

# **Minerals**

**Modified from a PowerPoint presentation prepared by J.  
Crelling, Southern Illinois University**

# Minerals

- **Building blocks of rocks, soil ,dirt, and mud**
- **Minerals are everywhere**
- **Rocks are aggregates of one or more minerals**

# **Mineral Definition**

- 1. Naturally Occurring**
- 2. Inorganic**
- 3. Crystalline – has a definite internal structure, i.e., atoms in the mineral are arranged in a regular way**
- 4. Chemical composition fixed or varies within certain limits**

# Minerals

- **Naturally Occurring** - minerals must be formed naturally - glass, concrete, synthetic diamonds, rubies and emeralds don't count
- **Inorganic** - minerals are not formed by anything that was ever alive.  
Therefore, materials such as:  
Ivory, Amber, Coal, Pearls  
**are not minerals!**





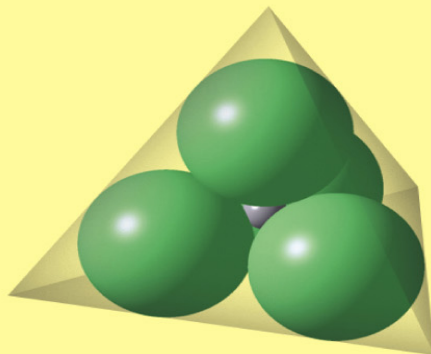
# Minerals

- **Crystalline** - the atoms in minerals have an orderly atomic arrangement giving them a definite structure that controls their properties.

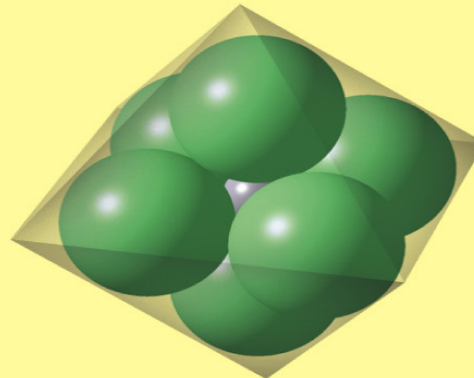
# Structure of minerals

- **Minerals consist of an orderly array of atoms chemically bonded to form a particular crystalline structure**
- **Internal atomic arrangement in ionic compounds is determined by ionic size**

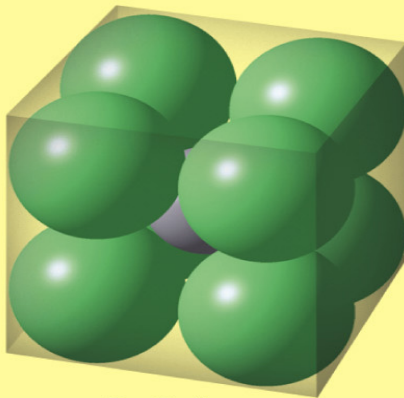
# *Geometric packing of various ions*



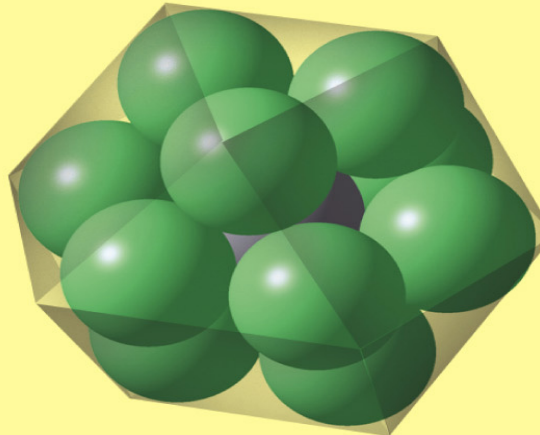
A. Tetrahedron



B. Octahedron



C. Cube



D. Cuboctahedron

Figure 3.8

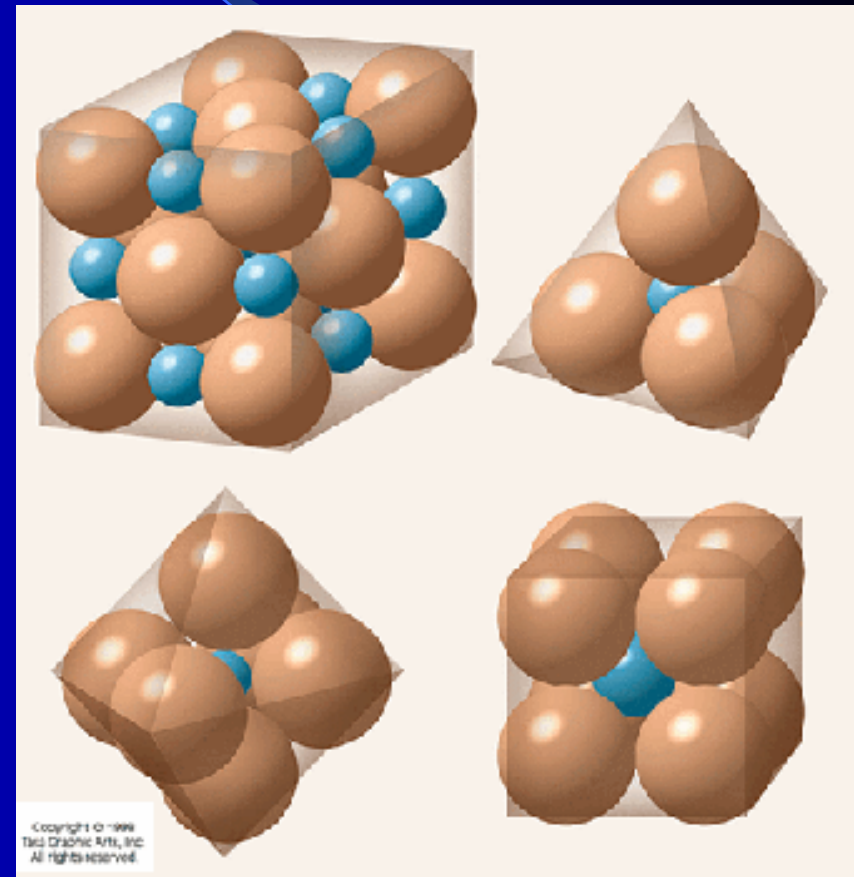
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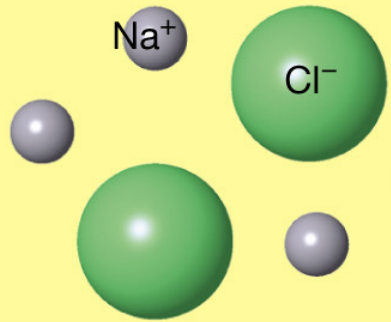


# Structure of Minerals

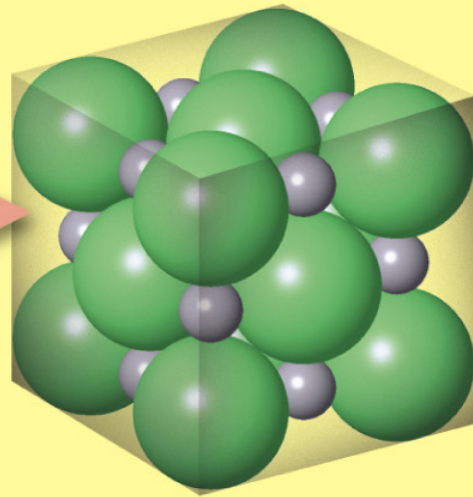
Crystal Lattice: the three dimensional molecular structure of a mineral.  
(Shape of the “unit cell.”)

- Various ions make up the mineral.
- Geometry + chemistry!

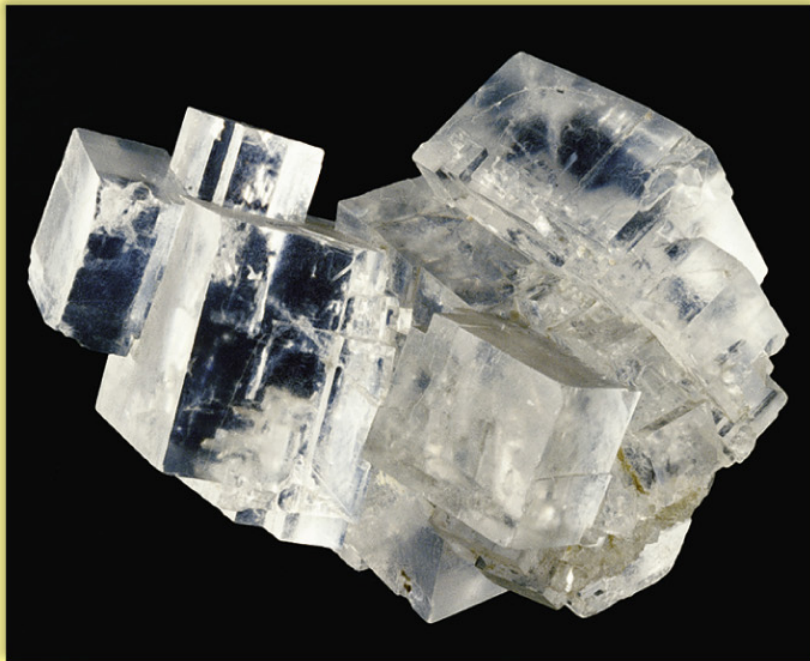




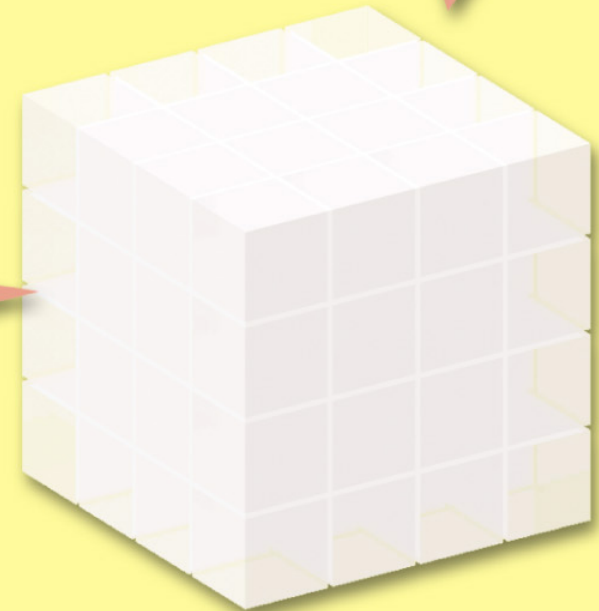
A. Sodium and chloride ions.



B. Basic building block of the mineral halite.



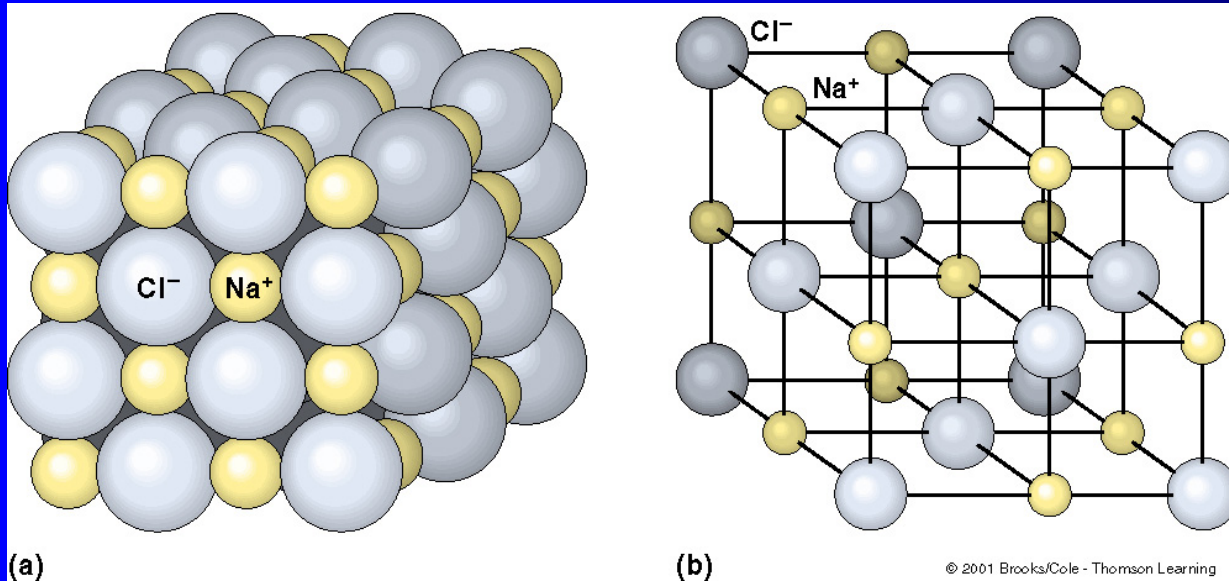
D. Intergrown crystals of the mineral halite.



C. Collection of basic building blocks (crystal).

# Structure of Minerals

## Halite (rock salt)

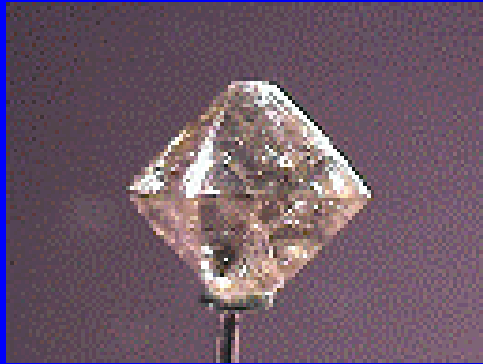


# Structure of minerals

## Polymorphs

- **Minerals with the same composition but different crystalline structures**
- **Examples include diamond and graphite**
- **Phase change – one polymorph changing into another**

# Structure of Minerals

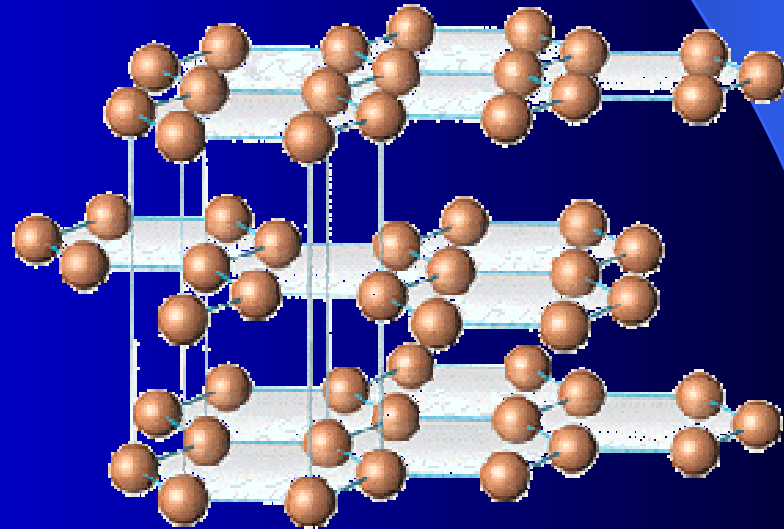
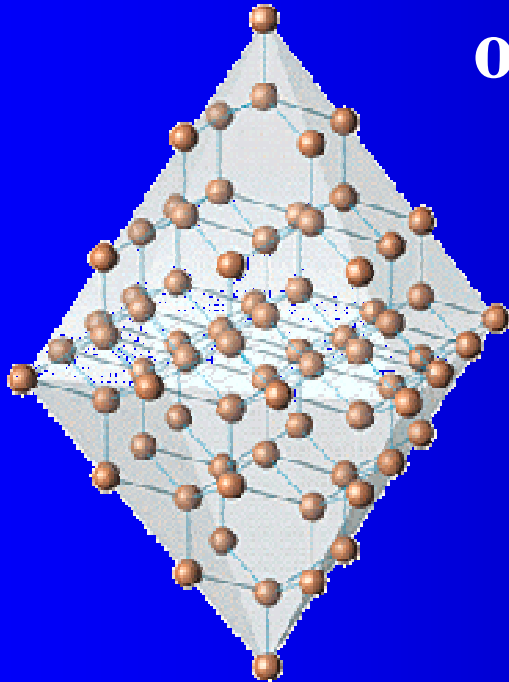


Diamond



Graphite

## Polymorphs of Carbon



# **Physical properties of minerals**

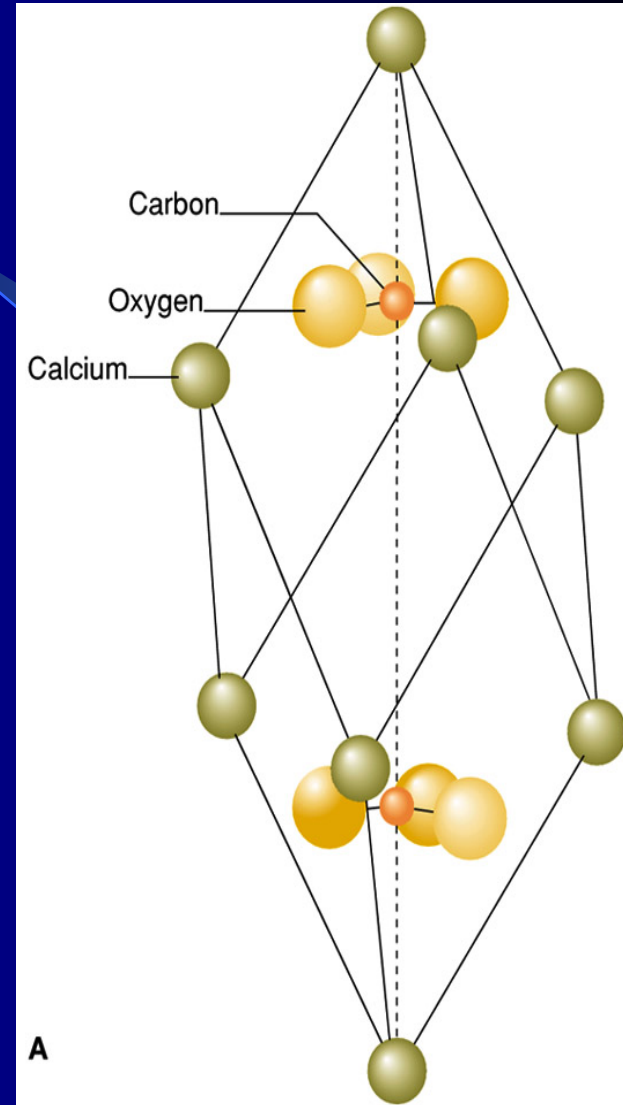
## **Crystal Form**

- **External expression of a mineral's internal structure**
- **Often interrupted due to competition for space and rapid loss of heat**



# Crystals

Crystals are the smallest “bits” of minerals and reflect the geometry of the mineral molecules



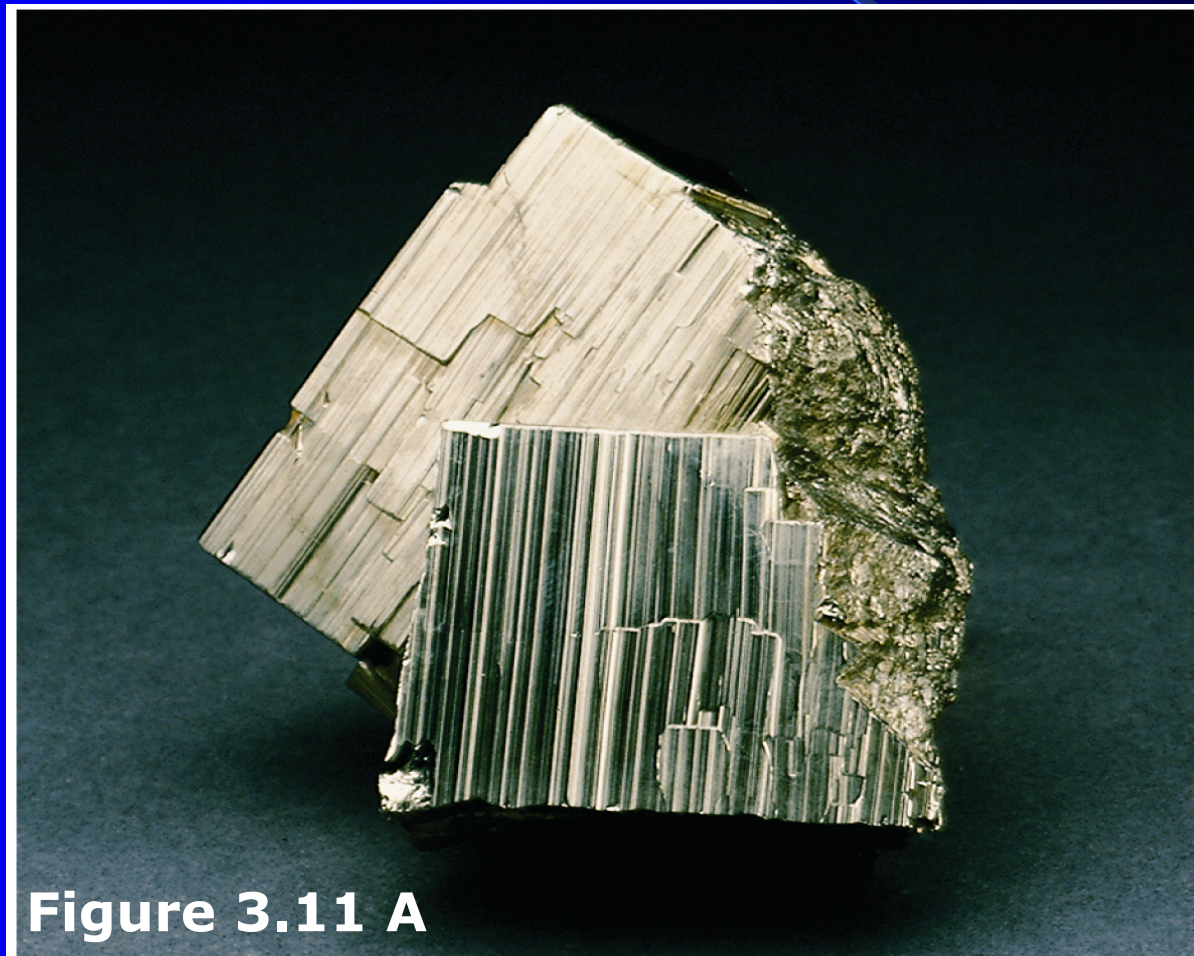
# *A garnet crystal*

← 2 cm →





# *Cubic crystals of pyrite*



**Figure 3.11 A**

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# OLIVINE



# TOURMALINE



**QUARTZ**





# ***Physical properties of minerals***

## **Color**

- **Generally unreliable for mineral identification**
- **Often highly variable due to slight changes in mineral chemistry**
- **Exotic colorations of certain minerals produce gemstones**
- **Some minerals are used as pigments**

# **Quartz ( $\text{SiO}_2$ ) exhibits a variety of colors**



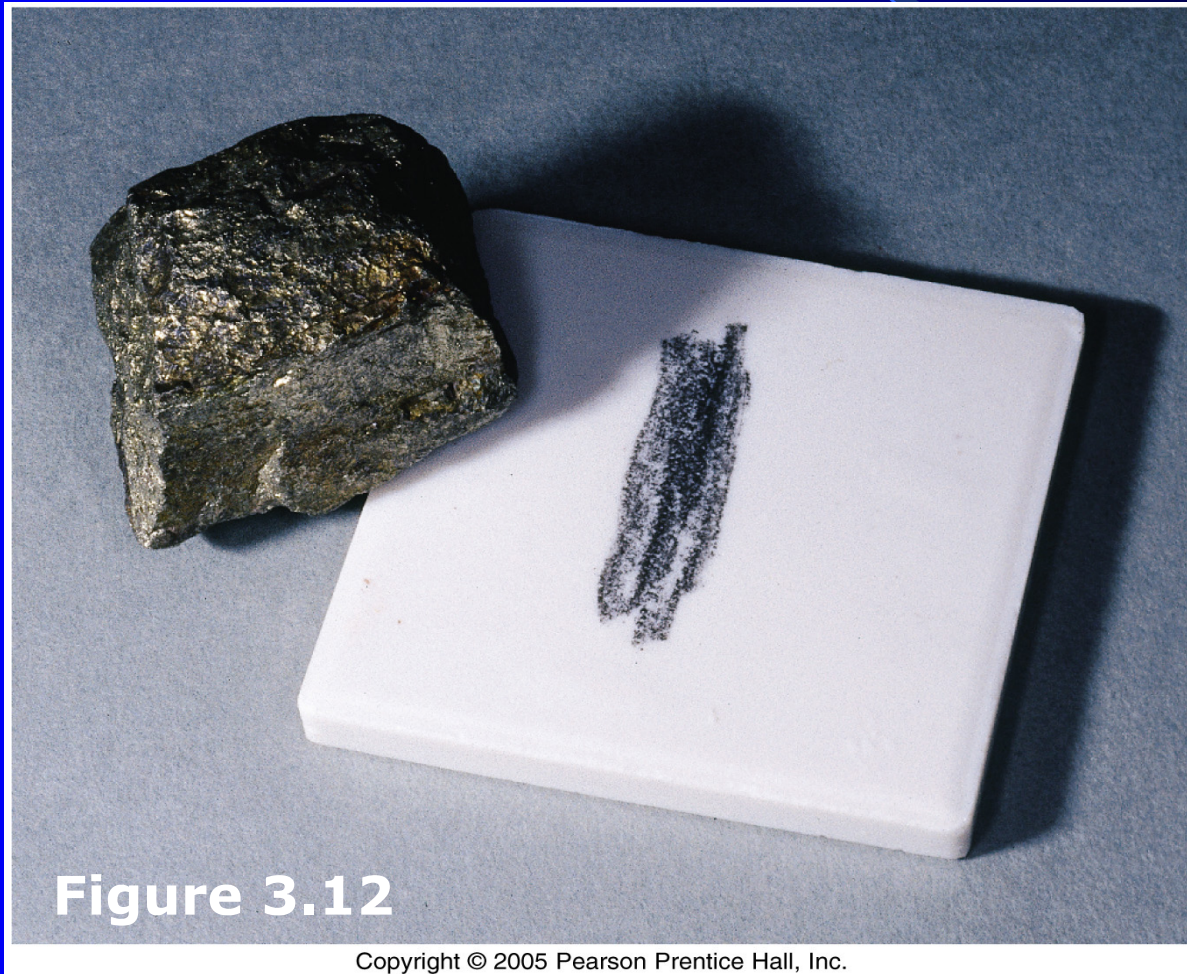
# ***Physical properties of minerals***

## **Streak**

**Color of a mineral in its powdered form**



# ***Streak is obtained on an unglazed porcelain plate***



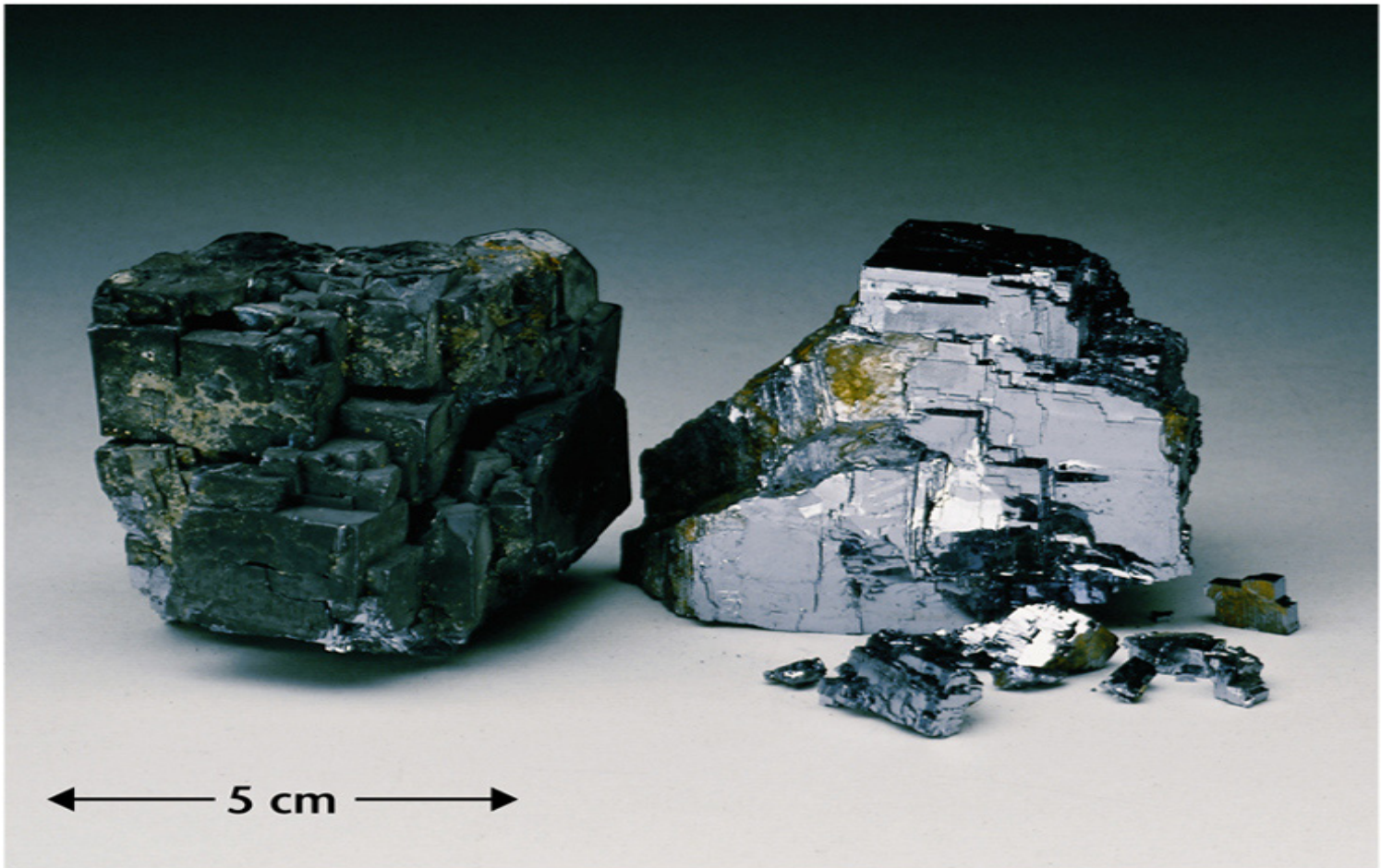
**Figure 3.12**

# ***Physical properties of minerals***

## **Luster**

- **Appearance of a mineral in reflected light**
- **Two basic categories**
  - **Metallic**
  - **Nonmetallic**
- **Other descriptive terms include vitreous, silky, or earthy**

# *Galena (PbS) displays metallic luster*





# ***Physical properties of minerals***

## **Hardness**

- **The hardness of a mineral is its resistance to scratching.**
- **The standard scale for measuring hardness is Moh's Hardness scale.**

Diamond — 10

Corundum — 9

Topaz — 8

Quartz — 7

Orthoclase — 6

Apatite — 5

Fluorite — 4

Calcite — 3

Gypsum — 2

Talc — 1

INDEX  
MINERALS

Streak plate (6.5)

Glass (5.5)

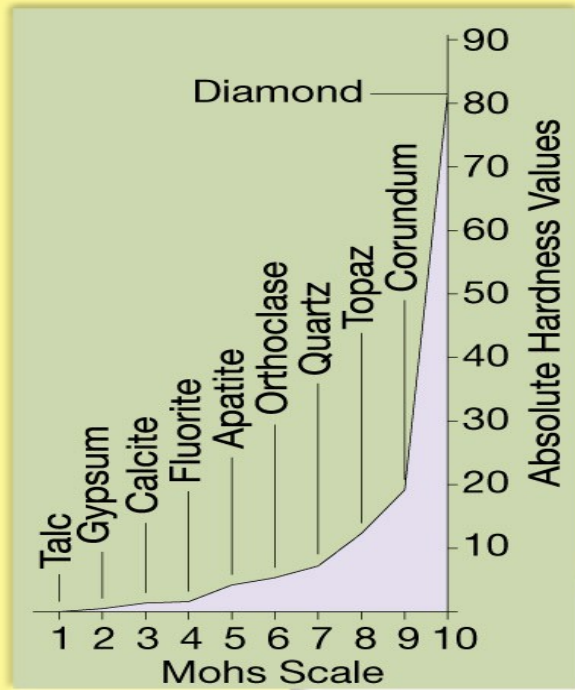
Knife blade (5.1)

Wire nail (4.5)

Copper penny (3.5)

Fingernail (2.5)

COMMON  
OBJECTS



# Mohs scale of hardness

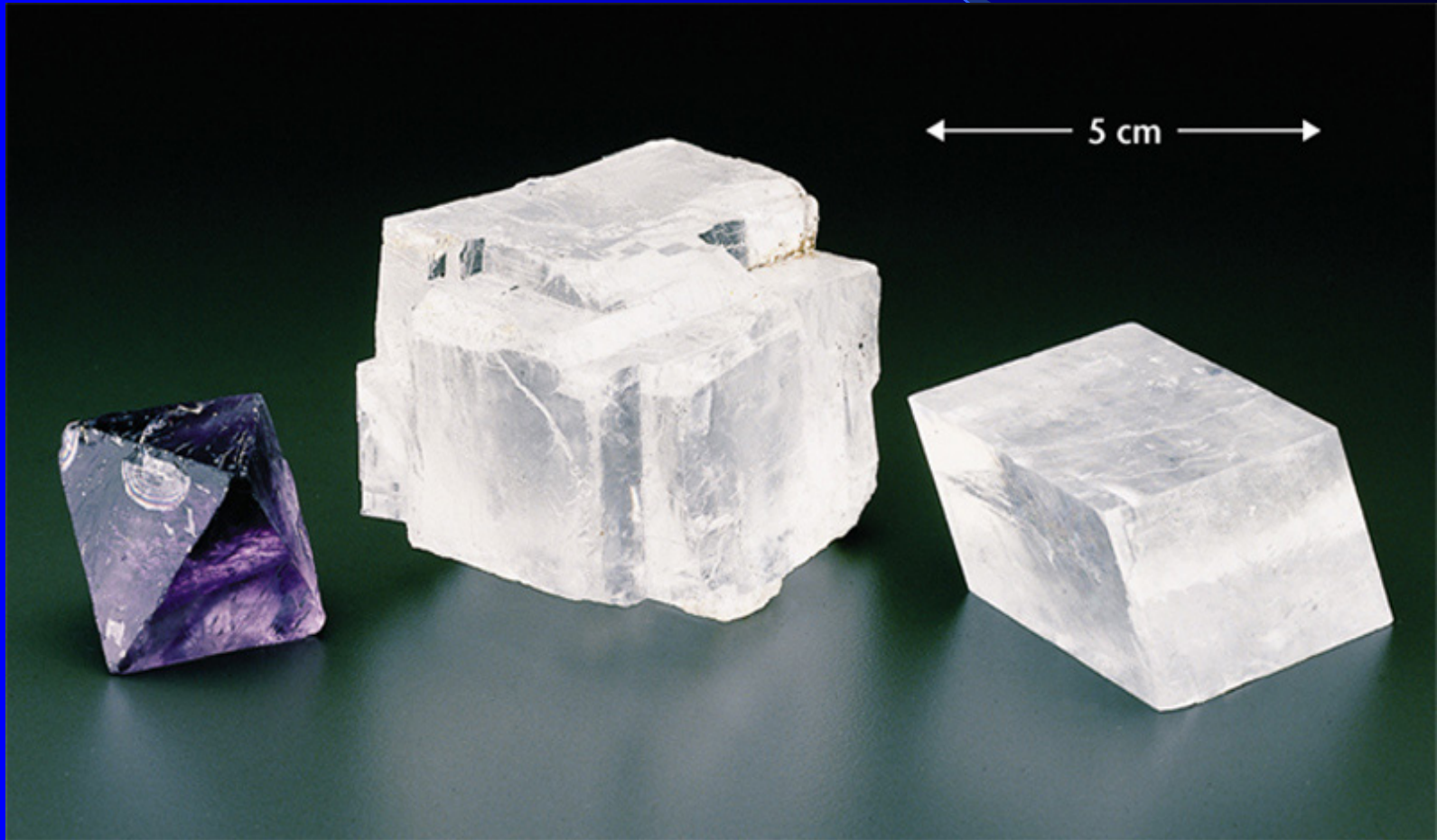


# ***Physical properties of minerals***

## **Cleavage**

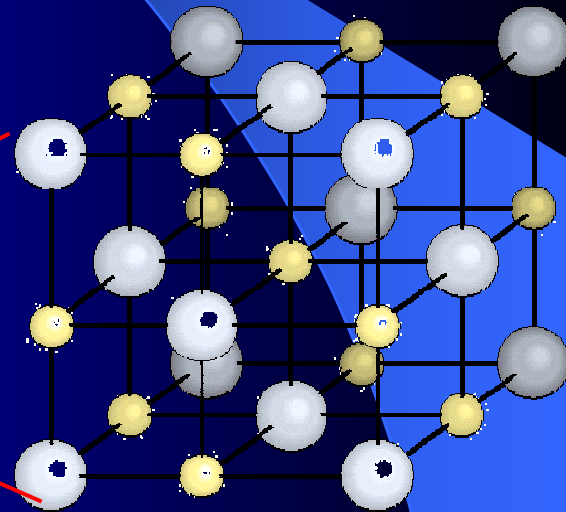
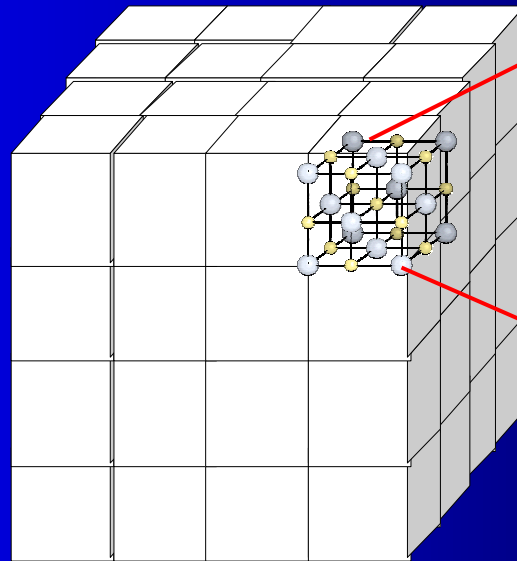
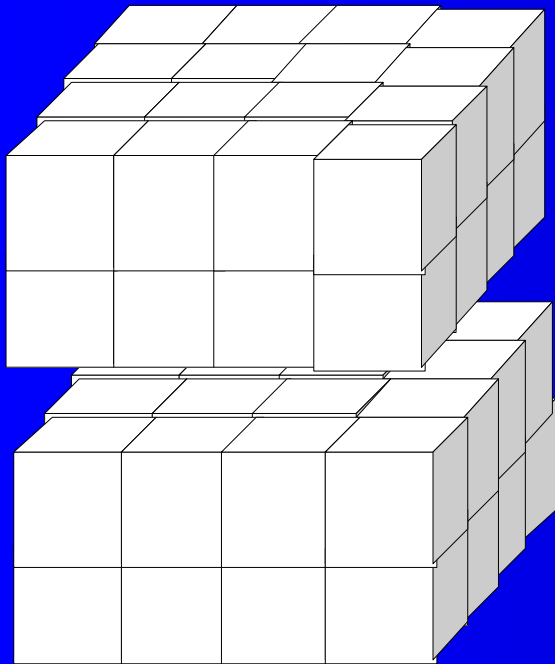
- **Tendency to break along planes of weak bonding**
- **Produces flat, shiny surfaces**
- **Described by resulting geometric shapes**
  - **Number of planes**
  - **Angles between adjacent planes**

***Fluorite, halite, and calcite all exhibit perfect cleavage***

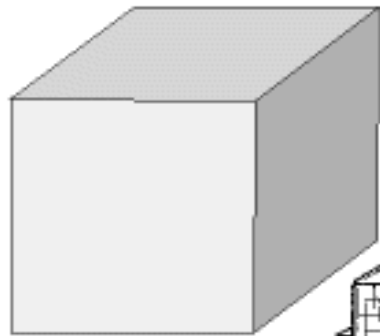


# Cleavage

- Planes of weakness caused by common crystal faces being aligned

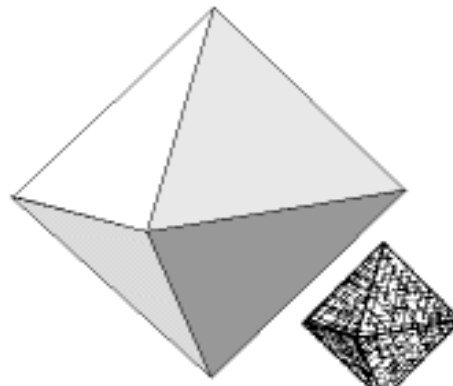


# Mineral Cleavage and Crystal Form



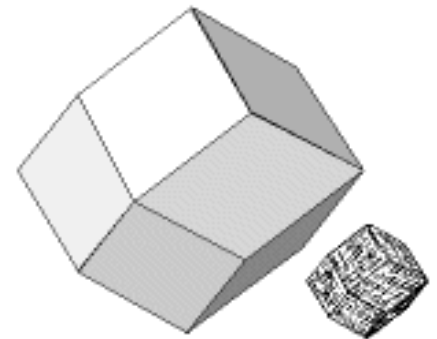
## Cubic

(3 cleavages, 6 faces at right angles; e.g. halite)



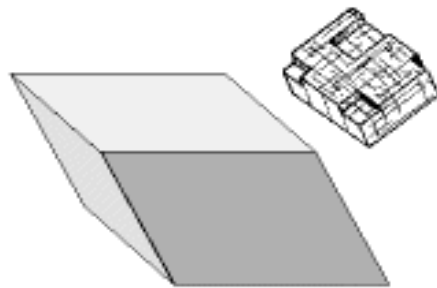
## Octahedral

(4 cleavages, 8 faces; e.g. fluorite)



## Dodecahedral

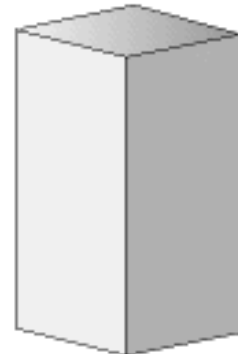
(6 cleavages, 12 faces; e.g. sphalerite)



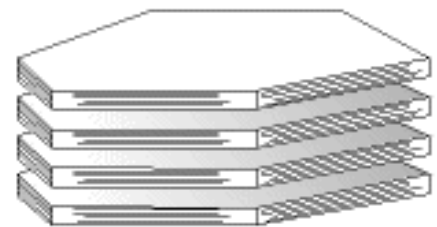
90°/90°



60°/120°



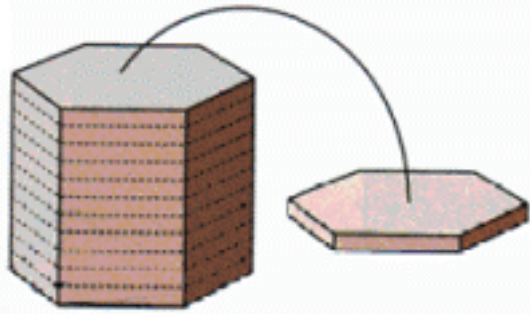
(2 cleavages, 4 faces of many possible angles; third side fractures irregularly; e.g. pyroxene, amphibole, feldspar)



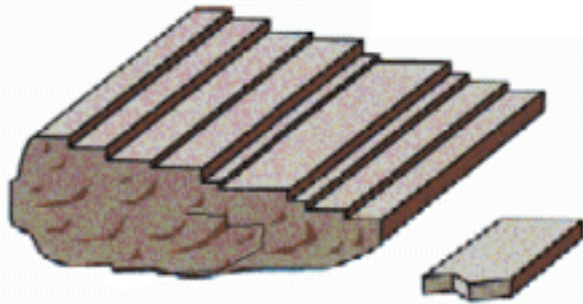
## Basal

(1 cleavage, 2 faces; e.g. biotite, muscovite, chlorite)

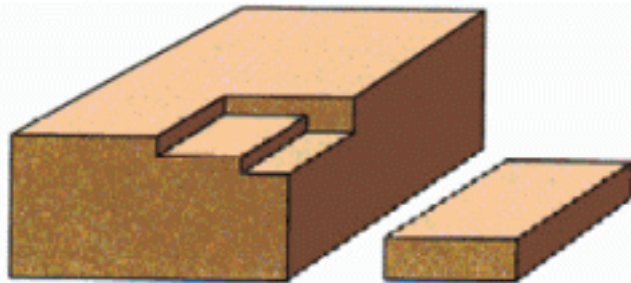




*One direction - basal*

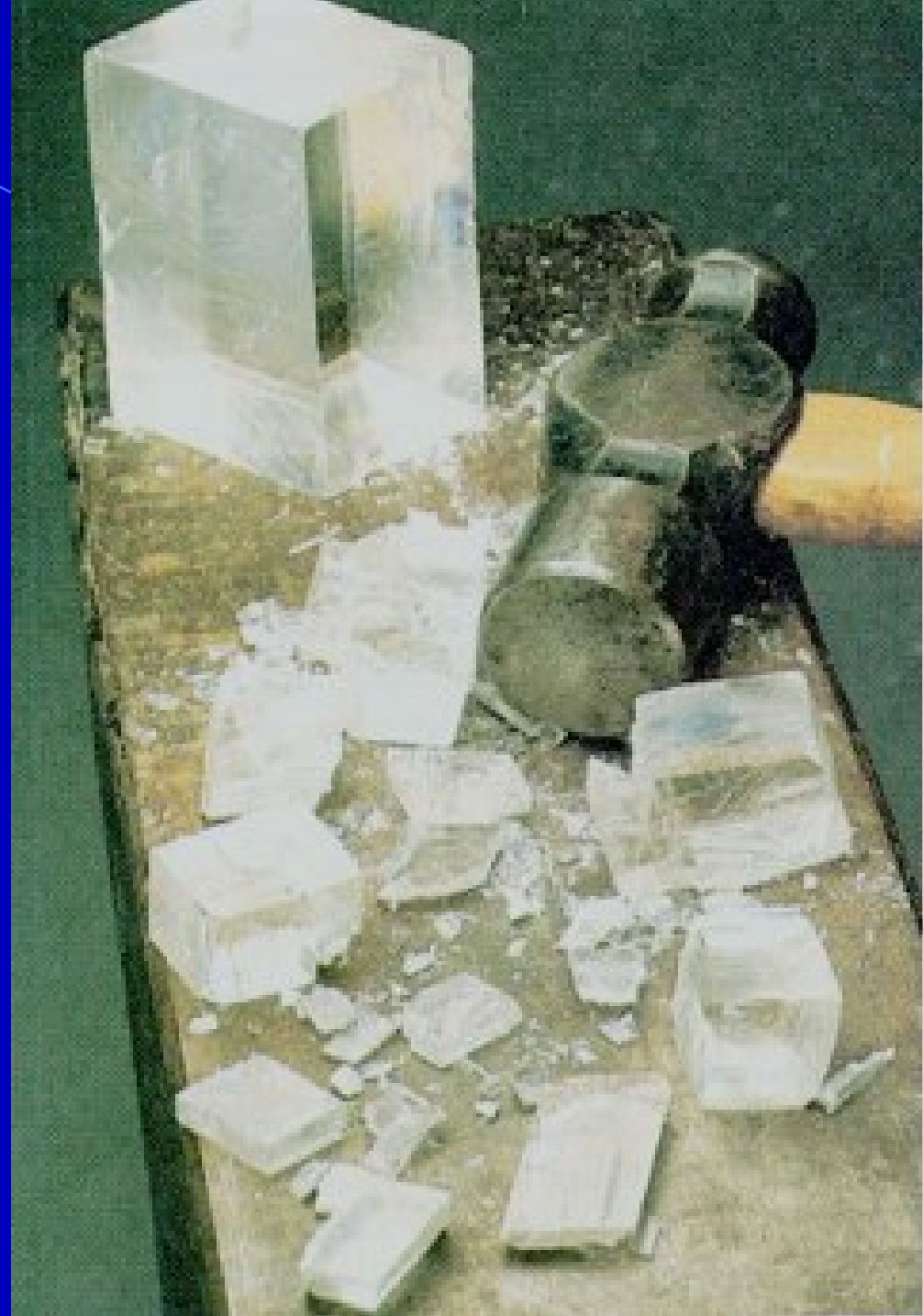


*Two directions - prismatic*



*Three directions - cubic*

## **Types of Cleavage**



**muscovite**



**1 - direction**

**feldspar**



**2-directions**

**fluorite**



**4-directions**

**quartz**



**none**

**calcite**



**3-directions**

# Fluorite Crystals



# Fluorite Cleavage Fragments



# ***Physical properties of minerals***

## **Fracture**

- **Absence of cleavage when a mineral is broken**

## **Specific Gravity**

- **Weight of a mineral / weight of an equal volume of water**
- **Average value = 2.7**



# ***Physical properties of minerals***

## **Other properties**

- **Magnetism**
- **Reaction to hydrochloric acid**
- **Malleability**
- **Double refraction**
- **Taste**
- **Smell**
- **Elasticity**