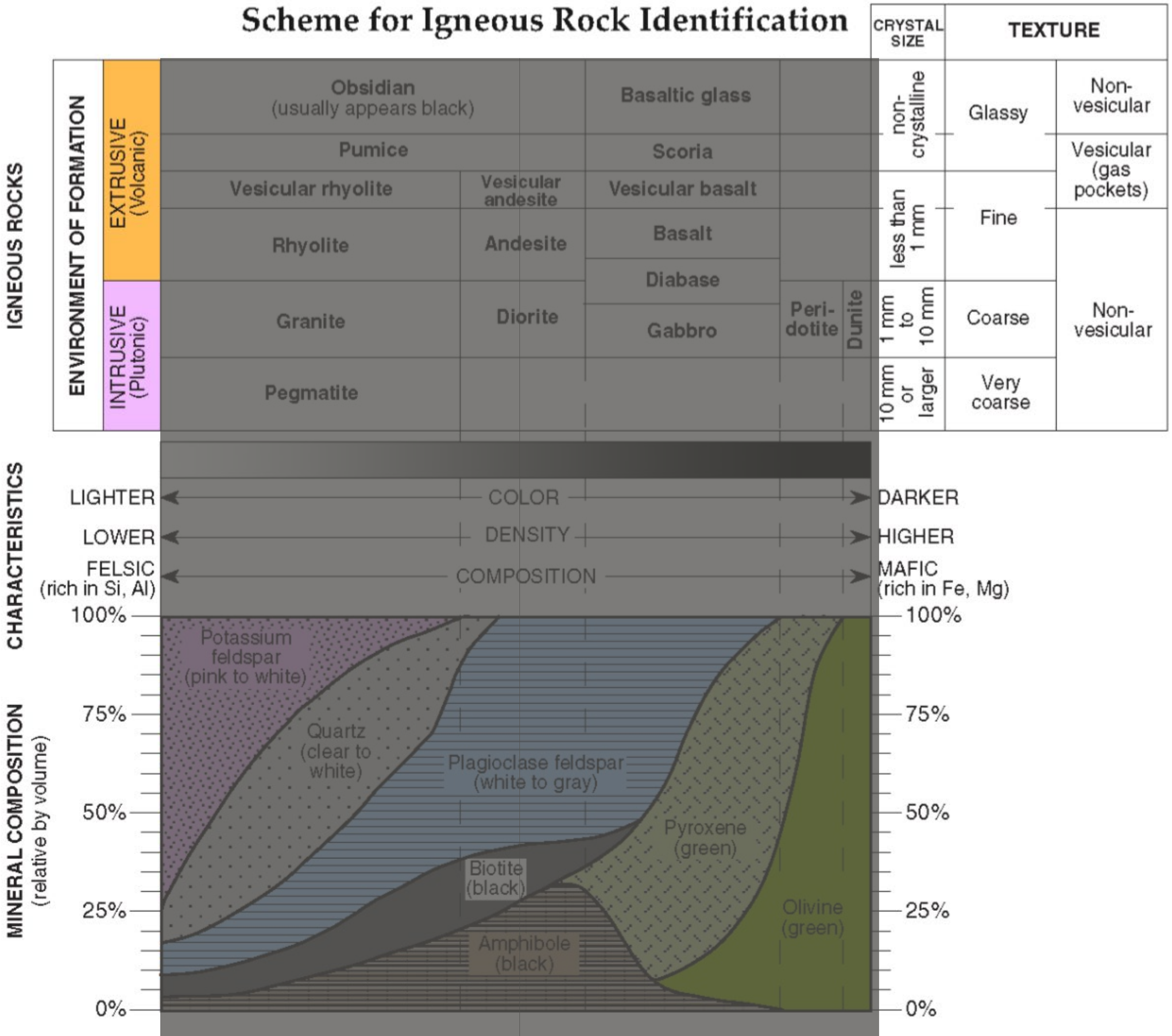
Scheme for Igneous Rock Identification

IGNEOUS ROCKS — ENVIRONMENT OF FORMATION	CRYSTAL SIZE	TEXTURE				
EXTRUSIVE (Volcanic)	non-crystalline	Glassy	Non-vesicular	Obsidian (usually appears black)		Basaltic glass
			Vesicular (gas pockets)	Pumice		Scoria
	less than 1 mm	Fine		Vesicular rhyolite	Vesicular andesite	Vesicular basalt
			Non-vesicular	Rhyolite	Andesite	Basalt
						Diabase
INTRUSIVE (Plutonic)	1 mm to 10 mm	Coarse		Granite	Diorite	Gabbro
	10 mm or larger	Very coarse		Pegmatite		

CHARACTERISTIC			
COLOR	LIGHTER	←	DARKER
DENSITY	LOWER	←	HIGHER
COMPOSITION	FELSIC (rich in Si, Al)	←	MAFIC (rich in Fe, Mg)



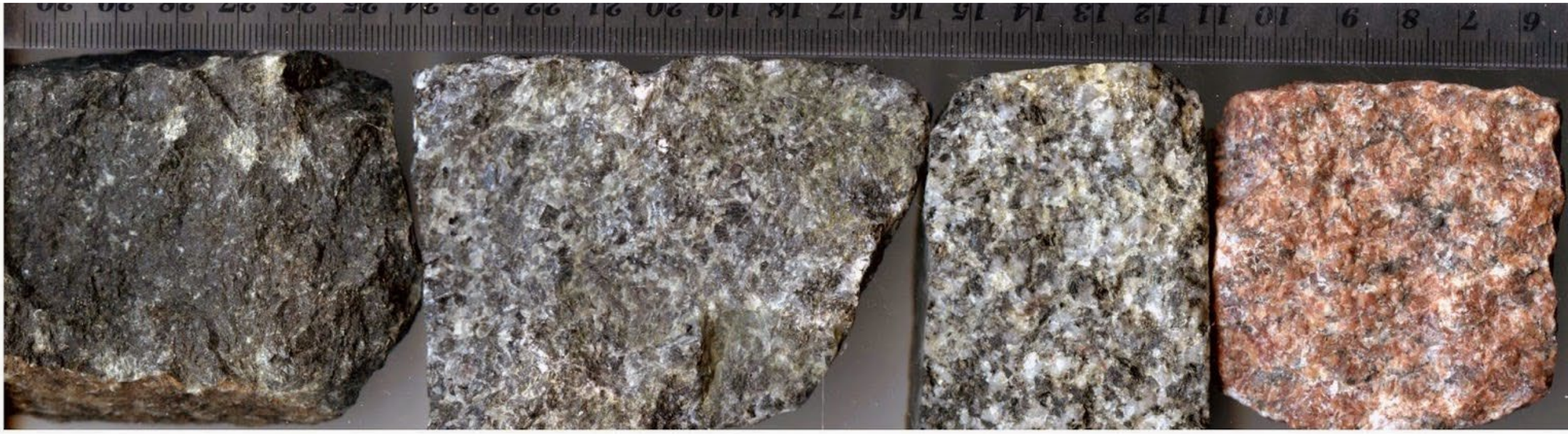
Goal: Students will be able to use the "Igneous Rock Chart" in the ESRT.



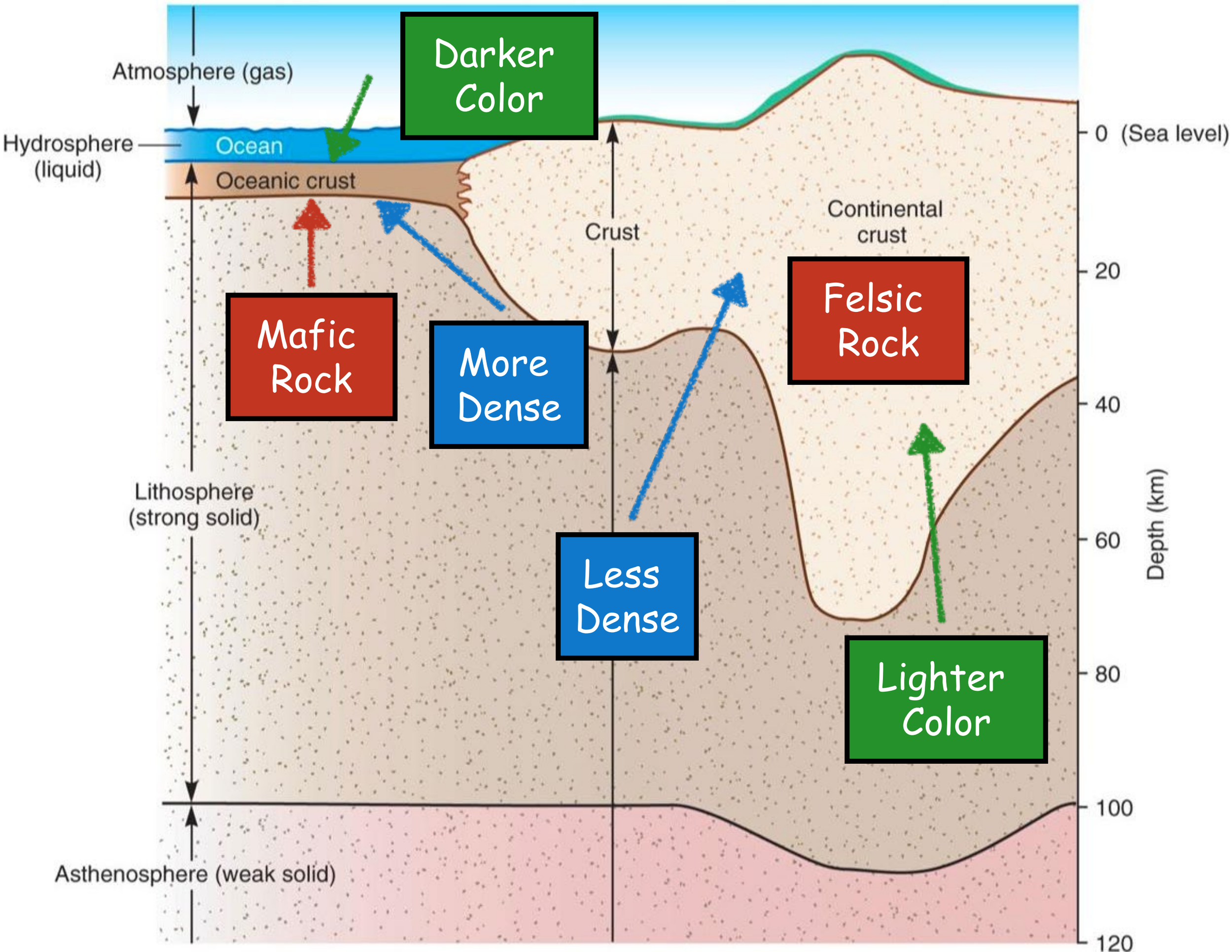
Goal: Students will be able to use the "Igneous Rock Chart" in the ESRT.

Felsic vs. Mafic

- Felsic rocks are made of less dense material usually found at Earth's surface. They are usually lighter in color.
- Mafic rocks are made of dense material usually found within Earth. They are usually darker in color.



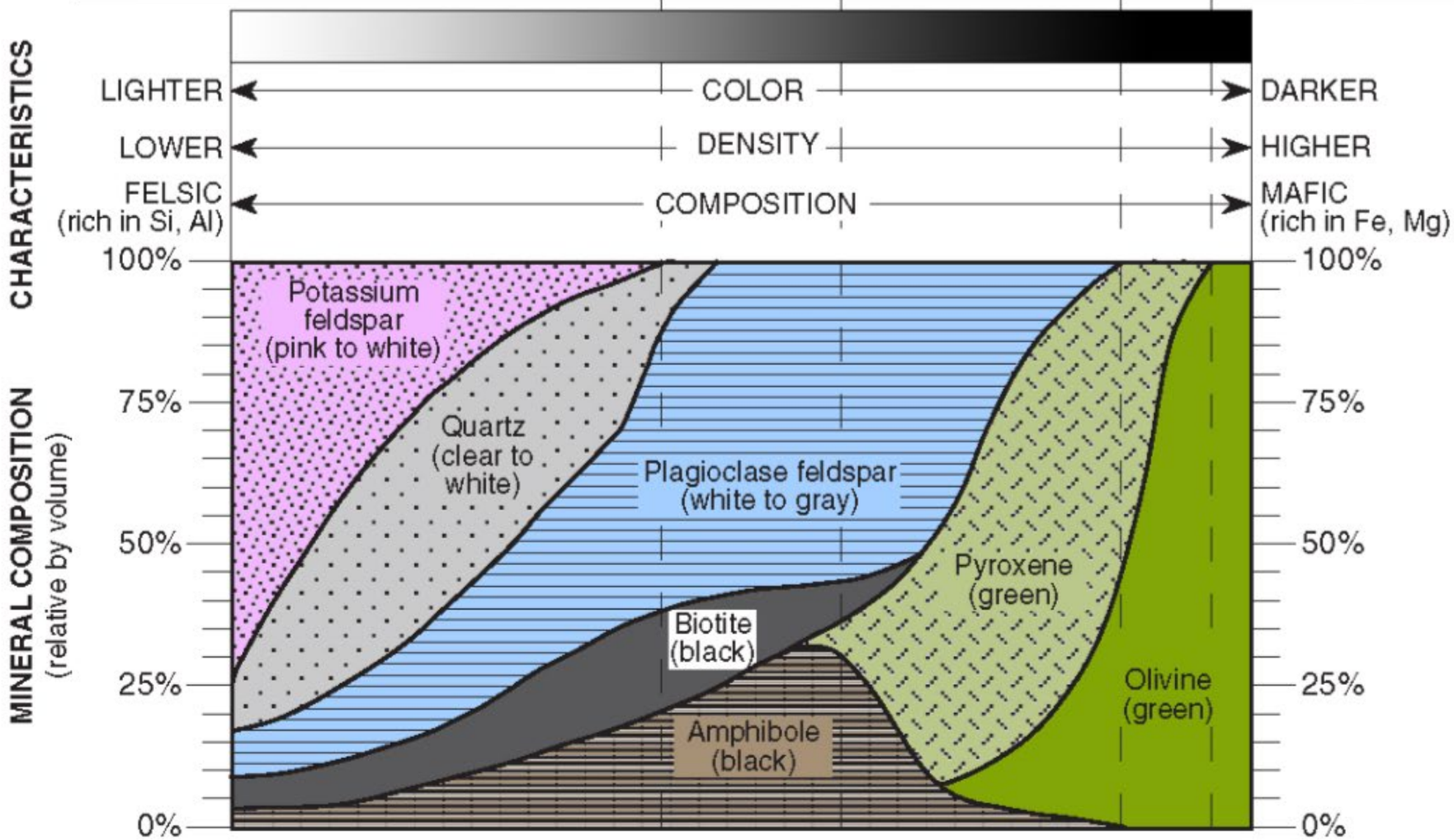
	Ultramafic	Mafic	Intermediate	Felsic
Color	Dark ◀	◀ ◀ ◀ ◀	◀ ◀ ◀ ◀	Light
SiO2	40%	50%	60%	70%
MgO	48%	15%	2.5%	0.95%
Major mineral content	Pyroxene and/or olivine	Pyroxene and Plagiocalse feldsapr	Biotite Alkali Feldspar Quartz	Quartz Alkali Feldspar


Darker Color
Atmosphere (gas)
Hydrosphere (liquid)
Ocean
Oceanic crust
Crust
Continental crust
Mafic Rock
More Dense
Felsic Rock
Less Dense
Lighter Color
Lithosphere (strong solid)
Asthenosphere (weak solid)
0 (Sea level)
20
40
60
80
100
120
Depth (km)

Goal: Students will be able to use the "Igneous Rock Chart" in the ESRT.

Scheme for Igneous Rock Identification

IGNEOUS ROCKS		CRYSTAL SIZE	TEXTURE				
ENVIRONMENT OF FORMATION							
EXTRUSIVE (Volcanic)	Obsidian (usually appears black)			Basaltic glass		non-crystalline	Glassy	Non-vesicular
	Pumice			Scoria		non-crystalline	Glassy	Vesicular (gas pockets)
	Vesicular rhyolite	Vesicular andesite		Vesicular basalt		less than 1 mm	Fine	Vesicular (gas pockets)
	Rhyolite	Andesite		Basalt		less than 1 mm	Fine	Non-vesicular
INTRUSIVE (Plutonic)	Granite	Diorite		Diabase		less than 1 mm	Fine	Non-vesicular
	Granite	Diorite	Peridotite	Gabbro	Dunite	1 mm to 10 mm	Coarse	Non-vesicular
	Pegmatite					10 mm or larger	Very coarse	Non-vesicular



Goal: Students will be able to use the "Sedimentary Rock Chart" in the ESRT.

Sedimentary Rocks

Goal: Students will be able to use the "Sedimentary Rock Chart" in the ESRT.

Sedimentary Rocks

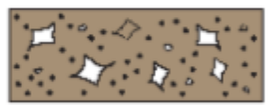
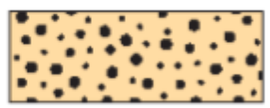
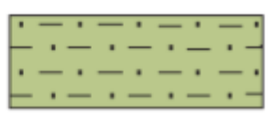
- Most sedimentary rocks are made of the weathered remains of other rocks that have been eroded and later deposited as sediment in layers.
- Others may form chemically or biologically.

Goal: Students will be able to use the "Sedimentary Rock Chart" in the ESRT.

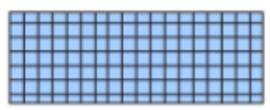
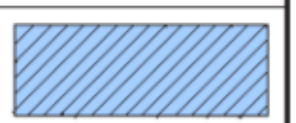
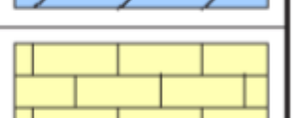
Goal: Students will be able to use the "Sedimentary Rock Chart" in the ESRT.

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**	

Goal: Students will be able to use the "Metamorphic Rock Chart" in the ESRT.

Metamorphic Rocks

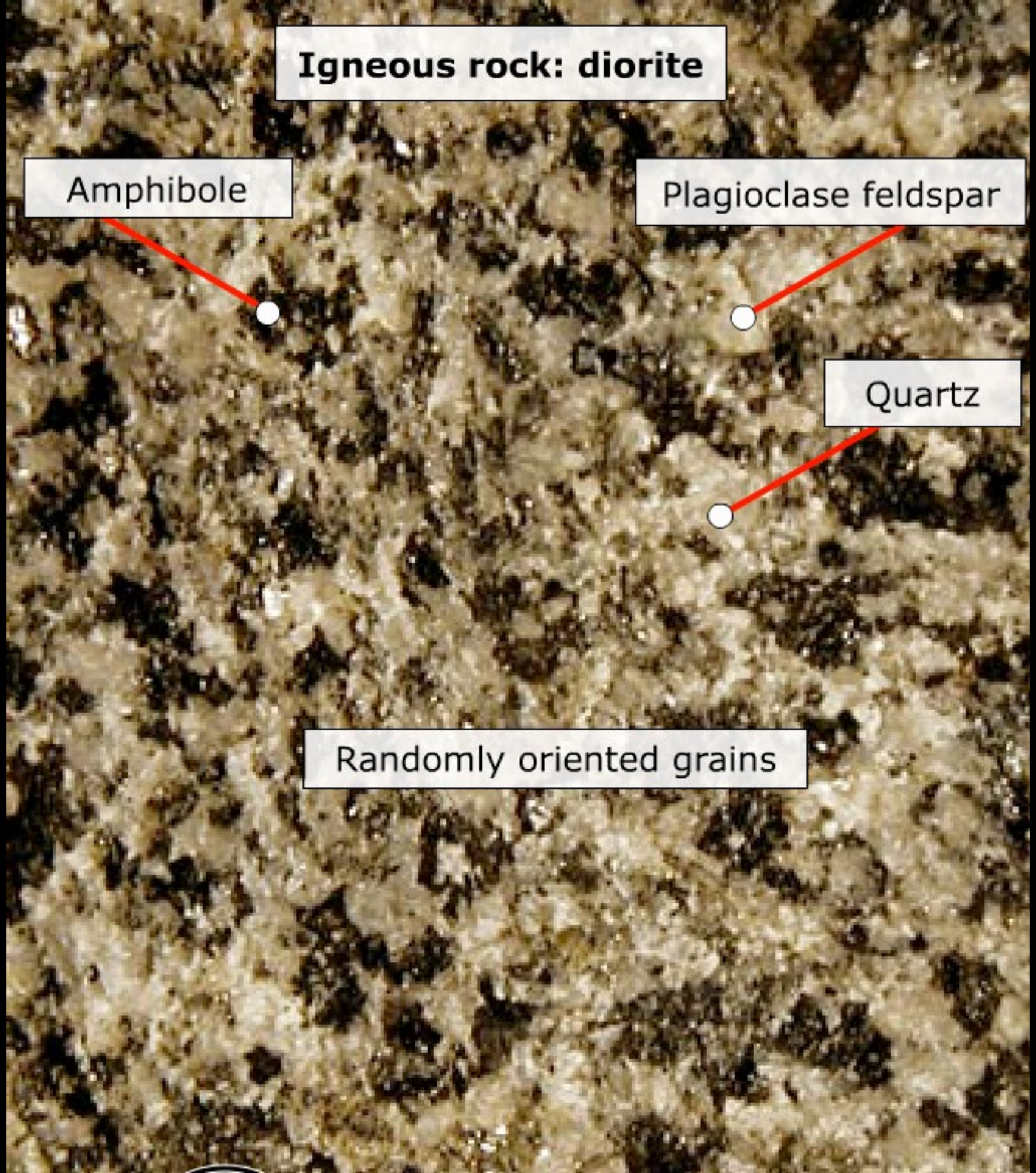
Goal: Students will be able to use the "Metamorphic Rock Chart" in the ESRT.

Goal: Students will be able to use the "Metamorphic Rock Chart" in the ESRT.

Goal: Students will be able to use the "Metamorphic Rock Chart" in the ESRT.

Metamorphic Rocks

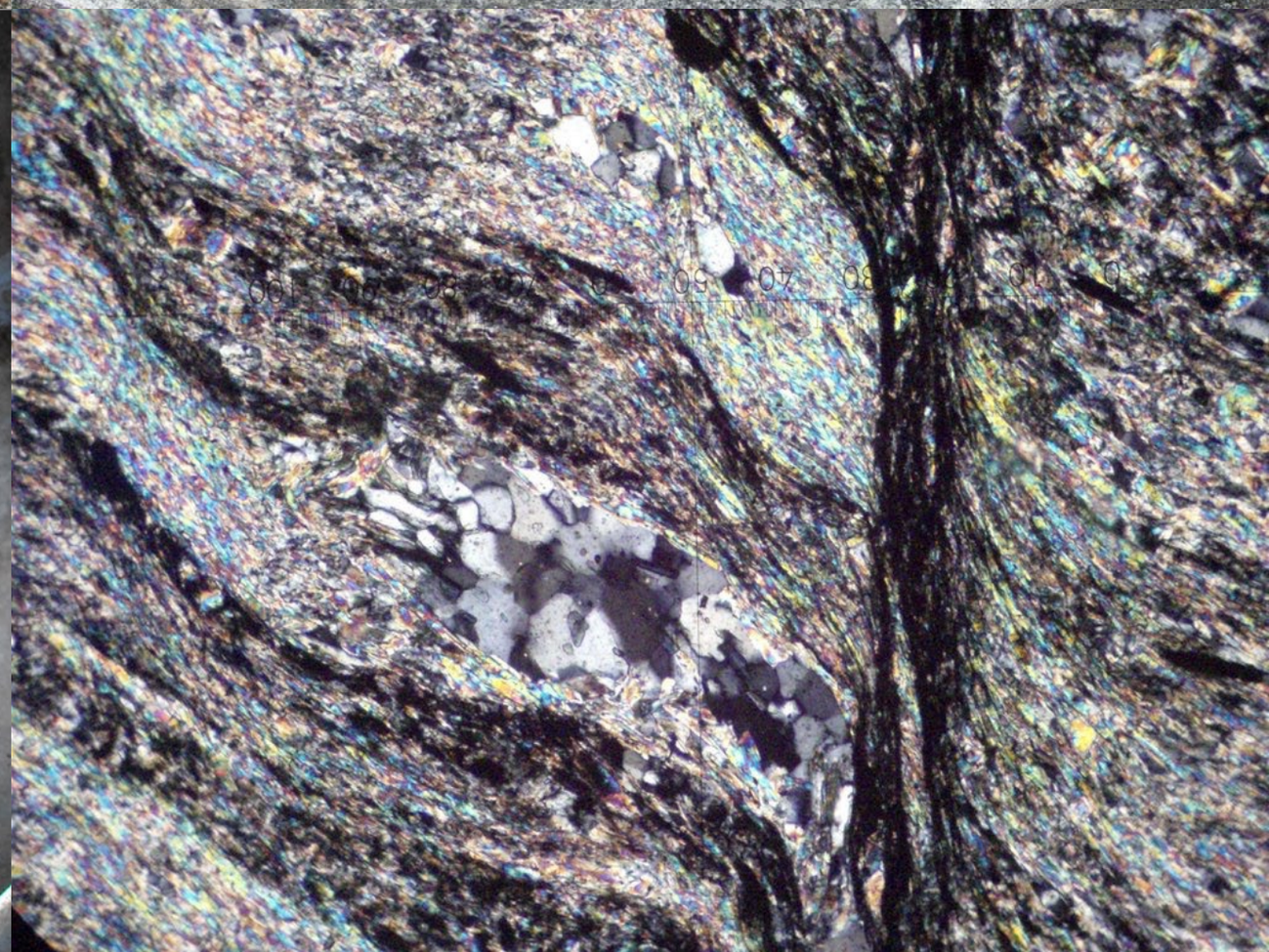
- Rocks that are subjected to conditions of heat and pressure, but do not melt.
- These rocks are changed from their original form, including changes in texture, mineral content, hardness, density, as well as other visible signs of change.


Igneous rock: diorite
Amphibole
Plagioclase feldspar
Quartz
Randomly oriented grains

Goal: Students will be able to use the "Metamorphic Rock Chart" in the ESRT.

Metamorphic Rocks

- Visible signs of change:
  - Foliation - repetitive layers of parallel crystal growth formed by intense pressure.
  - Banding - separation of light and dark minerals into layers.

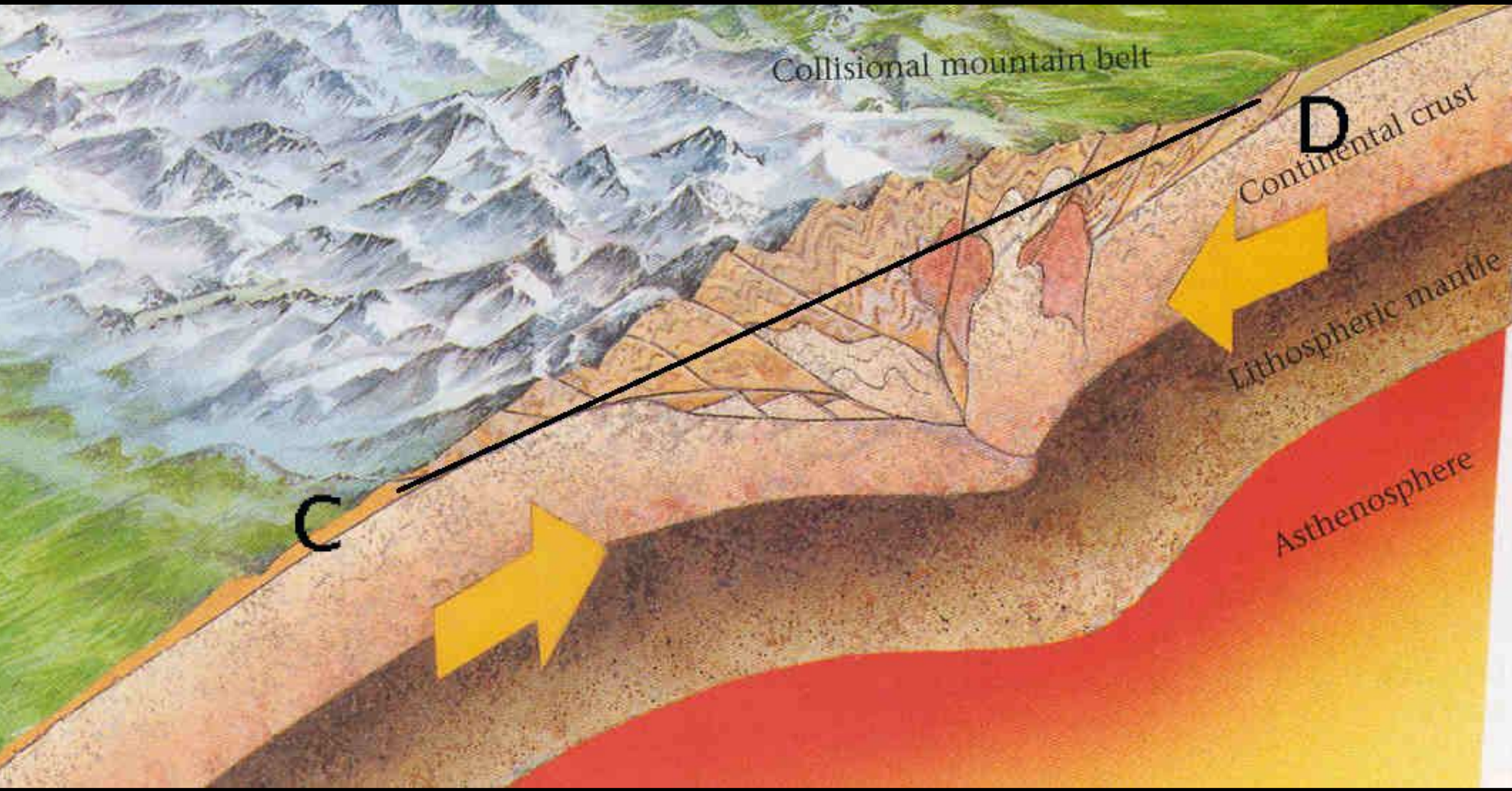


Goal: Students will be able to use the "Metamorphic Rock Chart" in the ESRT.

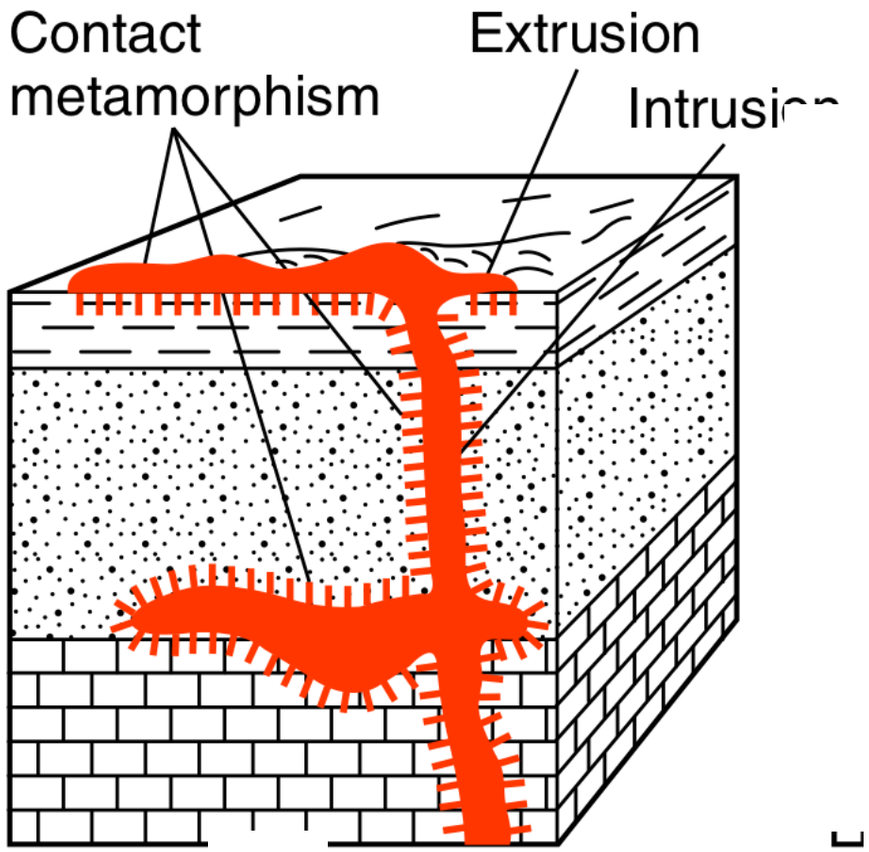
How do metamorphic rocks form?

- Need intense heat or pressure to change original rock.
  - Regional Metamorphism - when a large mass of rock experiences intense heat and pressure.
  - Contact Metamorphism - rocks are exposed to intense heat, but not pressure. This happens when magma or lava touches or comes near another rock.
- Recrystallization - forming of different mineral crystals without melting. Leads to:
  - Larger crystals
  - New minerals
  - Foliation development

Goal: Students will be able to use the "Metamorphic Rock Chart" in the ESRT.

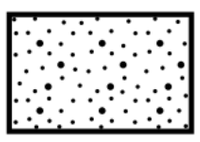


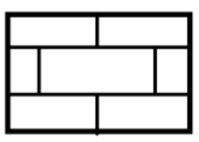
Goal: Students will be able to use the "Metamorphic Rock Chart" in the ESRT.

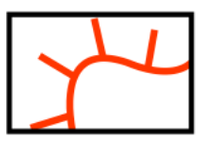


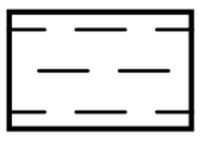
Intrusion and Extrusion

Key:


Sandstone


Limestone

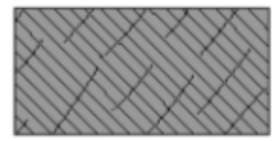
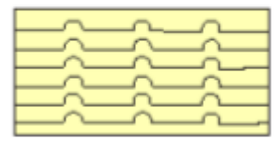
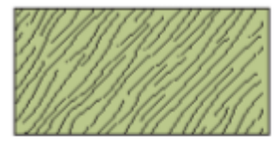
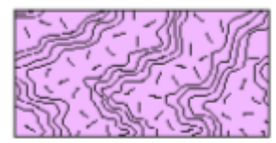
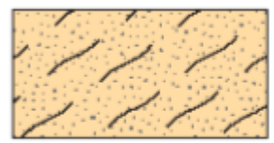
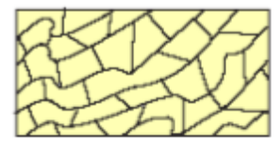
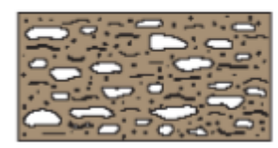

Contact metamorphism (transition zone)


Shale

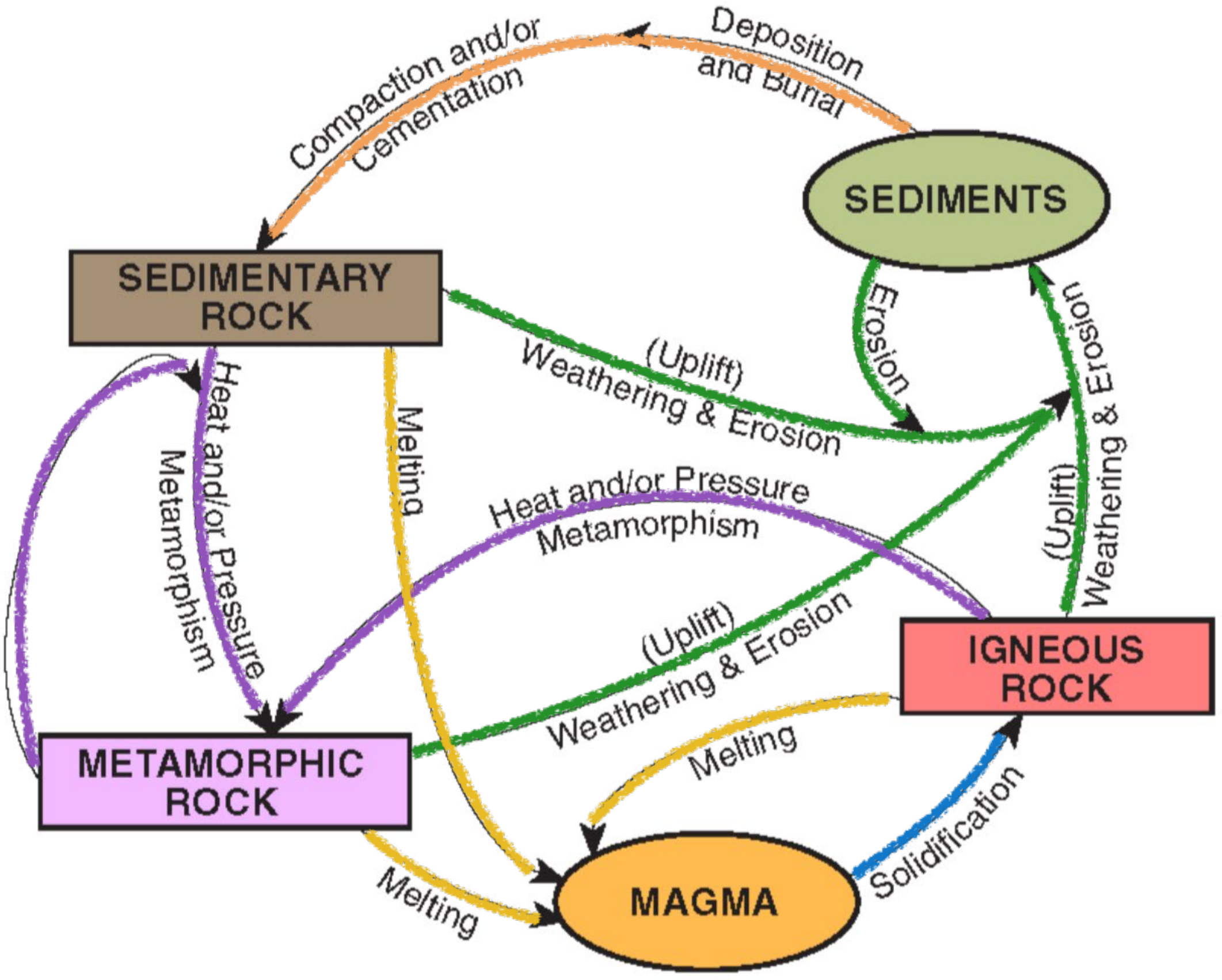

Basalt

Goal: Students will be able to use the "Metamorphic Rock Chart" in the ESRT.

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

Rock Cycle in Earth's Crust



Rocks and Minerals