Physical Properties of Minerals

Color, shape, density, hardness, etc

Definition of a Mineral

• A mineral is a naturally occurring, homogeneous solid with a definite, but not fixed, composition, and an ordered atomic arrangement that is formed by inorganic processes.

• A mineral is a natural, crystalline phase.

Each mineral species has unique and identifiable physical properties.

• Form and habit (Shape)
• Luster
• Color and Streak
• Cleavage and Fracture
• Hardness
• Density
• Tenacity

Form and Habit Terms (Crystal Growth Forms)

• Prismatic (well developed prism faces) (Pyramidal)
• Columnar (Irregular prism faces)
• Acicular (needle-like)
• Botryoidal (rounded growth surface)
• Tabular (Platey)
• Stellate (Radiating)
• Fibrous (fibers, asbestiform)
• Dendritic (tree-like)

Acicular

Fibrous
Luster and Transparency

- **Luster**
  - Metallic
  - Resinous (waxy)
  - Pearly
  - Greasy
  - Adamantine
  - Vitreous

- **Transparency**
  - Opaque
  - Translucent
  - Transparent
**Color and Streak**

- The reflectance color of minerals is strongly affected by transition metals (V, Cr, Mn, Fe, Co, Ni, and Cu). (Also rare earths)
- Color in hand specimen may not be diagnostic.
- Color in streak generally indicates presence of iron or other transition metals.

**Chatoyance, Asterism, and Luminescence**

- Chatoyance and asterism are optical effects due to diffraction of light from small inclusions.
- Luminescence is emission of light.
  - Visible or UV (black light)
  - Tribo-luminescence: glow when rubbed
  - Cathodo-luminescence is emission of light from electron bombardment

**Asterism: Star Sapphire**

**Cleavage and Fracture**

- Crystals tend to break on planes of weakness.
  - Cleavage: perfect
  - Parting: irregular
  - Hackly: very irregular
  - Conchoidal Fracture: no cleavage, breaks like glass.

**Hardness**

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

- Density units are g/cm$^3$ (water is 1.0)
- Densities range from 0.92 for ice to $\sim$1.8 for some zeolites to 22 for Os.
- Most silicates are 2.5 to 3.5.
- Most sulfides are 4.5 to 6.0
- Iron metal is $\sim$8
- Lead is $\sim$13
- Gold and platinum are 19-22.

**Tenacity:**
**How does it deform?**

- **Brittle:** Fractures (quartz)
- **Ductile:** Malleable (gold)
- **Sectile:** Cut with a knife (mica)

**Unique Properties**

- Ferro-magnetism
- Taste (Don’t do it. It might be witherite.)
- Radioactivity (U and Th minerals)
- UV Fluorescence
- Piezoelectricity (acentric crystals)
- Pyroelectricity (acentric crystals)

**Other Properties**

- Optical (Index of refraction)
- Optical (Birefringence)
- Optical (Spectroscopy)
- Chemistry (X-ray and electron fluorescence)
- X-ray diffraction (+ electron and neutron)
- Other spectroscopies
  - IR Raman (visible)
  - Mössbauer($\gamma$) Auger (electron)