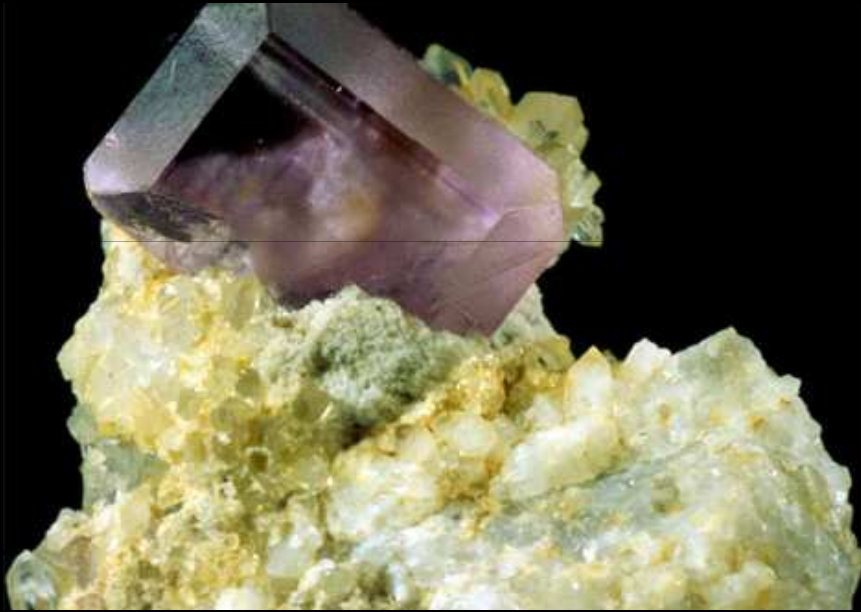


Rocks and Minerals



Unit 2

Looks normal. . .



But deep below in Mexico. . .









WILSON DE COLO



- **Minerals** – The building blocks of rocks.
 - Solid
 - Naturally Occurring
 - Inorganic - not living, never was
 - Fixed Composition
 - Elements and Compounds (*not a mixture*)



Some important facts –


- 🌍 There are more than 2,400 known minerals. . . .
- 🌍 Only a few common elements in the Earth's crust make up most minerals. . . .
- 🌍 Minerals are crystalline. . . .
- 🌍 Crystalline – made of crystals
- 🌍 Minerals are classified by their physical & chemical properties. . . .

****Important:** A mineral's physical properties are determined by its:


-internal arrangement of atoms

-composition

Mineral Characteristics

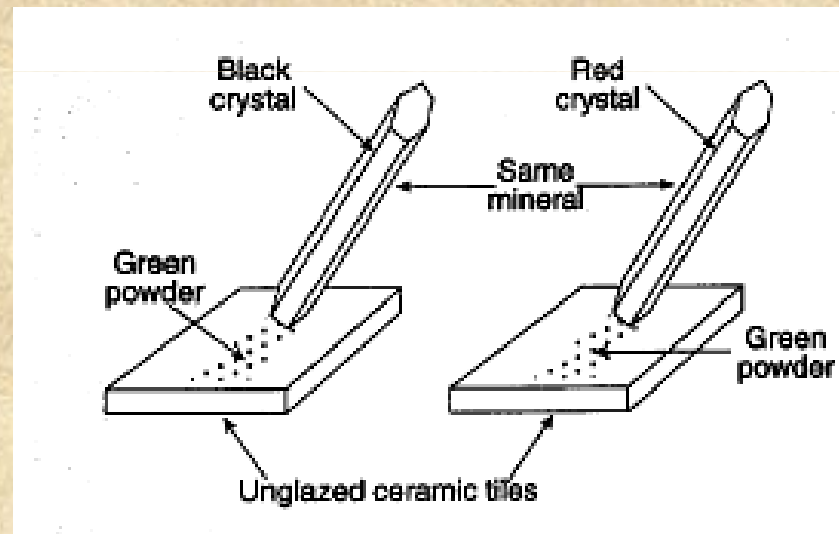
 **Color** – The actual mineral color. This is the poorest indicator of mineral type, since mineral color can vary due to impurities when forming



 **Streak** – The color of the powder of a mineral which is usually more consistent than normal mineral color.



The red-brown streak of the mineral hematite.



🌐 **Luster** – The way a mineral looks or shines in reflected light.



Metallic Luster - Pyrite

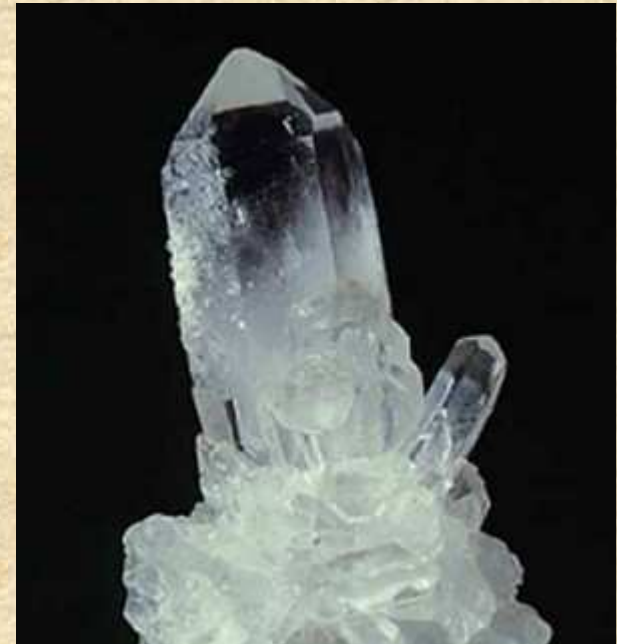



Nonmetallic Luster - Kaolinite

Metallic Luster



Nonmetallic Luster




 **Hardness** – The resistance a mineral has to being scratched or dented; usually measured by comparison to the **Mohs hardness scale of minerals**.

Mohs Hardness Scale

Mohs Hardness Scale	
1. Talc Fingernail	6. Microcline Steel tool
2. Gypsum Fingernail	7. Quartz
3. Calcite Copper coin	8. Topaz
4. Fluorite	9. Corundum
5. Apatite Knife-Glass	10. Diamond



 **Cleavage** – The tendency of a mineral to break along the zones of weakness and form smooth to semi-smooth parallel surfaces.



🌐 **Fracture** – The way in which a mineral breaks producing an uneven breaking surface





Density – Each mineral has a specific density, which can vary slightly due to imperfections. This is an excellent test because it doesn't damage the mineral.



- **Crystal Shape** –
The 3-D shape of a mineral specimen that reflects the internal atomic structure



Galena Cubes



Pyrite Pyritohedrons



Hexagonal Beryl



Calcite Scalenohedrons



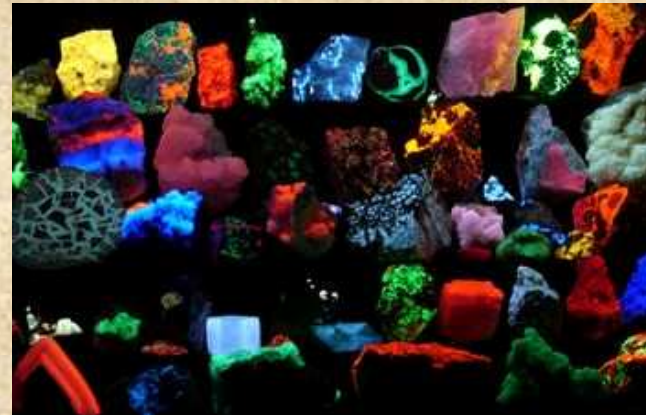
Tabular Wulfenite



Prismatic Stibnite



- **Special Properties** – Sometimes, minerals will have special properties like magnetism, fluorescence, or reaction to acid.



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 ₃ O 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 ₂ O ₃	Hematite
Nonmetallic luster	1	✓	white to green	greasy feel	ceramics, paper	Mg ₃ Si ₄ O 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 •2H ₂ O	Selenite gypsum
	2-2.5	✓	colorless to yellow	flexible in thin sheets	paint, roofing	KAl ₃ Si ₃ O 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 ₃ O 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) ₂ O 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 ₆ O ₂₂ (O,OH) ₂	Amphibole (commonly hornblende)
	6	✓	white to pink	cleaves in 2 directions at 90°	ceramics, glass	KAlSi ₃ O ₈	Potassium feldspar (commonly orthoclase)
	6	✓	white to gray	cleaves in 2 directions, striations visible	ceramics, glass	(Na,Ca)AlSi ₃ O ₈	Plagioclase feldspar
	6.5	✓	green to gray or brown	commonly light green and granular	refractory bricks, jewelry	(Fe,Mg) ₂ SiO 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 ₃ Al ₂ Si ₃ O 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

Geology
Rocks & Minerals
Minerals have families?

Mineral Composition:

- **Some minerals** consist of only one type of element. An example is graphite (carbon).

Mineral Composition:

- **Most minerals** consist of more than one type of element; a compound.

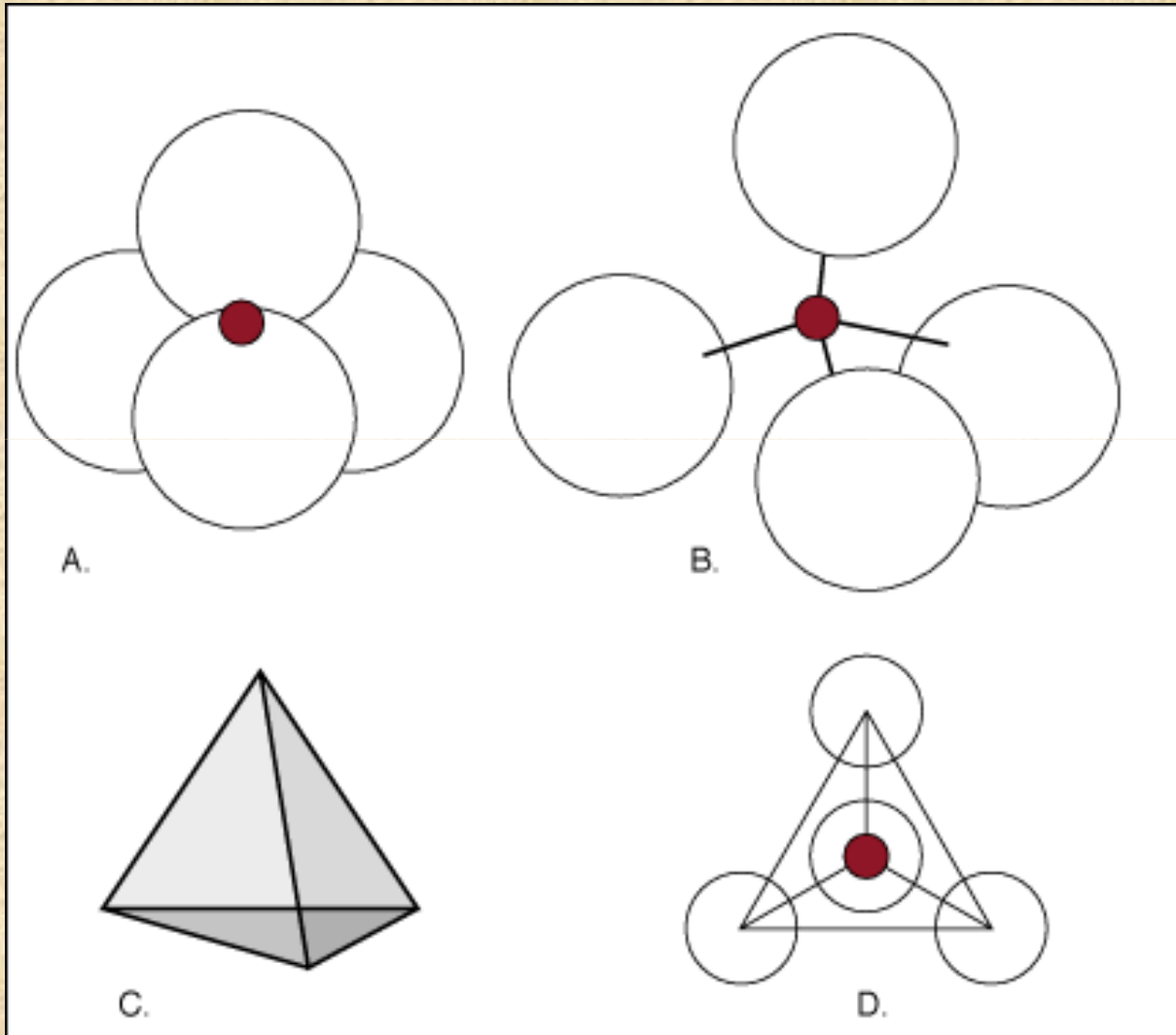
Some important information:

- Most minerals are made of only a few elements found in the Earth's crust. . .
- Minerals share common characteristics depending on their composition and arrangement of atoms
- The arrangement of atoms also gives minerals their unique physical and chemical properties. . .

Mineral Groups:

- **Silicates** –
 - By far the largest class of minerals.
 - Quartz is the most common Silicate.
 - The basic chemical unit of silicates is the silicon tetrahedron (**SiO₄**).
 - This allows them to form as single units, double units, chains, sheets, and rings.

Silicates



- **Carbonates** –

- Tend to originate in sedimentary environments.
- Often precipitate out of sea water.
- Usually react with acid.

- **Oxides** - Chemical compounds containing at least one oxygen atom as well as at least one other element.

- **Sulfides** - Group of minerals that are compounds of one or more metallic elements combined with the non-metallic element sulfur.

What are rocks?

- **Rocks** –
 - Any naturally forming solid that is part of the Earth or any other celestial body
 - usually composed of one or more minerals, except for a few rocks such as coal, obsidian, and coral, which do not possess any minerals

- **Monomineralic rock** – A rock composed of only one type of mineral

- **Polymineralic rock** – A rock composed of more than one type of mineral.

Some important information:

- There are over 4,000 different minerals but only 10 – 15 of them compose 90% of rocks. . . these minerals are known as rock forming minerals. . .
- Rocks are classified by the way that they form. . .

Types of Rocks

- **Igneous rocks** – A rock formed when natural, molten rock-forming material (magma or lava) cools and turns into a solid

Igneous Rocks

- **Magma** – Liquid rock beneath the Earth's surface. When it reaches the surface, it becomes lava.

Igneous Rocks

- **Crystallization** – A type of solidification in which molten rock (magma or lava) cools to form igneous rocks composed of mineral crystals. This is also known as **solidification**.

Igneous Rocks

- **Intrusions** – A mass of igneous rock formed when molten rock magma squeezes or melts into preexisting rocks and crystallizes.

Igneous Rocks

- **Intrusive rocks (a.k.a. plutonic rocks)** –
Rocks that form by the slow cooling and solidification of magma beneath Earth's solid surface.

Igneous Rocks

- **Extrusive rocks (a.k.a. volcanic rocks)** –
Rocks that form by the rapid solidification of lava at or above Earth's surface.

Characteristics of igneous rocks:

- **Crystal size** (a.k.a. texture or grain size) – Igneous rocks that cooled slowly have larger crystals, while those that cooled quickly have small crystals.

Texture.



Fine grained



Glassy



coarse grained

Characteristics of igneous rocks:

- **Mineral composition** (Felsic vs. Mafic) –
 - Felsic rocks have a high percent of aluminum present in their mineral composition,
 - Mafic rocks have a high percentage of iron and magnesium in their composition.

Characteristics of igneous rocks:

- **Density** – Mafic minerals tend to be high in density, felsic minerals tend to be low in density.

Characteristics of igneous rocks:

- **Color** – Mafic minerals are dark in color, felsic minerals are light in color

Sedimentary Rocks

- **Sedimentary Rocks** – Rocks that form directly from sediments deposited near Earth's surface (usually in water) by the processes of cementation, precipitation of minerals, loss of water, and compaction.

Sedimentary Rocks

- **Sediments** – Particles or materials formed by the weathering and erosion of rocks or organic materials.

Sedimentary Rocks

- **Strata** – The layers or beds of sedimentary rock and extrusive igneous rock.

Types of Sedimentary Rocks

- **Clastic sedimentary rocks** – Rocks that are largely composed of solid sediments, such as pebbles, sand, and silt.

Types of Sedimentary Rocks

- **Chemical sedimentary rocks** – A rock composed of interconnected crystals of just one mineral that form by evaporation and/or precipitation of dissolved minerals; include rock salt and rock gypsum; also called evaporite.

Types of Sedimentary Rocks

- **Organic (biological) sedimentary rocks**
 - Any rock made by living organisms or composed of materials from life forms.

Characteristics of Sedimentary Rocks

Examples: sandstone, conglomerate, shale, soft coal

1. Most sedimentary rocks are composed of fragments of other rocks that look very much like sediment. Some sedimentary rocks have a range of particle sizes, while other sedimentary rocks consist mainly of one sediment size. See Figure 1.

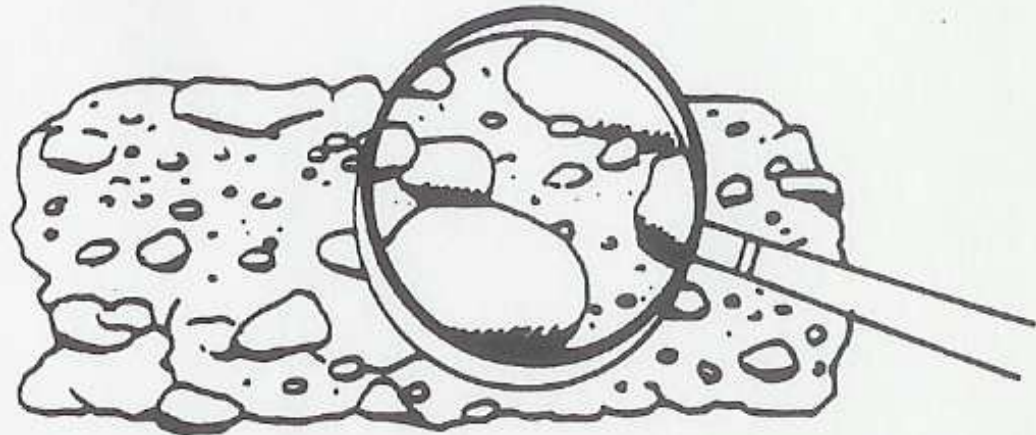


Figure 1

2. Some sedimentary rocks are of organic origin; that is, they are composed of plant and animal products or remains. Such rocks often contain fossils. See Figure 2.

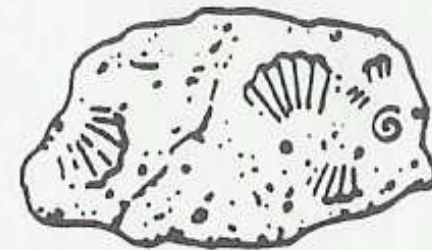


Figure 2

3. Sedimentary rocks often have distinct parallel layers. See Figure 3.

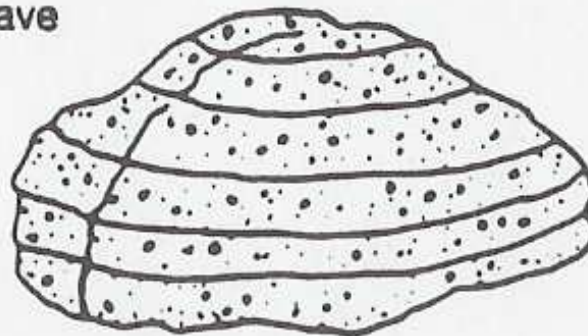


Figure 3

4. Sedimentary rocks often appear dull or earthy.

Some stuff to know

- Clastic sedimentary rocks are classified on the basis of grain size
- Organic & chemically formed sedimentary rocks are primarily identified by composition & texture. . .

Metamorphic Rocks

- **Metamorphic rocks** – A rock that forms from changes in previously existing rocks due to extreme heat and pressure.

Metamorphic Rocks

- **Recrystallization** – A process during metamorphism where mineral or sediments in a rock are partially melted and re-shaped, or combined with others to make larger crystals.

Metamorphic Rocks

- **Parent rock** – The original rock which undergoes the metamorphism

Characteristics of Metamorphic Rocks

- **Foliation** – Texture of metamorphic rocks caused by the layering of mineral crystals

Types of foliation

- **Banding** – A type of foliation caused by the separation of minerals into layers. The layers are not usually continuous like in sedimentary rocks.



Types of foliation

- **Mineral alignment** – Individual mineral crystals are flattened in the same direction, but are not connected in bands.

Some metamorphic rocks may also have a distorted structure.

- **Distorted structure** – mineral layers are folded or bent by heat and pressure.

Characteristics of Metamorphic Rocks

Examples: schist, gneiss, quartzite, slate, marble, hard coal

1. Metamorphic rocks often may look like igneous rocks except that they do show bands of color. See Figure 6.
2. Metamorphic rocks may show signs of bending and distortion. See Figure 7.
3. Mineral crystals in metamorphic rocks will generally be flattened.

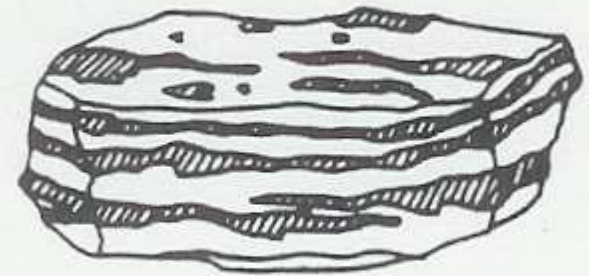


Figure 6

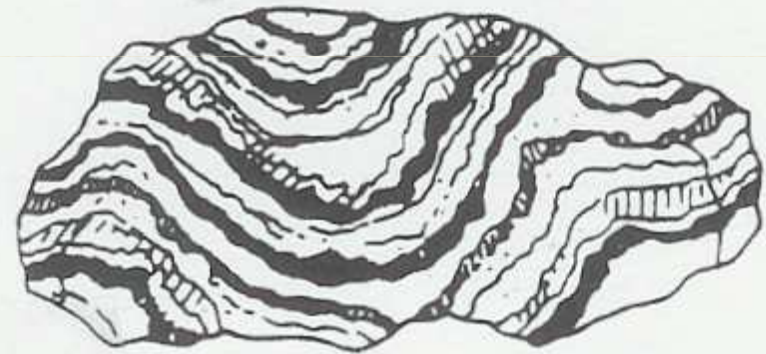


Figure 7

Some important information:

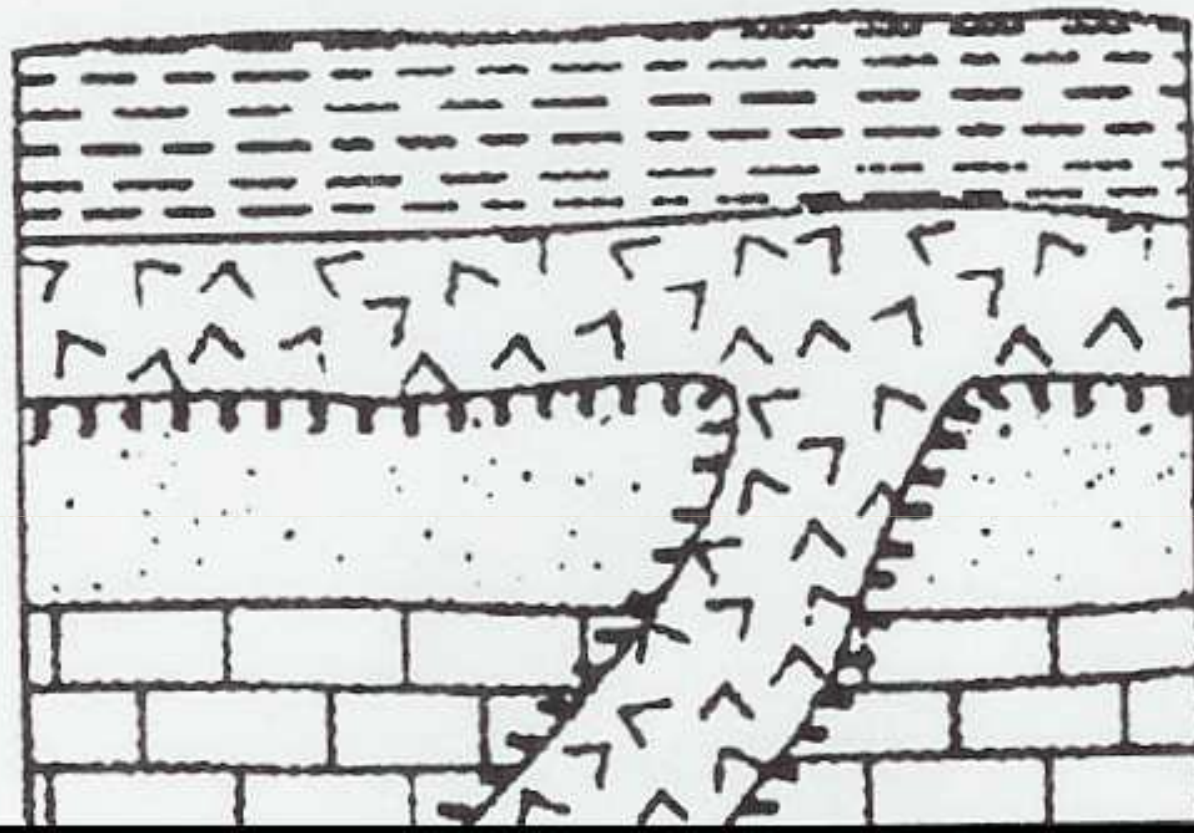
- **Contact metamorphism** – Older rocks come in contact with the magma of an intrusion or lava of an extrusion, and the heat recrystallizes the older rock.

Some important information:

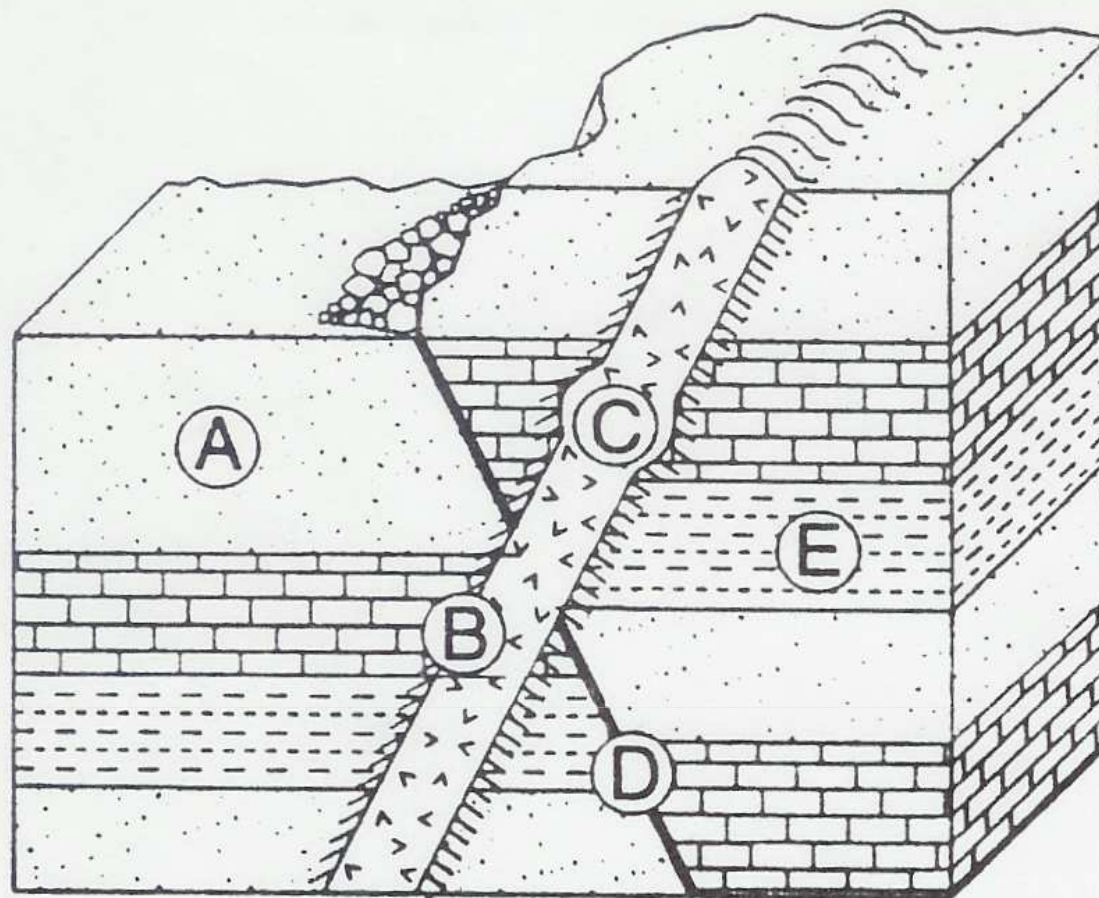
- **Regional metamorphism** – Formation of metamorphic rock over large areas due to an increase in temperature and pressure, usually as the result of mountain building associated with plate collision or convergence

Some important information:

- Metamorphic rocks are classified by their texture, composition, foliation, & banding. . .



- Shale
- Basalt
- Contact metamorphosis
- Sandstone
- Limestone

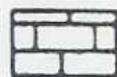


Transition zone

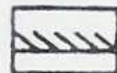
Key



Sandstone



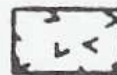
Limestone



Transition zone



Shale



Igneous
rock

REVIEW

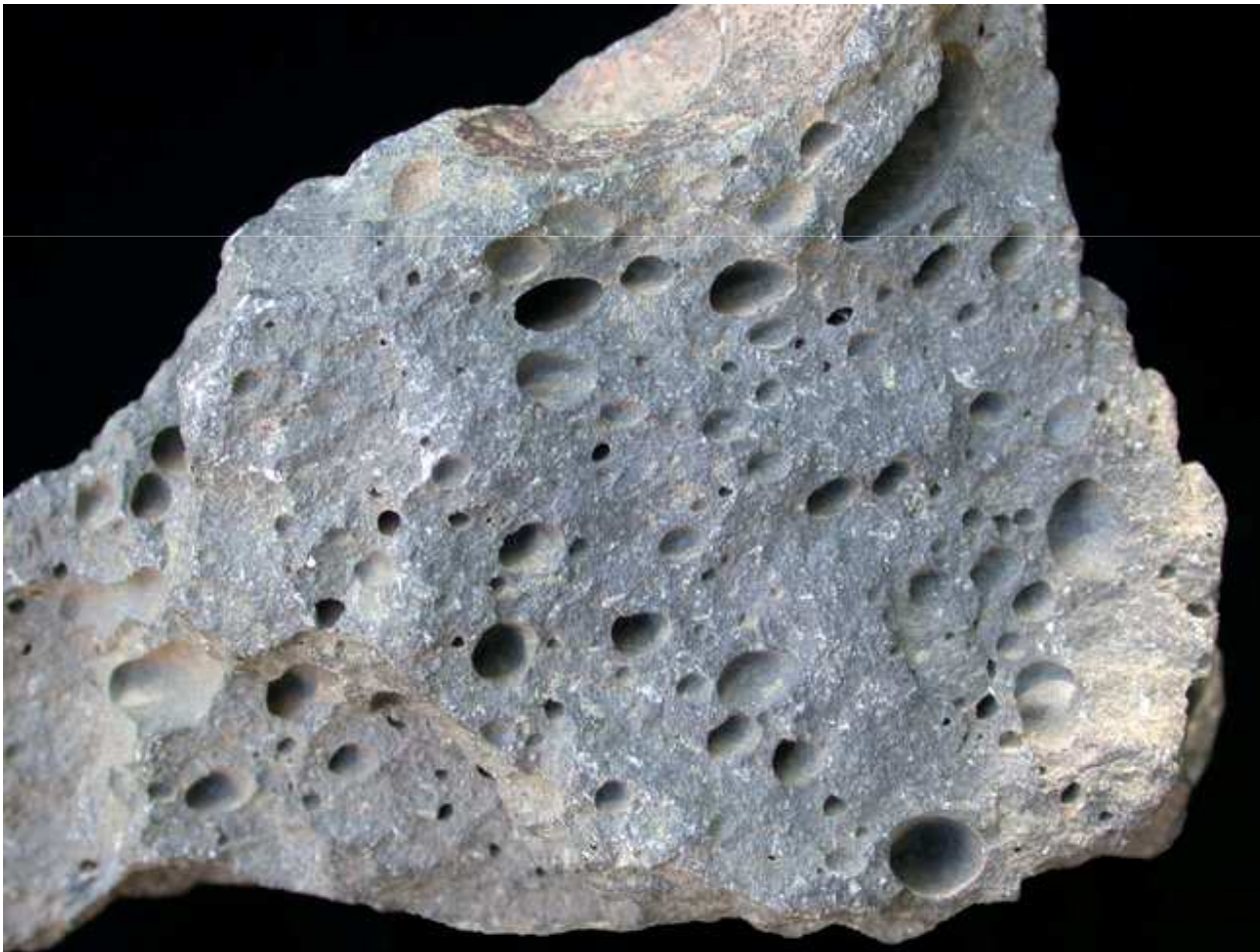
Identifying Rocks

- Igneous rocks:
 - Often have large, intergrown crystals.
 - This means that as the rock formed the crystals grew into each other.



Identifying Rocks

- Igneous rocks:
 - May be vesicular (contains bubbles).



Identifying Rocks

- Sedimentary rocks:
 - *Only* sedimentary rocks can contain fossils.
 - But not all sedimentary rocks contain fossils.



Identifying Rocks

- Sedimentary rocks:
 - Often made up of visible sediments, like sandstone and conglomerate.
 - The sediments are cemented together and are not intergrown like igneous rocks.



Identifying Rocks

- Sedimentary rocks:
 - Some have layers that formed as the sediments were being deposited...



Identifying Rocks

- Metamorphic rocks:
 - Are often foliated, which means the minerals are lined up.
 - Types of foliation include banding and mineral alignment.
 - The bands are not usually continuous like they are in sedimentary rocks.
 - These "layers" may also be distorted into waves and odd angles.
 - Small flat mica crystals may be aligned in some metamorphic rocks.

Identifying Rocks

- Metamorphic rocks:
 - Examples of foliation:



Identifying Rocks

- Summary:
 - The rock is sedimentary if:
 - It has fossils
 - It is layered
 - It is made of sediments

Identifying Rocks

- Summary:
 - The rock is igneous if:
 - It has intergrown crystals
 - It has vesicles (bubbles)

Identifying Rocks

- Summary:
 - The rock is metamorphic if:
 - It has mineral alignment
 - It has banding of minerals