I. Minerals

Earth and Space Science

A. Definition – four part definition

→ Naturally occurring

→ Inorganic substance (non-living)

→ Crystalline solid

→ Definite chemical composition

- There are substances that meet 3 of the 4 criteria, and are called mineralloids

→ Example: Opal – does not have an orderly arrangement of atoms

B. How many minerals are there?

- 3500 known minerals in the Earth's crust
- Minerals combine to form all rocks on Earth

  → Rock type depends on mineral composition

- 20 minerals combine to form 95% of all rocks on Earth.

C. Physical Properties

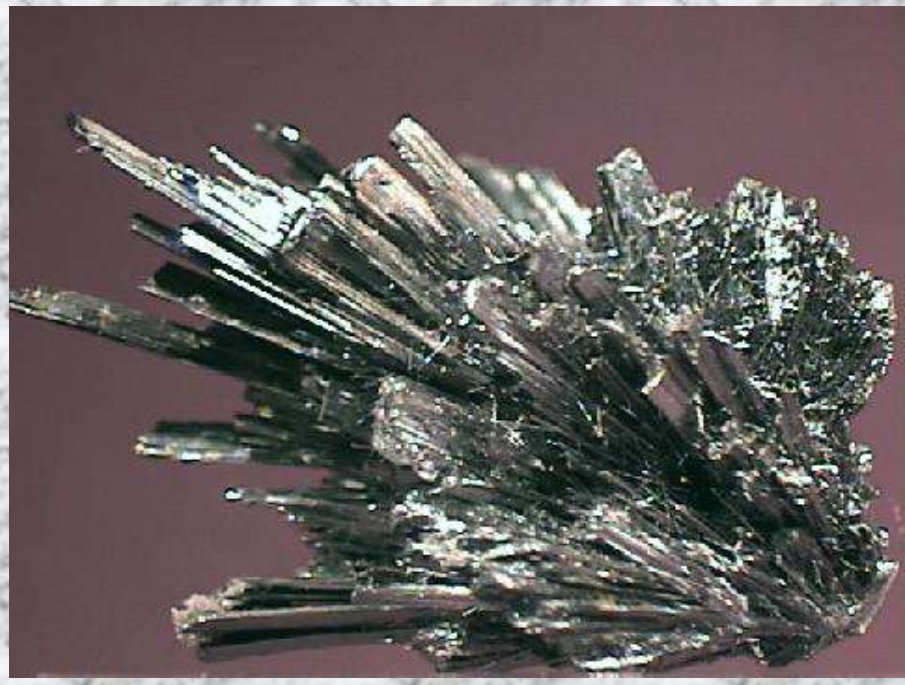
- All minerals have at least 9 physical properties that can be used to define, describe, and identify them as unique minerals.

- 1. Color – every mineral is some color and some are found in multiple colors
- → could be very helpful and distinctive, or could be very ambiguous

2. Luster – the manner in which a mineral reflects light

→ Glassy – reflects light like a piece of glass does

→ Metallic – reflects light like a piece of metal does

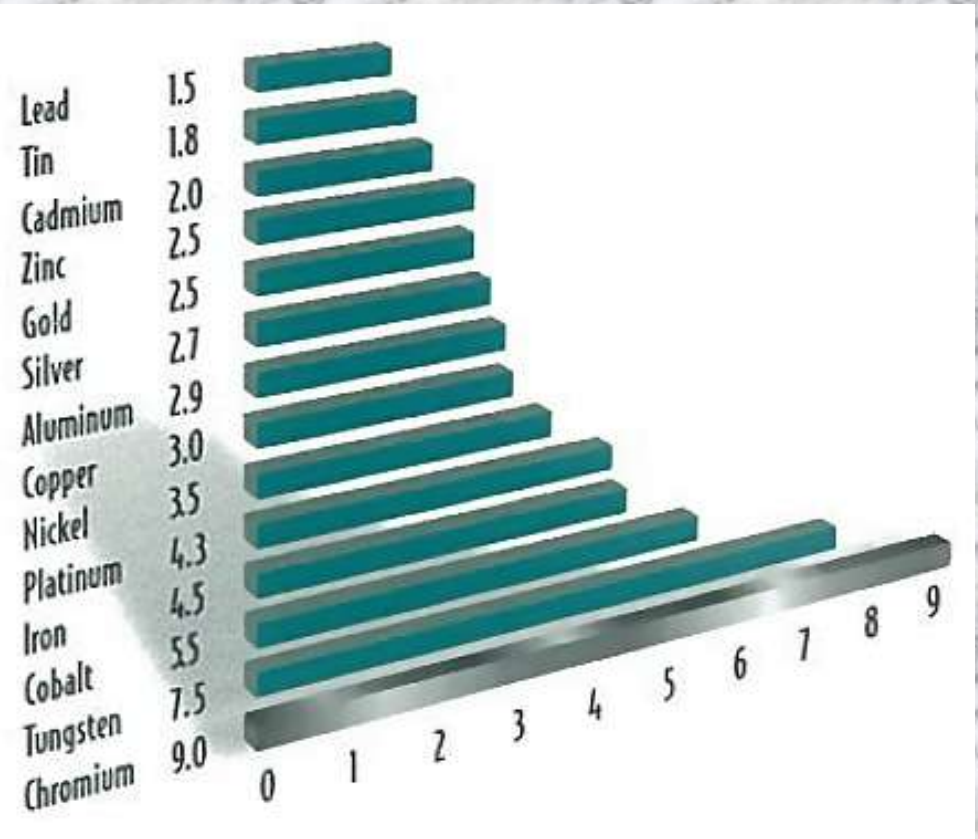


3. Streak – the color of the pulverized powder of a mineral

The color could be different from the crystal's color, and is always distinctive

- 4. Hardness – the scratchability of a mineral, or a mineral's durability

→Uses the Moh's Hardness scale with a rating system of 1-10



*1 = very soft

*10 = hardest substance known to man

*A streak plate has a hardness of 7

Moh's Hardness Scale

SCALE OF HARDNESS

MOHS HARDNESS SCALE

1	Talc
2	Gypsum
3	Calcite
4	Fluorite
5	Apatite
6	Orthoclase
7	Quartz
8	Topaz or Beryl
9	Corundum
10	Diamond

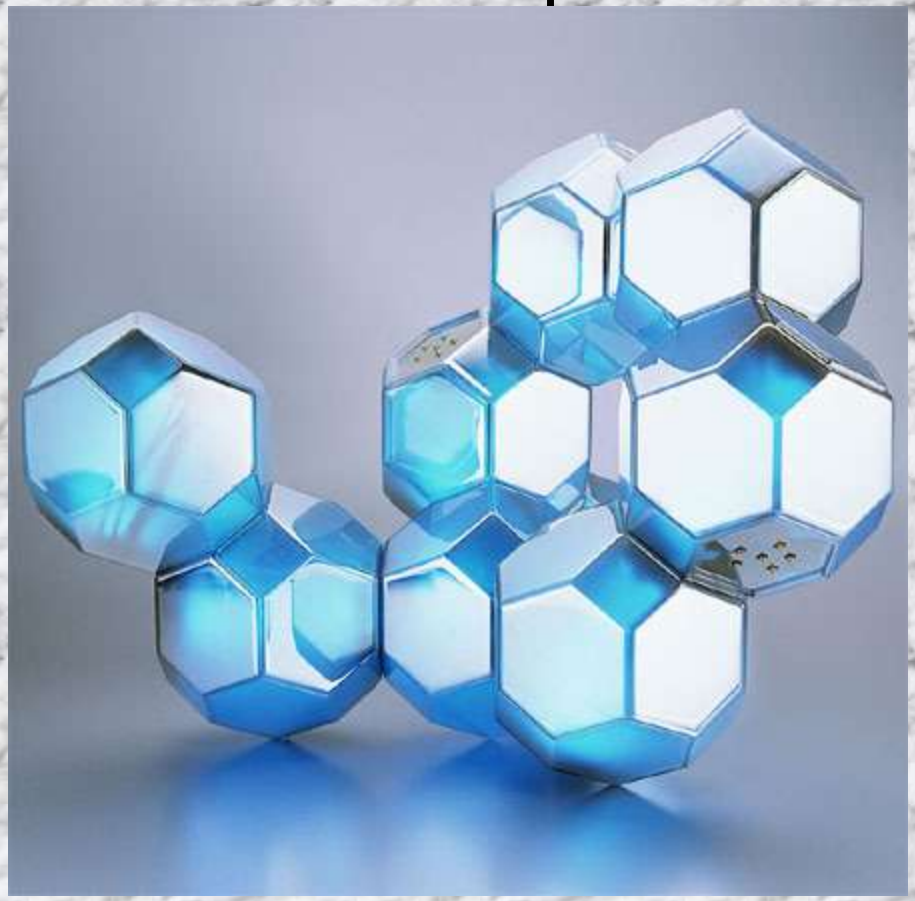
MOHS HARDNESS OF COMMON ITEMS

Fingernail	2 to 2.5
Copper coin	3.5
Steel knife	5 to 6
Glass	5 to 5.5
Streak plate	6.5 to 7

(Adapted from Jones, 2001: Laboratory Manual for Physical Geology, 3rd edition.)

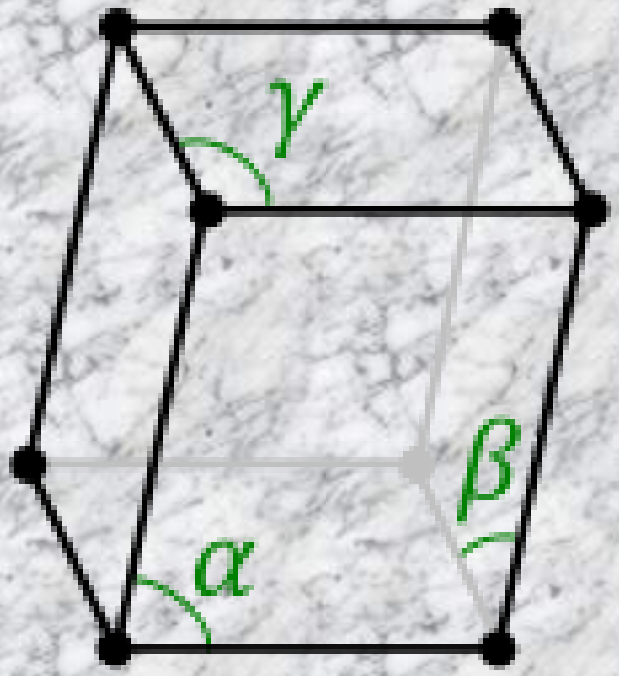
5. Crystal shape / External Crystal Form / Crystal Systems

→ a set of faces that have a definite geometric relationship to each other

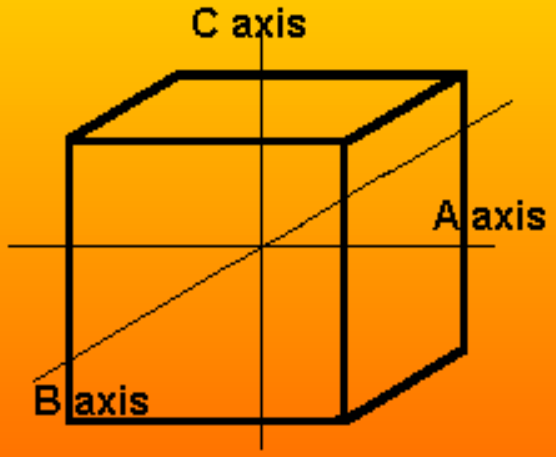


- This is not always shown clearly when crystals are growing and competing for space with other minerals

$$\alpha, \beta, \gamma \neq 90°$$

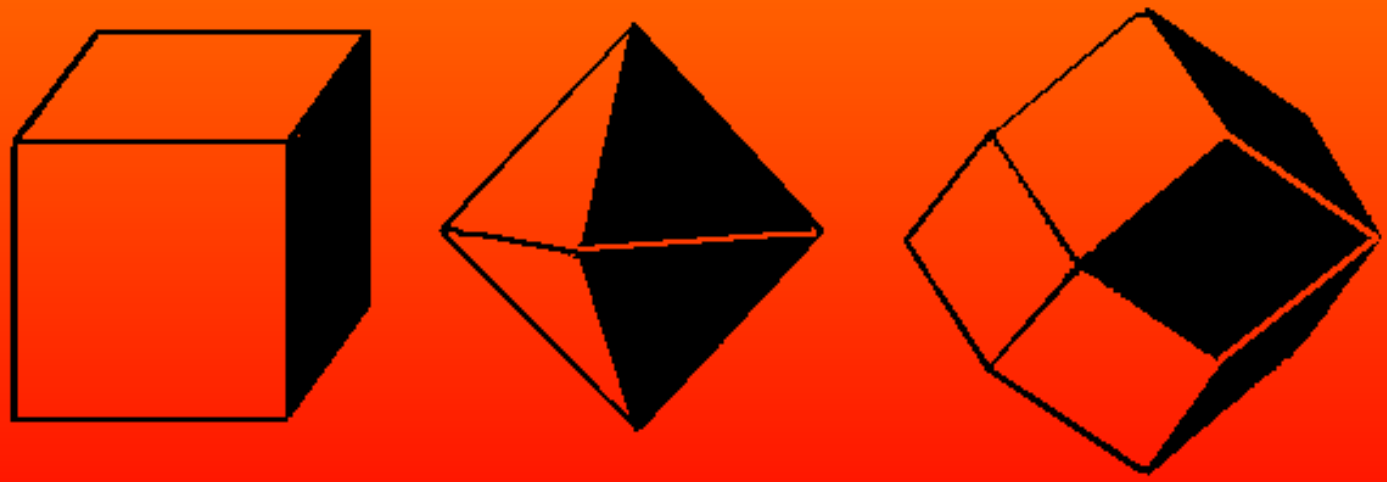


Common Face Arrangements and Angles



- A. Isometric – most symmetrical
  - Three axes of equal length
  - All axes at right angles to each other

Isometric System



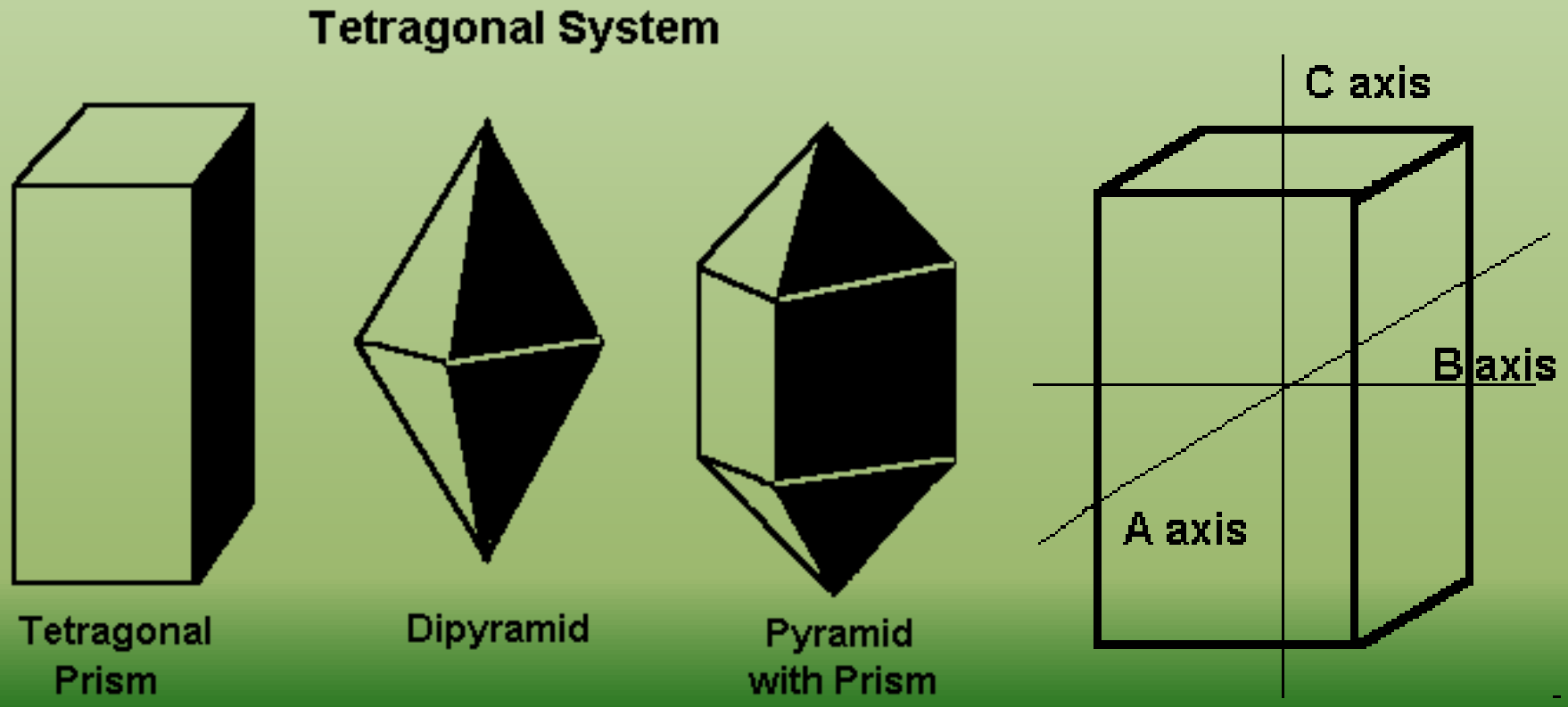
Cube

Octahedron

Dodecahedron

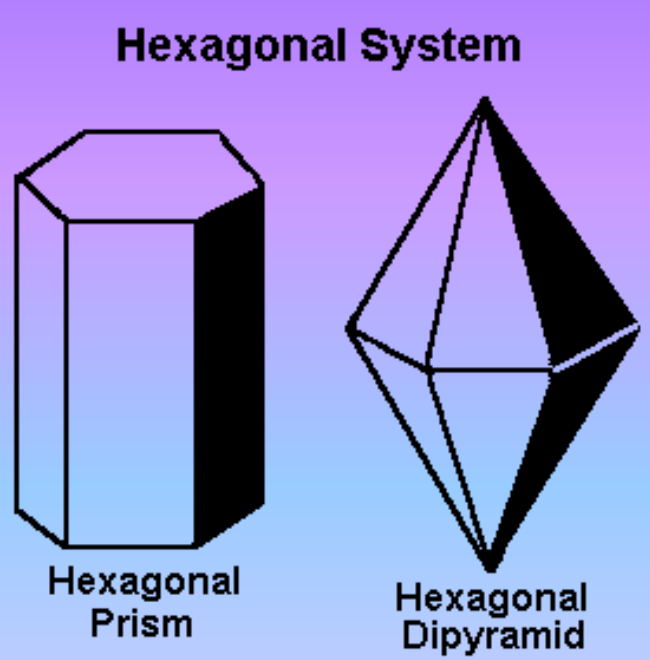
Common Face Arrangements and Angles

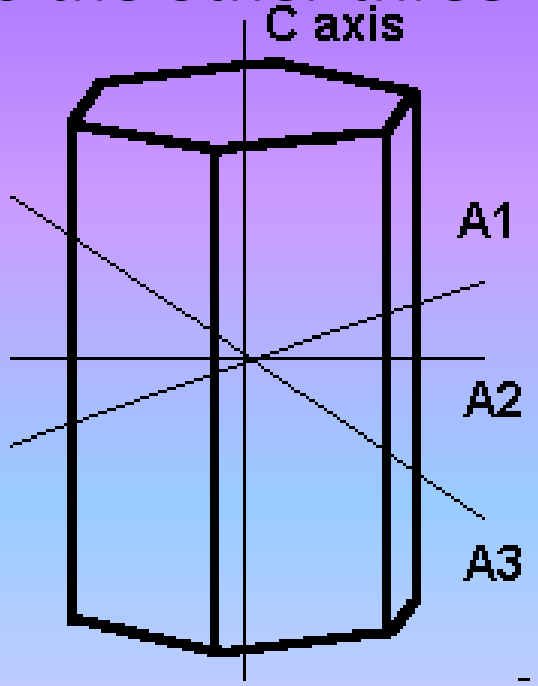
- B. Tetragonal – similar to isometric
  - Three axes, two equal length, the third is longer
  - All axes at right angles to each other



Common Face Arrangements and Angles

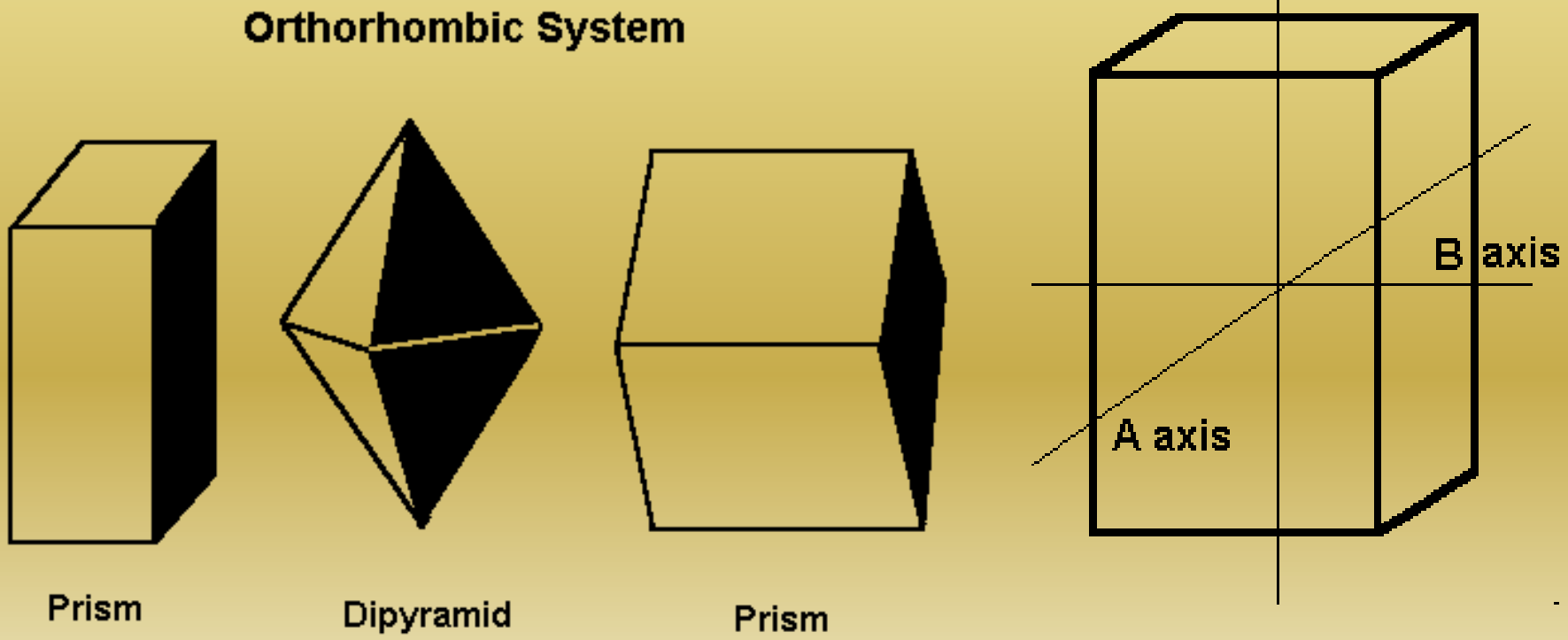
- C. Hexagonal
  - Three equal axes in the same plane
  - Intersect at angles of 60 degrees
  - A fourth axis is at a right angle to the other three





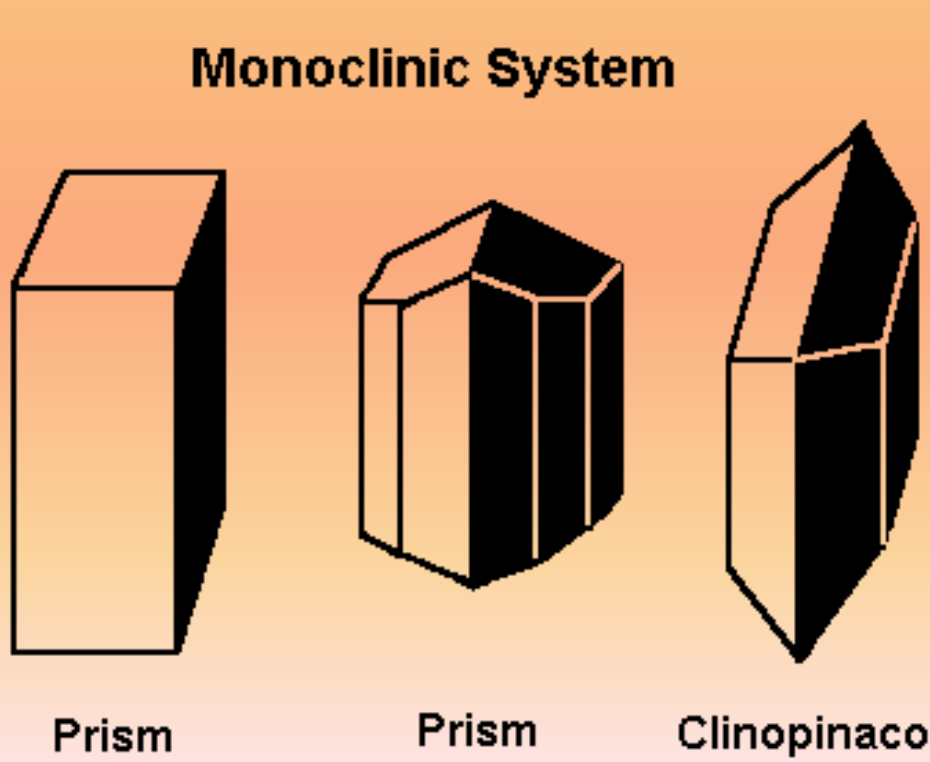
Common Face Arrangements and Angles

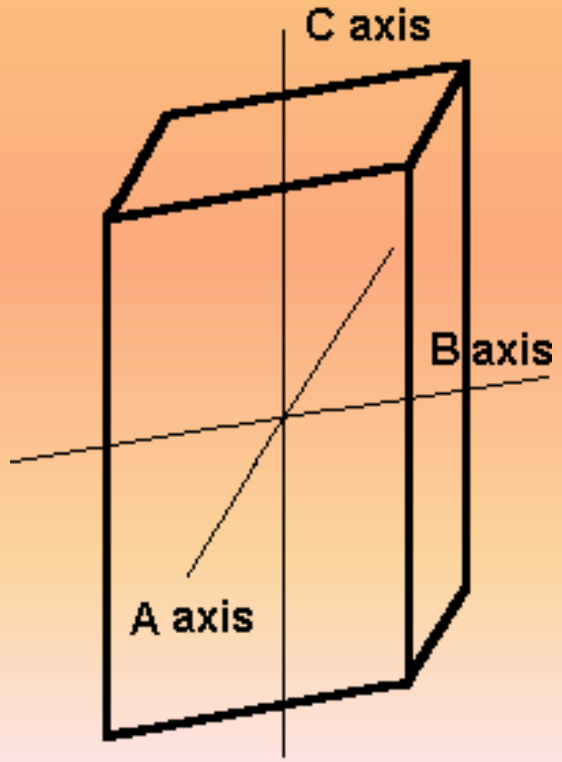
- D. Orthorhombic
  - Three axes all unequal to each other
  - All axes intersect at right angles



Common Face Arrangements and Angles

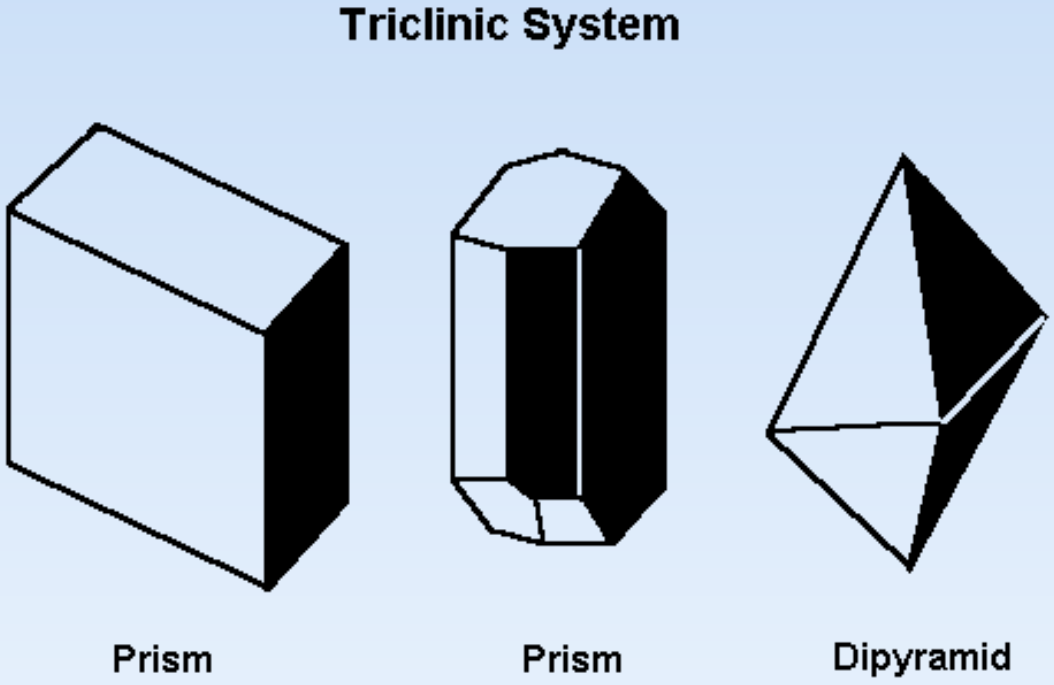
- E. Monoclinic
  - Two non-equal axes at right angles to each other
  - A third axis is inclined to one of the first two

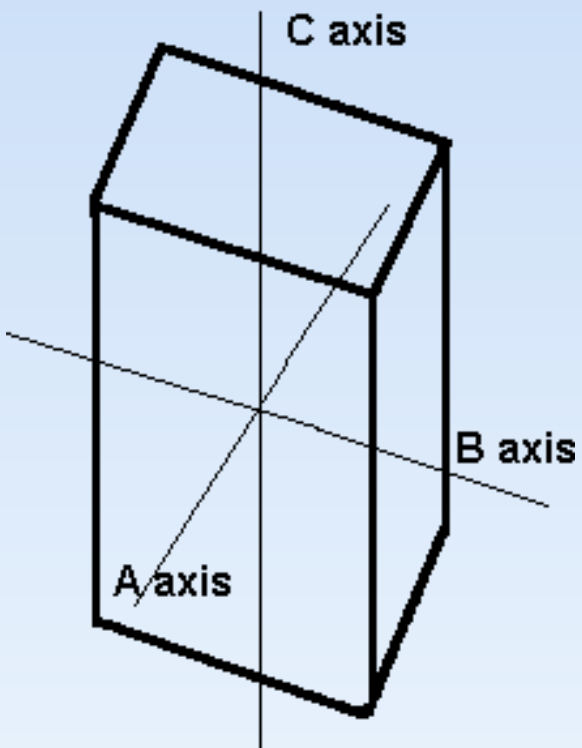




Common Face Arrangements and Angles

- F. Triclinic
  - Three axes
  - All axes are inclined with respect to each other

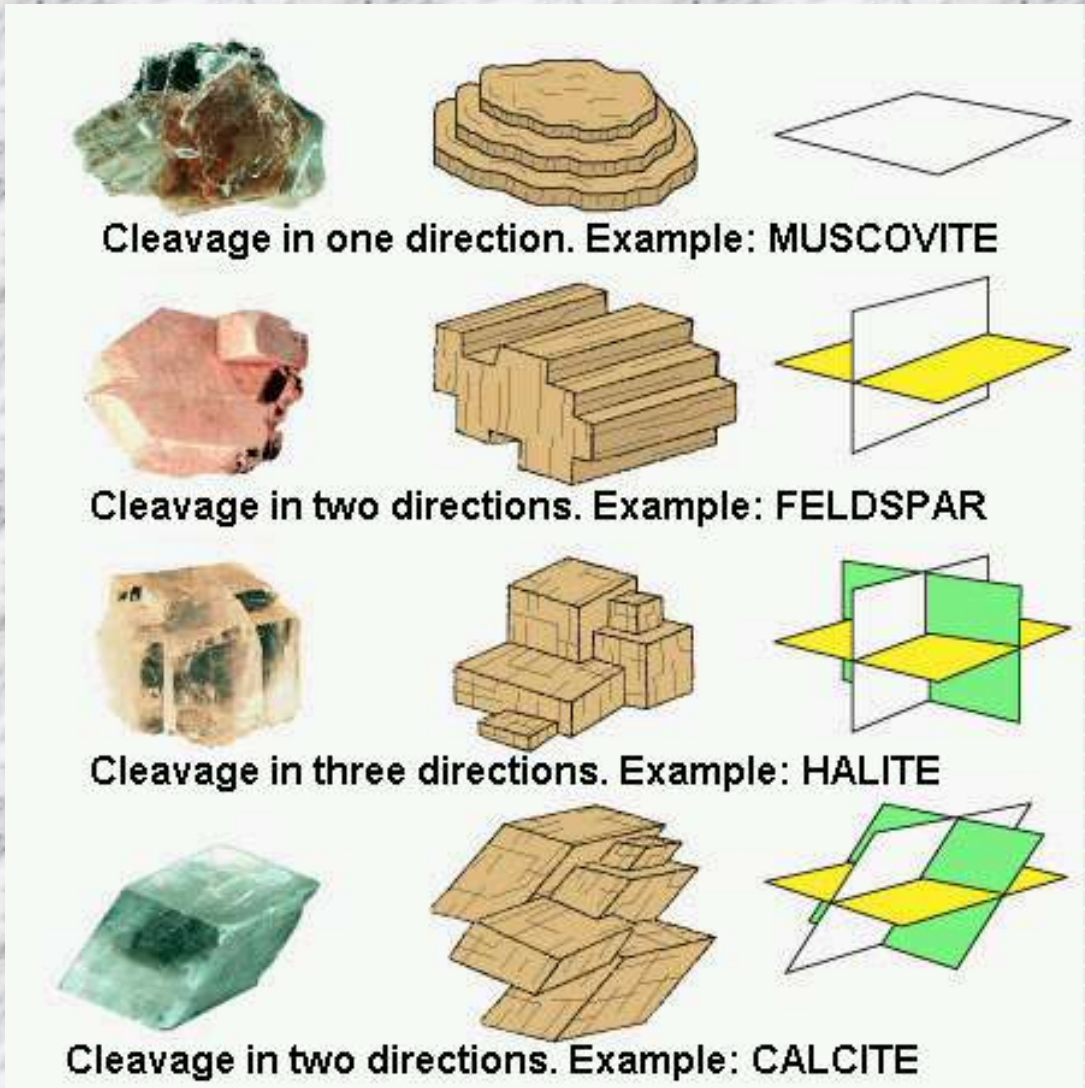




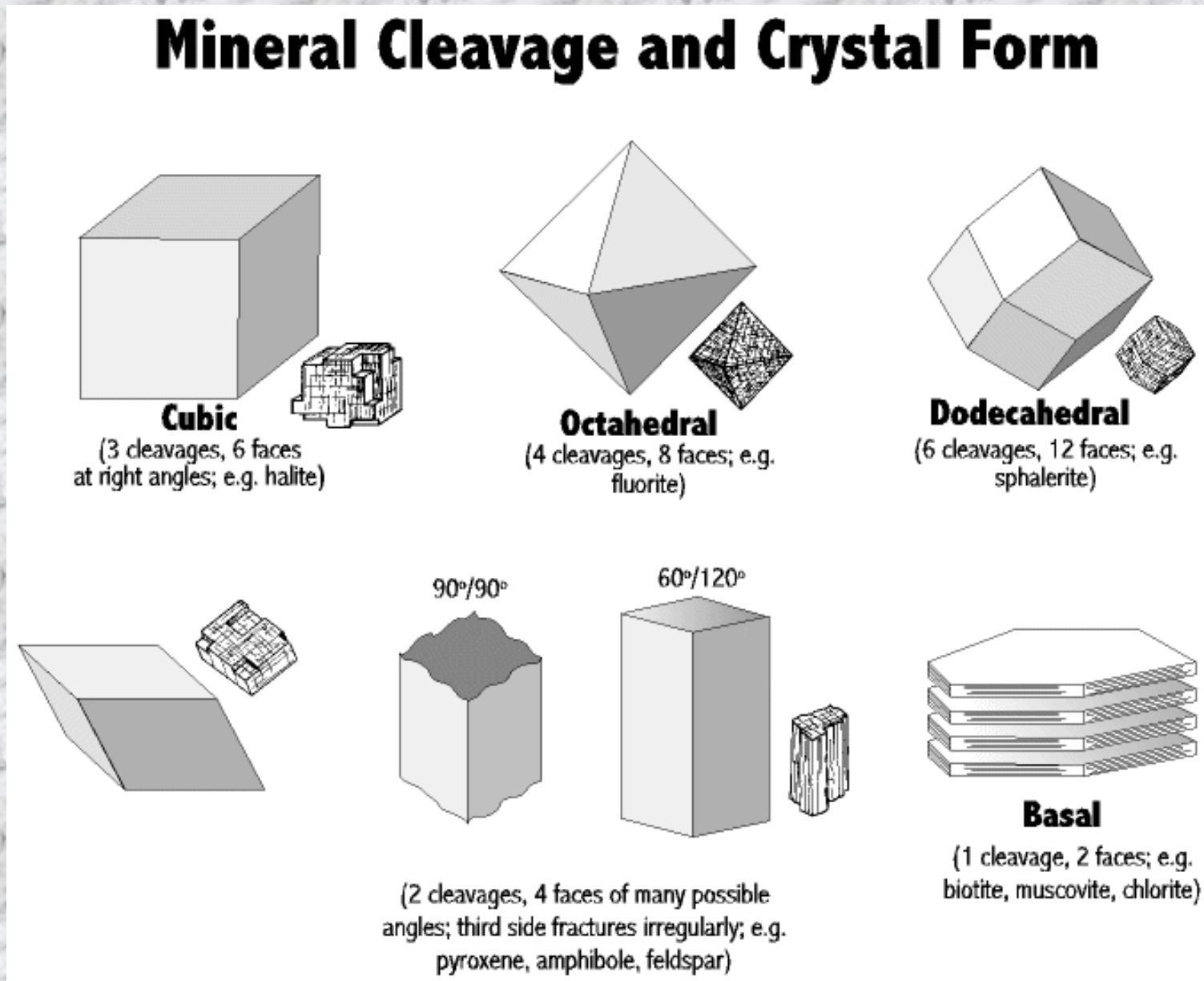
6. Mineral Cleavage – the ability of a mineral to break, when struck along specific planes

→Based on the bonding between atoms

→Where the bonds are weakest = breakage plane



Mineral Cleavage

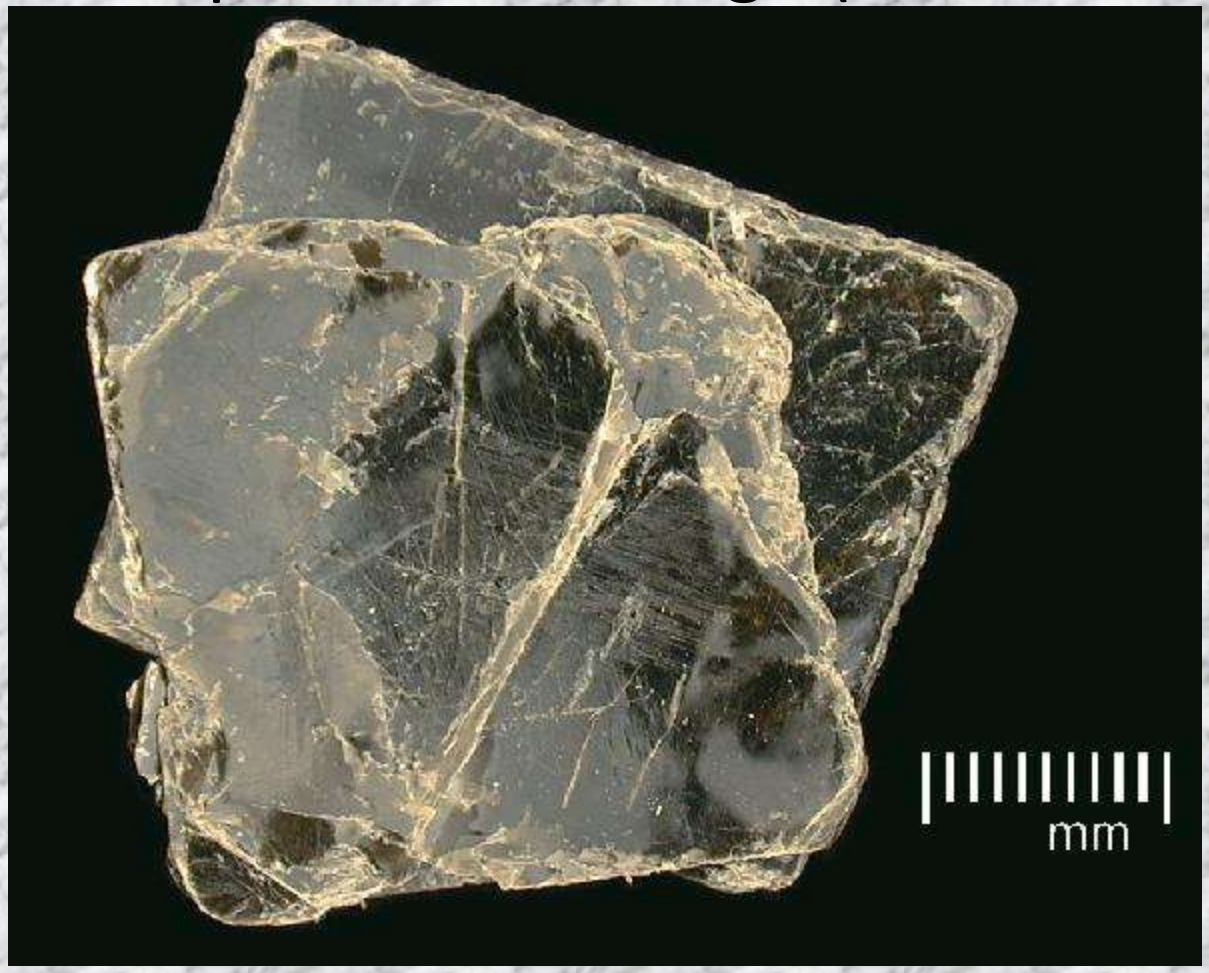


Mineral Cleavage

→Can have no cleavage (example = quartz)

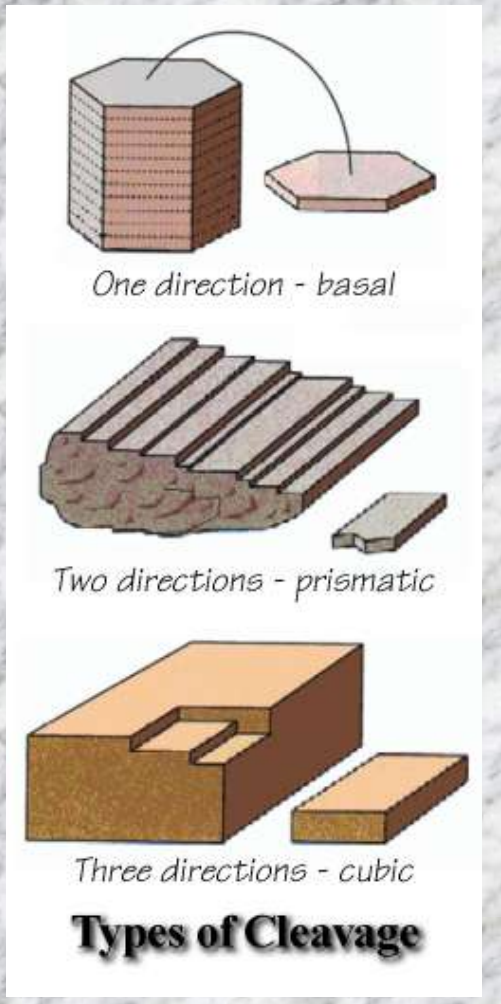
Mineral Cleavage

→ Can have 1 plane of cleavage (ex. = Biotite)



Mineral Cleavage

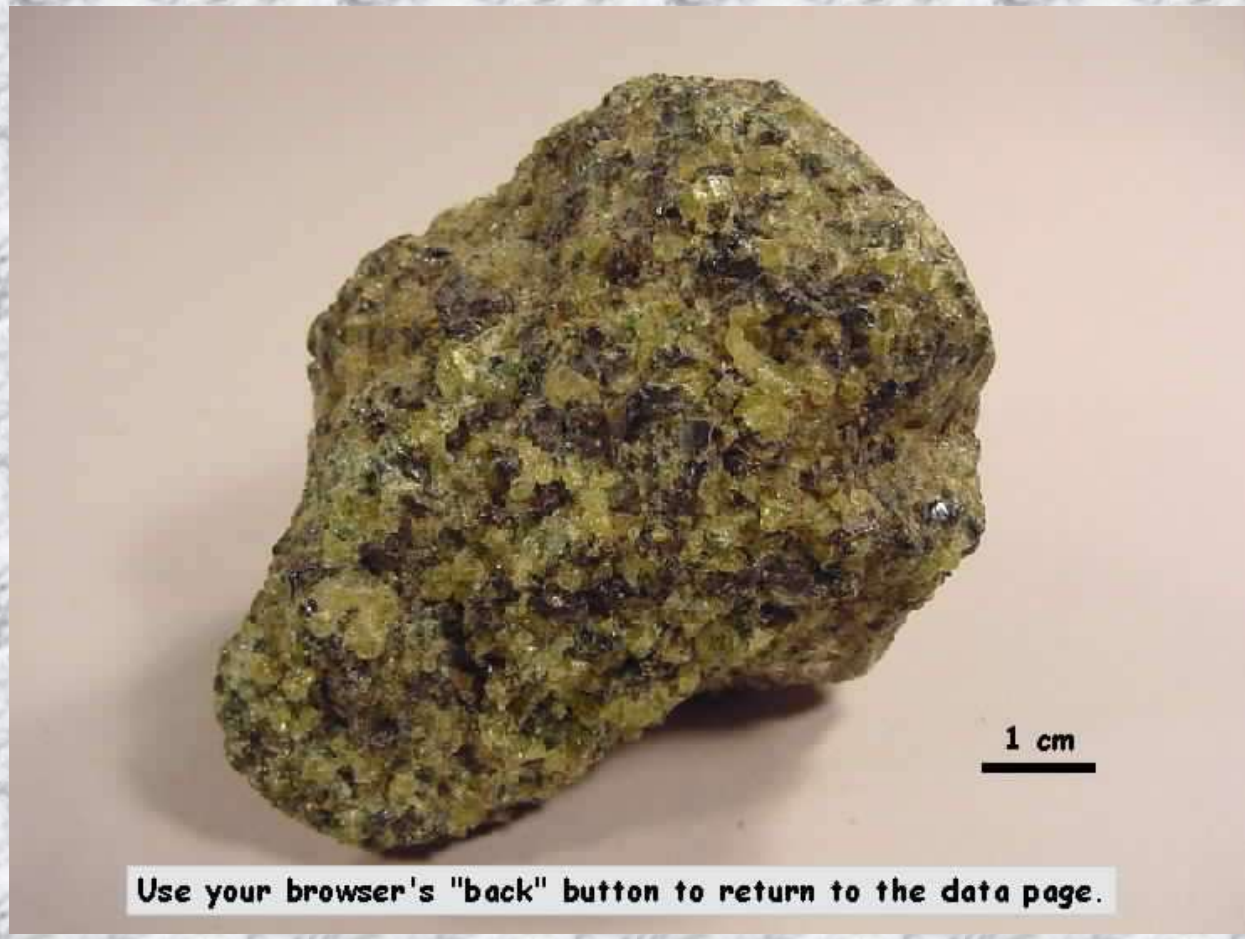
→ Can have multiple planes of cleavage



7. Fracture

The way a substance breaks where not controlled by cleavage

→Minerals with no cleavage generally break with irregular fracture



Fracture

→ If minerals break with curved fracture surfaces, it is called concoidal fracture

- This is seen in glass, the igneous rock Obsidian,

and the mineral Quartz

8. Specific Gravity – the density of a mineral

- Density = mass of an object / volume of the object
- The ratio of the mass of an object to the mass of an equal volume of water
- The density of pure water = 1 g / mL
- If the density of the object is < 1 = lighter than water, and will float to some degree
- If the density of the object is > 1 = heavier than water, and will sink
    - Examples:
        - → Quartz = 2.65 g / mL
        - → Galena = 7.5 g / mL
        - → Gold = 19.3 g / mL

9. Other Special Properties

a. Taste – a few minerals have a characteristic taste

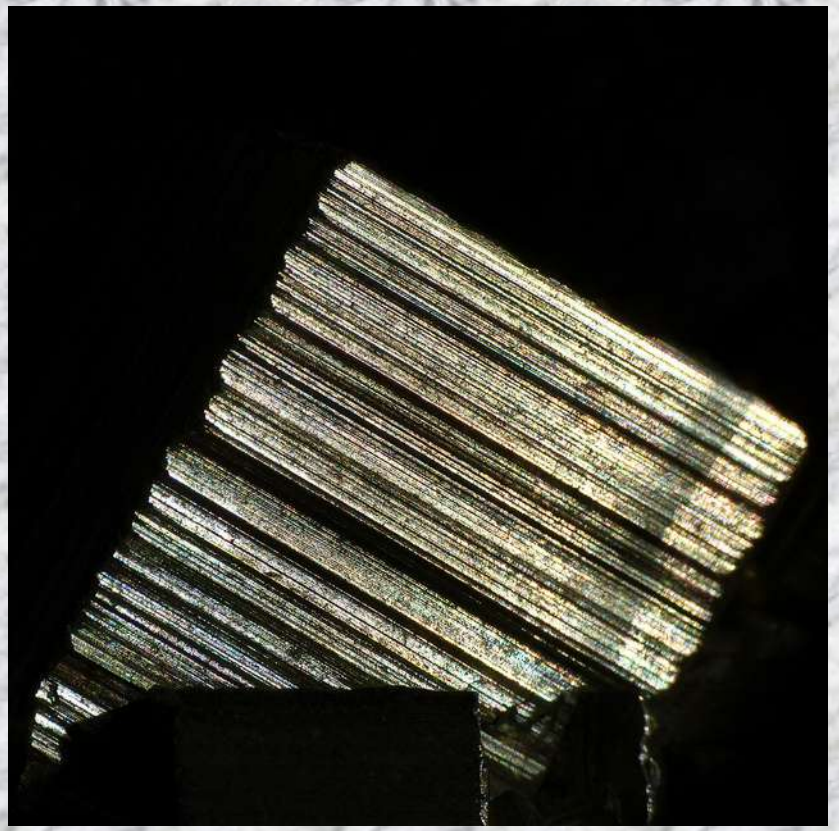
Halite tastes like salt

b. Odor – a few minerals have a characteristic odor

Clay minerals have an “earthy” smell

9. Other Special Properties

- c. Striations – straight parallel lines on the flat surface of the cleavage directions



9. Other Special Properties

- d. Magnetism – some minerals with large amounts of iron oxide are attracted to magnets

9. Other Special Properties

- e. Double Refraction – a clear mineral placed over an image will show 2 images by the light being split as it enters some crystalline minerals

→ Example - Calcite

9. Other Special Properties

- f. X-ray fingerprints – when x-rays are directed through minerals, the x-rays are deflected out at specific angles

→ Each mineral has a specific pattern

9. Other Special Properties

- g. Chemical tests – how do minerals react to specific chemicals

→Example –

Carbonate minerals (calcite) will react to weak hydrochloric acid, they will fizz to produce carbon dioxide (CO_2) gas

→ Generally this is the only field chemical test