Minerals, Rocks and Rock Types, Rock cycle, Rock Structures

Minerals

- A mineral is a naturally occurring inorganic element or compound having an orderly internal structure and characteristic chemical composition, crystal form, and physical properties.

- Common minerals include quartz, feldspar, mica, amphibole, olivine, and calcite.

- A rock is an aggregate of one or more minerals, or a body of undifferentiated mineral matter.
- Common rocks include granite, basalt, limestone, and sandstone.

- To meet the definition of "mineral" used by most geologists, a substance must meet five requirements:
  (i) naturally occurring
  (ii) inorganic
  (iii) solid
  (iv) definite chemical composition
  (v) ordered internal structure

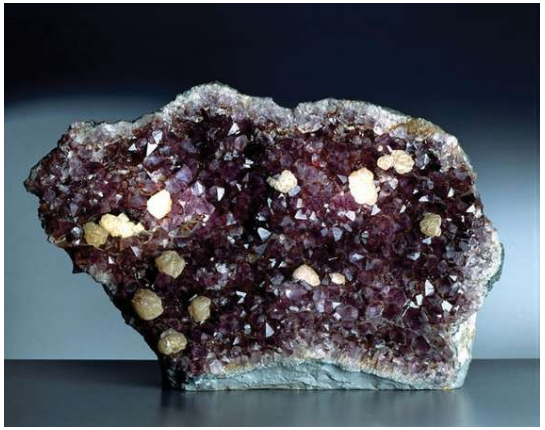
- "Naturally occurring" means that people did not make it.
  eg. Steel is not a mineral because it is an alloy produced by people.

- "Inorganic" means that the substance is not made by an organism.
  eg. Wood and pearls are made by organisms and thus are not minerals.

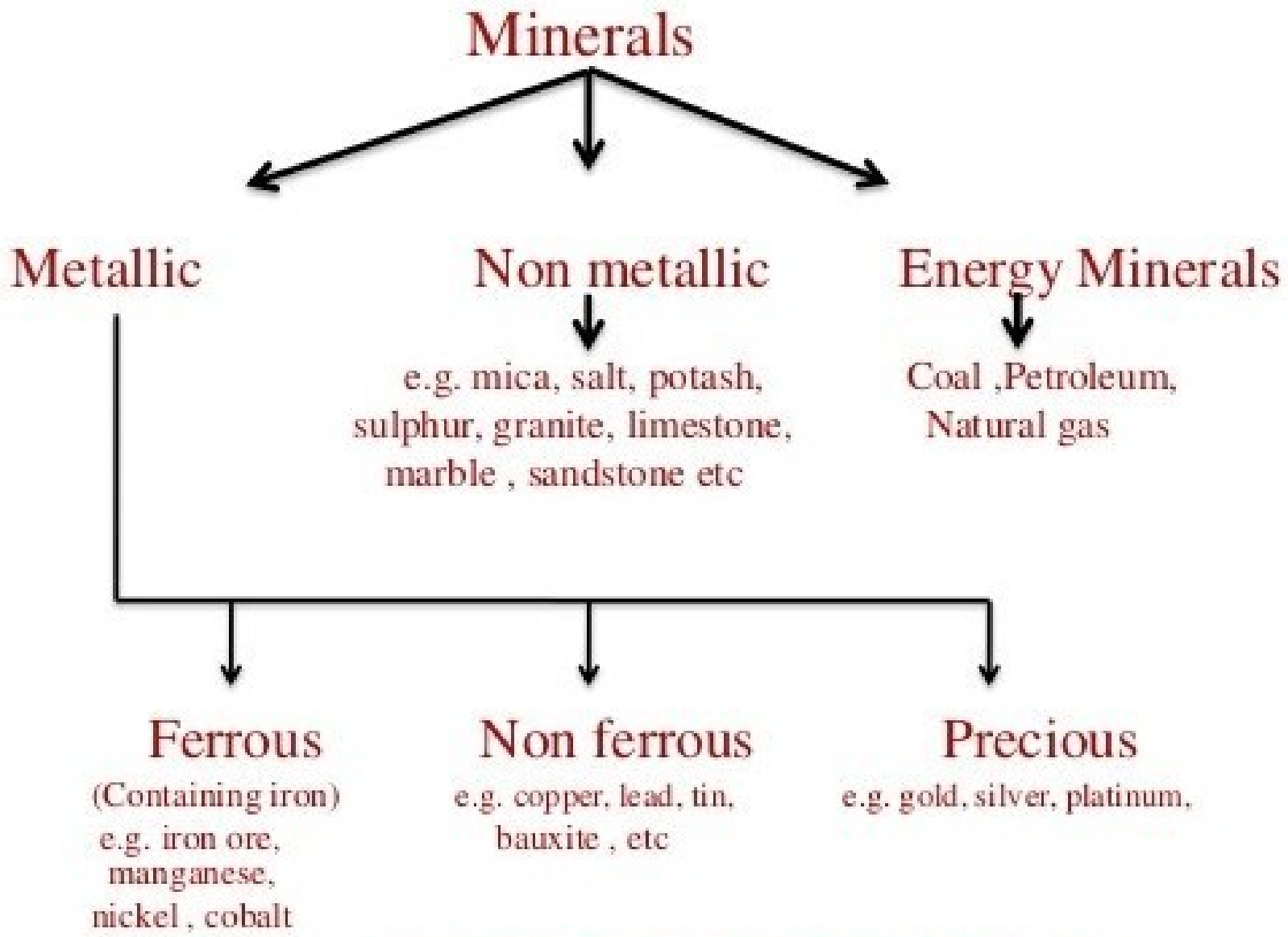
- "Solid" means that it is not a liquid or a gas at standard temperature and pressure.

- "Definite chemical composition" means that all occurrences of that mineral have a chemical composition that varies within a specific limited range.
  For example: the mineral halite (known as "rock salt" when it is mined) has a chemical composition of NaCl. It is made up of an equal number of atoms of sodium and chlorine.

Rock salt



Amethyst

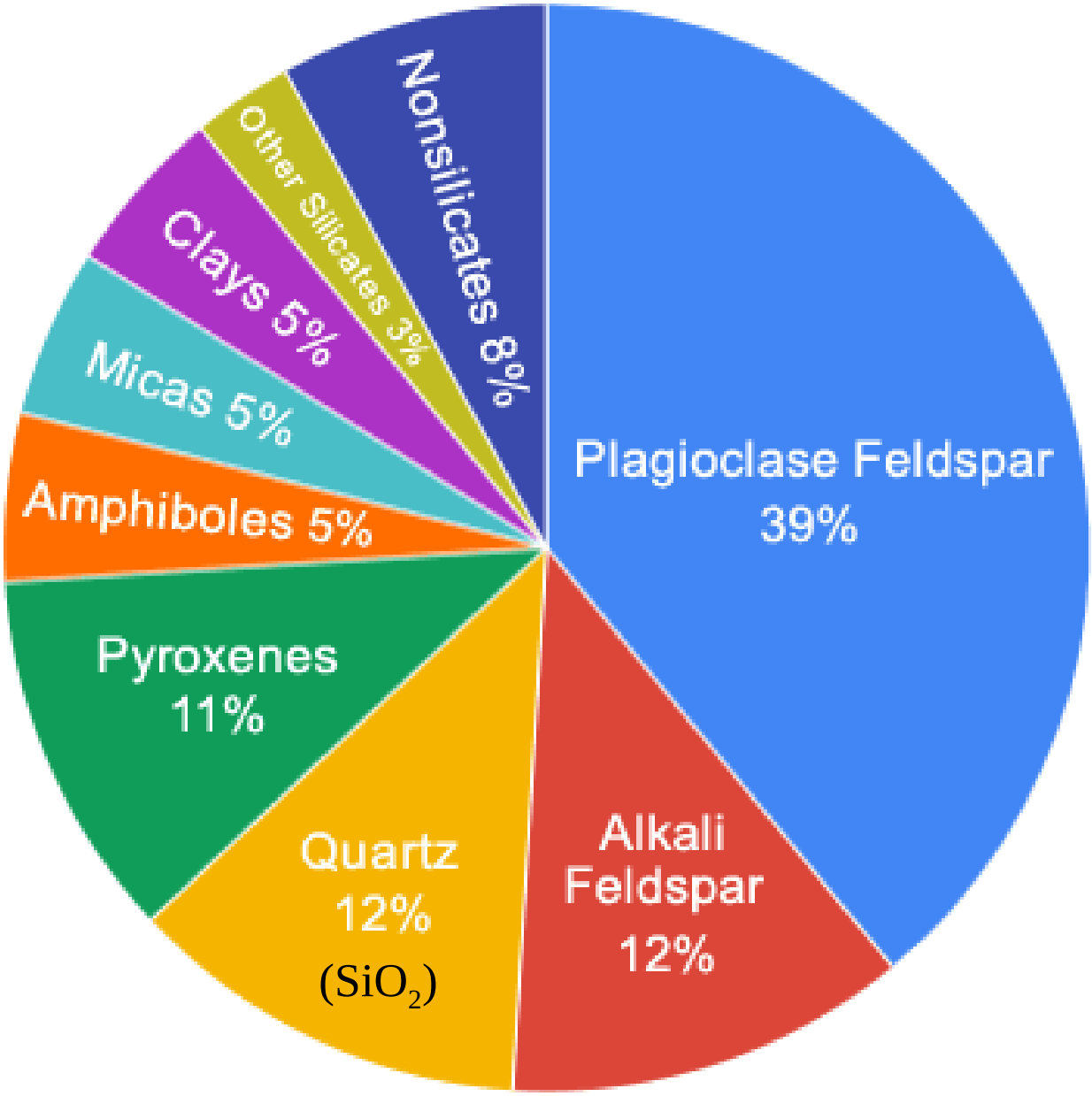


CLASSIFICATION OF MINERALS

Classification of Minerals

- Minerals are classified based upon their chemical composition.
  - Silicates SiO_2^{4-} Rock-forming minerals
  - Oxides O^{2-} Magnetite, Hematite
  - Sulfides S^{-} Pyrite, Galena
  - Sulfates SO_4^{2-} Gypsum
  - Halides Cl^- or F^- Fluorite, Halite
  - Carbonates CO_3^{2-} Calcite, Dolomite
  - Native elements Cu, Au, C Copper, Gold, Graphite

Most Abundant Minerals in Earth's Crust



Common Silicate Minerals

Rocks: Classification and description of some common rocks

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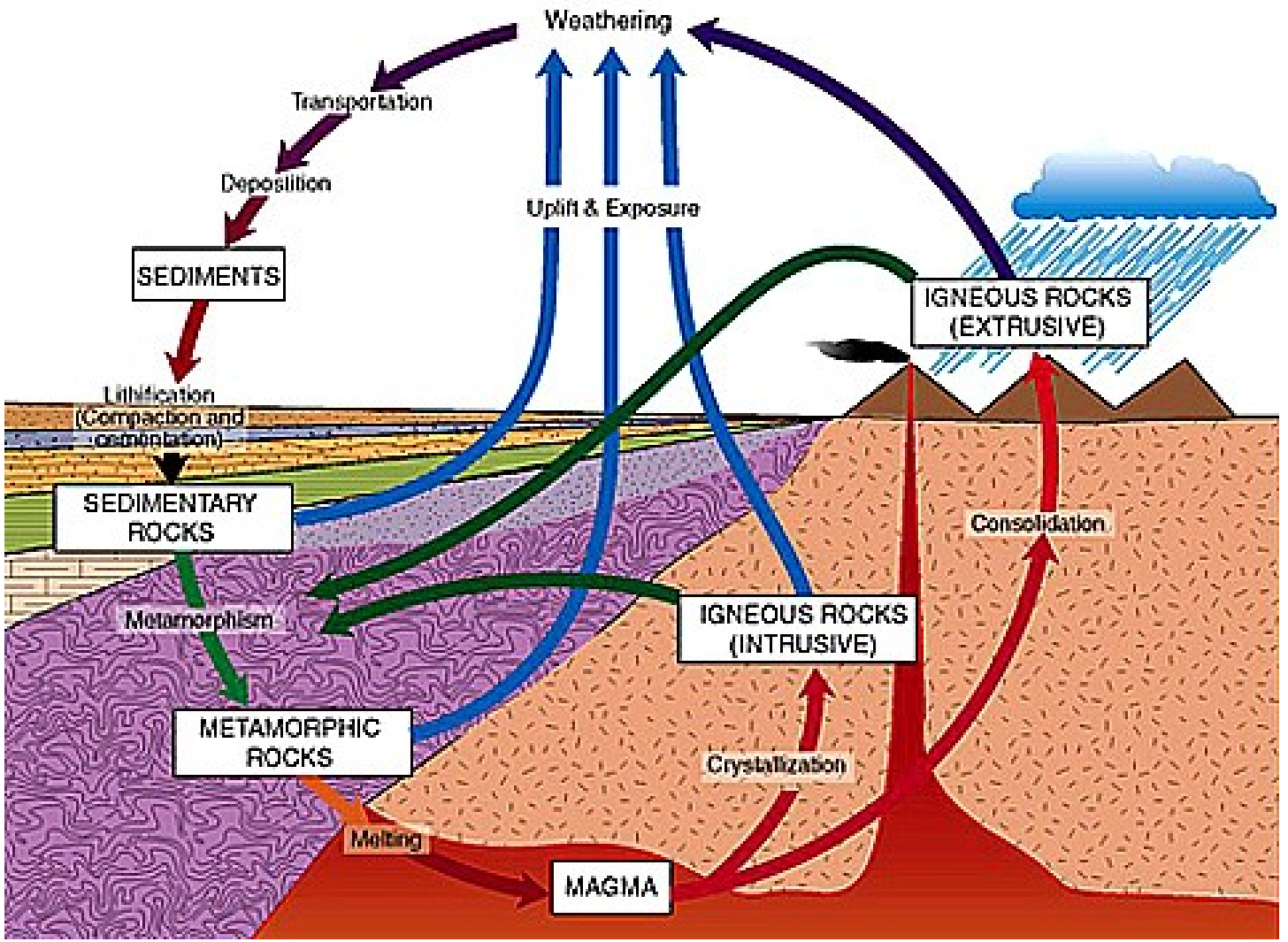
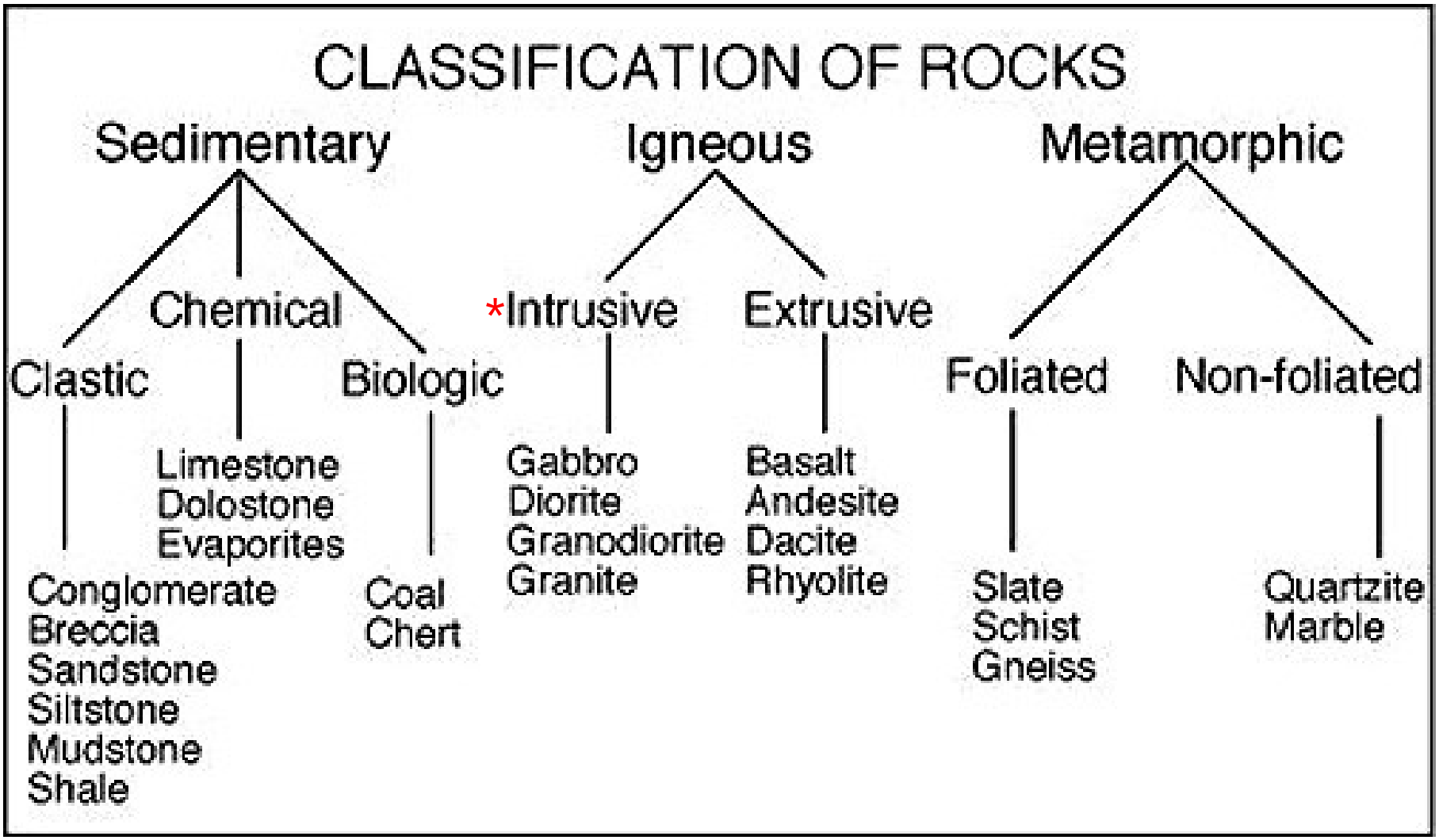


(Rock cycle)



*Intrusive igneous rocks → Plutonic

*Intrusive igneous rocks → Hypabyssal

gneous rocks :

- **Igneous** rocks form directly by crystallization of hot melts made up of silicates (Si_mO_n) combined with Fe, Mg, Ca, Al, Na, K, Ti, H_2O). Minerals formed from these make up nearly all the mantle and crust.

Sedimentary rocks

- Rocks at the surface decompose/disintegrate by reaction with the atmosphere/hydrosphere to produce solid debris and soluble chemicals that are transported/deposited to form sediments, that upon burial are converted to (usually layered; strata) sedimentary rocks.

Metamorphic rocks

- Previously formed rocks that are heated and pressurized when buried to shallow to moderate depths (5 to 70 km) of the crust recrystallise as solids

Igneous rocks:

(Granite)

Igneous rocks are made from crystals - minerals that crystalized from once hot melts. Intrusive igneous rocks are commonly without notable layering - they can be described as massive, and result from cooling and solidification well beneath the Earth's surface. Granite is the most familiar intrusive rock type. Extrusive igneous rocks often occur in layers, which may vary in thickness, formed either by outflows of lava or

Basalt

Sedimentary rocks:

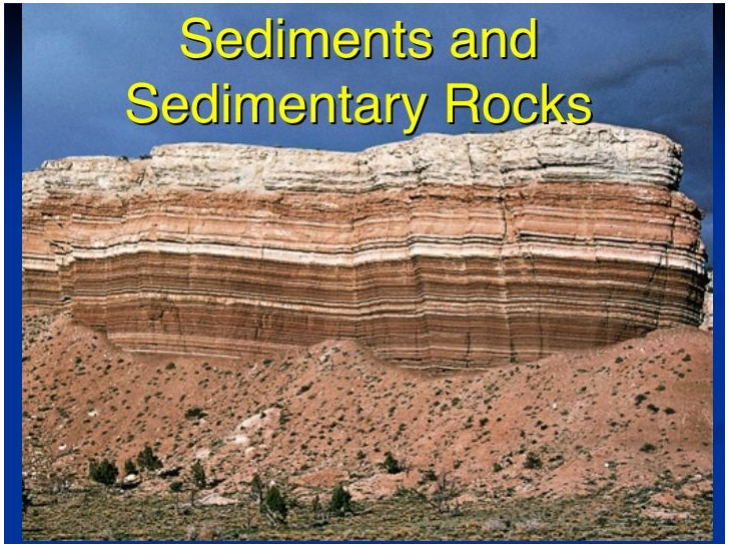
- Sedimentary rocks nearly occur always in layers.

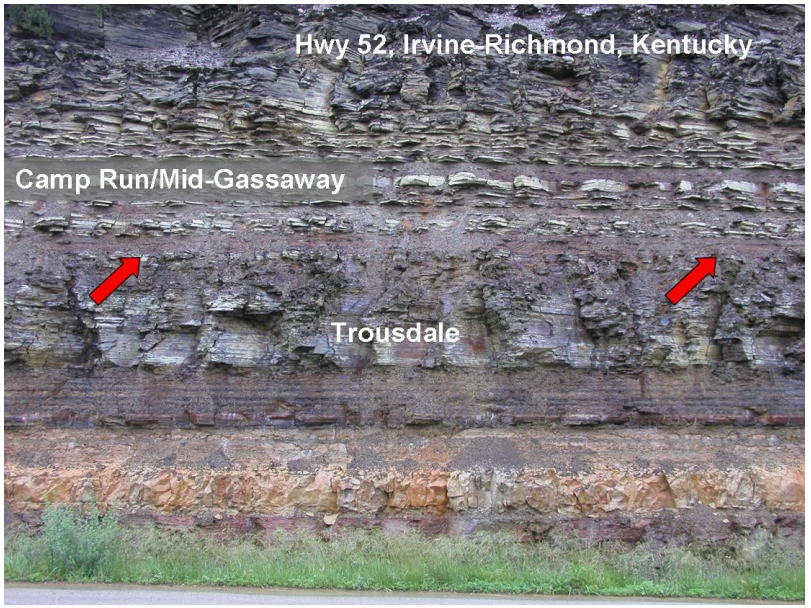
- These are beds (also called *strata*) made up of deposits from the ocean or other water bodies that consist of clastic fragments (e.g., sand grains), or chemical or biochemical precipitates.

- Most frequently, the layers are initially laid down as horizontal units.

- The most common types of sedimentary rocks are shales, mudstones, sandstones, limestones, and evaporites (such as salt beds).

- If the strata are inclined (dipping), this usually means that the rocks have subsequently been





Here is a typical outcrop of shale beds

(Sandstones)

Limestones are the principal member of carbonate rocks. Typically, the limestone is a light whitish-gray, as seen in this outcrop:

(Limestones)


Limestone
Chert
Arkose
Shale
Sandstone
Conglomerate

Metamorphic rocks:

- Metamorphic rocks result from the action of heat and pressure on pre-existing rocks (sedimentary, igneous or metamorphic) that are brought to depths of a few to tens of kilometers below the surface.
- New minerals are produced by this metamorphism. Shales (mudstones) may be recrystallized into mica-rich rocks called schists.
- As such rocks are heated to temperatures below but not far from those that would melt the rocks, they become soft, recrystallize further, and can be deformed into crenulated light and dark units that resemble layers, forming rocks called gneisses.

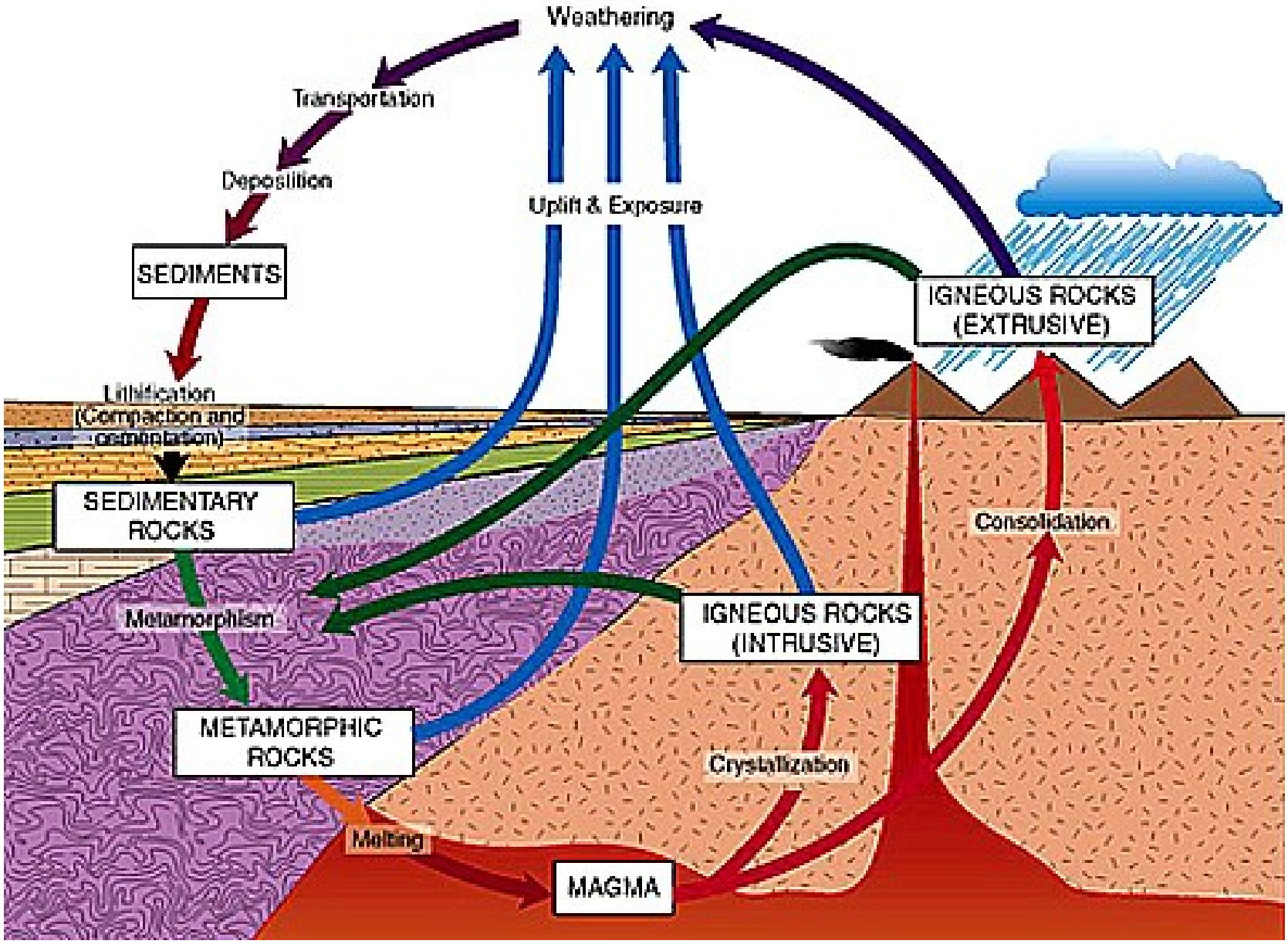
Examples of slate, schist and gneiss are:

(Slate)

(Mica schist containing garnets)

(Gneiss)

Rock cycle


Weathering
Transportation
Deposition
SEDIMENTS
Uplift & Exposure
IGNEOUS ROCKS (EXTRUSIVE)
Lithification (Compaction and cementation)
SEDIMENTARY ROCKS
Consolidation
Metamorphism
IGNEOUS ROCKS (INTRUSIVE)
METAMORPHIC ROCKS
Crystallization
Melting
MAGMA

ROCK STRUCTURES

- Most rocks are not uniform throughout.
- On a scale usually best measured in millimeters or centimeters, they are composed of individual mineral grains that vary in size, shape and composition.
- The geometric characteristics of and relationships between these small-scale rock features constitute rock texture.
- Rock commonly also vary on larger scales, best measured in centimeters to meters to kilometers.
- The individual, contrasted, larger-scale features of rocks are called 'structures’.
- Our task will be to see if there are rock structures that can provide clues to a rock's formational environment: whether it's igneous, sedimentary or metamorphic.
- There are hundreds of distinct rock structures.

- Geologists find it convenient to divide them into 'primary' and 'secondary' structures.
- Primary Structures: structures formed before or at the same as material is in the process of becoming rock. For example, formed as magma crystallizes or as sediment accumulates.
- Secondary Structures: structures imposed on rock after it has already formed. For example, formed as a result of compression of existing rock.

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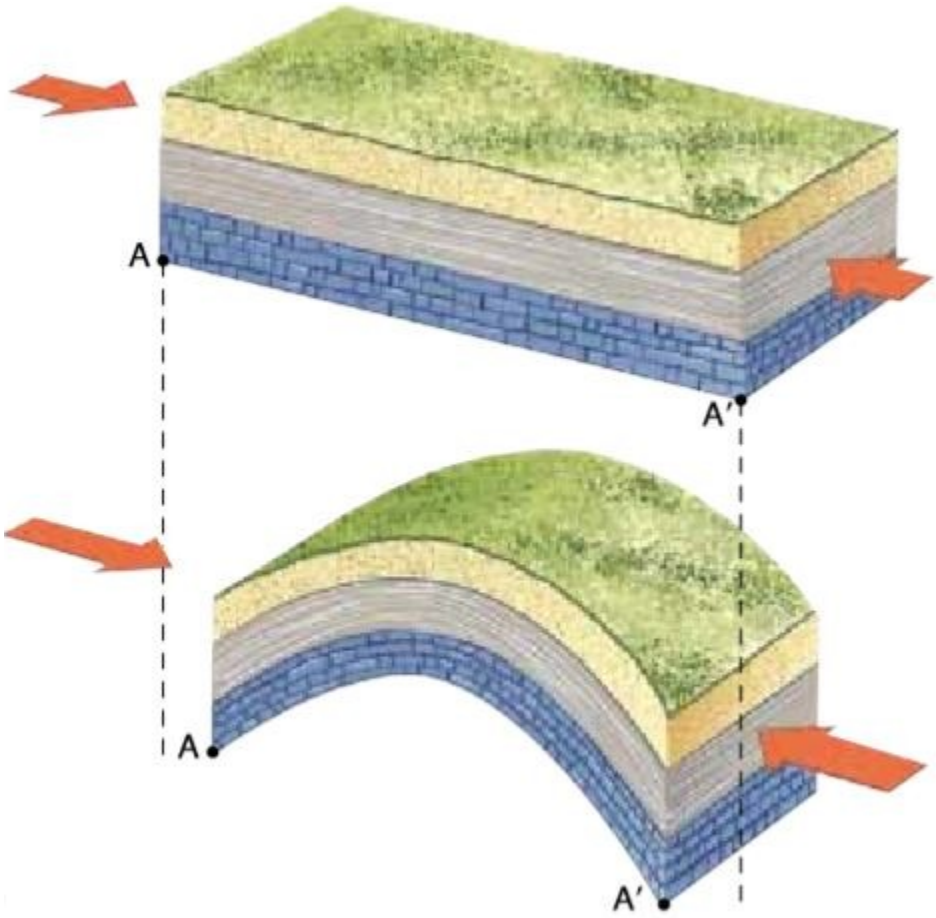
- (Bedding planes, sedimentary rocks)

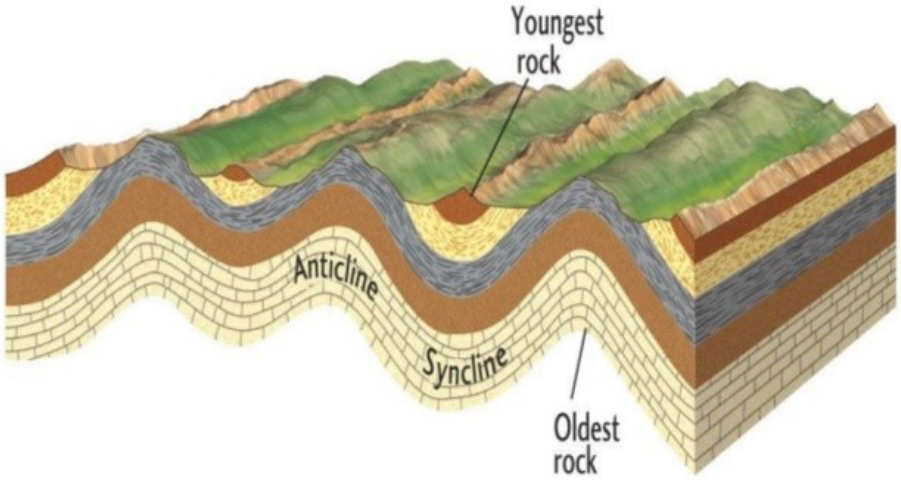
(Lava flows in basalts, Igneous rocks)

- Secondary Structures: structures imposed on rock after it has already formed. For example, formed as a result of compression of existing rock.
- eg. Folds, Faults etc.

Folds

- Folds are geologic structures that develop due to deformation of rocks.
- Layered strata are compressed and shortened, resulting in wave-like formations, consisting of crest and troughs.
- Folds develop from deformation of rock in response to tectonic stress.





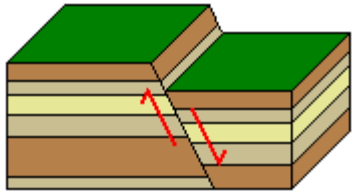
Faults:

•A fault is a planar fracture or discontinuity in a volume of rock, across which there has been significant displacement as a result of rock-mass movement.

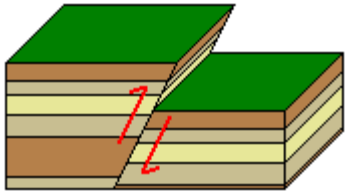
•Not every crack in the ground is a fault.

•What defines a fault is the movement of the rock on either side.

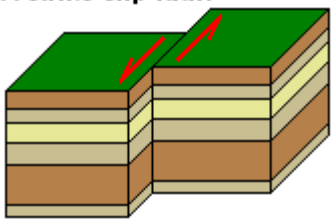
A normal fault



A reverse fault



A strike-slip fault



An oblique fault