Lecture # 3

Rock, soil and Minerals

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Outlines of the Presentation

1. Rock, soil and Minerals
2. Identification of minerals: Physical properties
3. Common rock forming minerals

Minerals and Rock

Minerals are naturally occurring inorganic substances of more or less definite chemical composition, displaying more or less definite physical properties.

A **mineral** is a naturally occurring solid formed through geological processes that has a characteristic chemical composition, a highly ordered atomic structure, and specific physical properties.

The study of minerals is called mineralogy.

However, the International Mineralogical Association in 1995 adopted a new definition:

A mineral is an element or chemical compound that is normally crystalline and that has been formed as a result of geological processes.

Minerals and Rock

There are currently more than 4,000 known minerals, according to the International Mineralogical Association, which is responsible for the approval of and naming of new mineral species found in nature.

Of these, perhaps 100 can be called "common",

50 are "occasional", and the rest are "rare" to "extremely rare".

Hematite carving.

Minerals and Rock

Rocks: A rock, by comparison, is an aggregate of minerals and/or mineraloids, and need not have a specific chemical composition. Minerals range in composition from pure elements and simple salts to very complex silicates with thousands of known forms.

Geologist define rock as aggregates or mass composed of one or more commonly, several of minerals. There are few exceptions to this rule: not all rocks are composed of minerals-for example, coal.

Engineers (or contractor) define rock to be a 'hard, durable material that can't be excavated without blasting'. The definition is based on strength and durability.

Can you name some names of Rocks and Minerals?

Minerals and Rock

- Minerals are naturally occurring inorganic substances of more or less definite chemical composition, displaying more or less definite physical properties.
- As the basic constituent of rock, minerals control much of rock behavior.
- Some minerals are very strong and resistant to deterioration and produce rock with similar properties, while others are much softer and produce weaker rock.
- More than different 2000 minerals are present in the earth's crust. They can be identified by their physical and chemical properties; by standard tests; or by examination under microscope.

Identification of minerals

1. Color
2. Streak
3. Hardness: Mohs scale of hardness
4. Cleavage
5. Fracture
6. Luster

Identification of minerals

- **Color:** ***Color*** **indicates the appearance of the mineral in reflected light or transmitted light for translucent minerals (i.e. what it looks like to the naked eye).**
  - **Some minerals have characteristics color due to composition of the minerals and the arrangement of the constituent atoms: for example black color of magnetite, green COLOR of chlorite and brassy yellow color of pyrite.**
  - **Minerals like quartz and calcite have variable color.**
  - **Color can't be sole identification property**
- **Streak:**
  - **Color of mineral in powder form is called streak.**
  - **Powder is obtained by crushing the mineral.**
  - **Color of the streak differs from color of mineral: for example the color of pyrite is brass yellow and its streak is dark green.**

Identification of minerals

- **Cleavage:**
  - **The cleavage of the minerals is its capacity to split more readily in certain directions than in others, due to the arrangement of the atoms.**
  - **Minerals break with ease producing smooth surfaces is called perfect cleavage. It can be either good, distinct, indistinct and imperfect.**
  - **Some minerals such as mica have perfect cleavage in one direction. The feldspars, which is the most abundant of all minerals, have two cleavages.**

Identification of minerals

- **Luster:**
  - **Appearance of mineral in ordinary light (that is the appearance due to reflected light). Luster may be metallic, glassy, earthy, pearly or silky.**
  - **If the minerals looks metal as do galena and pyrite, its luster is said to be metallic. If the minerals looks glassy, like quartz, its luster is glassy.**

Metallic – high reflectivity like metal: galena and pyrite
Sub-metallic – slightly less than metallic reflectivity: magnetite
Non-metallic luster:

Adamantine – brilliant, the luster of diamond also cerussite and anglesite
Vitreous – the luster of a broken glass: quartz
Pearly – iridescent and pearl-like: talc and apophyllite
Resinous – the luster of resin: sphalerite and sulfur
Silky – a soft light shown by fibrous materials: gypsum and chrysotile
Dull/earthy – shown by finely crystallized minerals: the kidney ore variety of hematite

Identification of minerals

- **Fracture**
  - **Describes how a mineral breaks when broken contrary to its natural cleavage planes.**
  - **Chonchoidal fracture is a smooth curved fracture with concentric ridges of the type shown by glass.**

    Hackley is jagged fracture with sharp edges.
    Fibrous
    Irregular

Identification of minerals

- **Hardness:**
  - **The hardness of a mineral, as commonly determined on fresh material, is measured by its ability to resist scratching. If a mineral is scratched by a knife, it is softer than the knife. If it cannot be scratched by a knife, the two are equal hardness or the mineral is the harder.**
  - **In order to have a standard method of expressing hardness of minerals, a simple scale, known as the Mohs scale, has been universally adopted.**

Identification of minerals

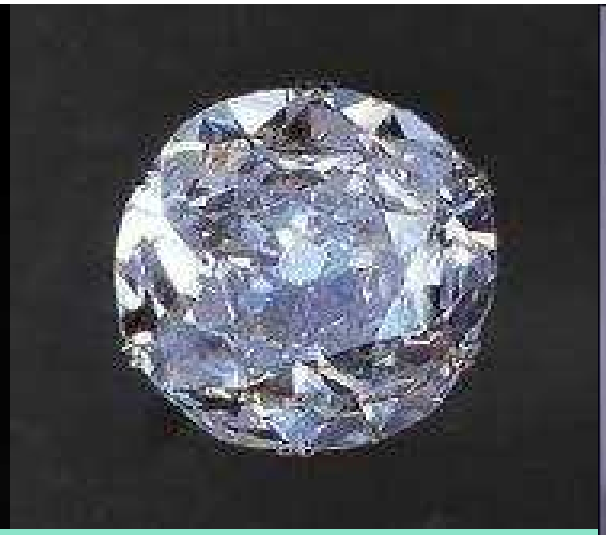
- **In sequence of increasing hardness from 1 to 10, the following minerals are used as standard of comparison:**
  - **Talc 01**
  - **Gypsum 02**
  - **Calcite 03**
  - **Fluorite 04**
  - **Apatite 05**
  - **Orthoclase (feldspar) 06**
  - **Quartz 07**
  - **Topaz 08**
  - **Corundum 09 and**
  - **Diamond -10**

Mohs hardness	Mineral	Absolute Hardness	Image
1	Talc ($Mg_3Si_4O_{10}(OH)_2$)	1	
2	Gypsum ($CaSO_4 \cdot 2H_2O$)	3	
3	Calcite ($CaCO_3$)	9	
4	Fluorite (CaF_2)	21	
5	Apatite ($Ca_5(PO_4)_3(OH\text{-},Cl\text{-},F\text{-})$)	48	
6	Orthoclase Feldspar ($KAlSi_3O_8$)	72	
7	Quartz (SiO_2)	100	
8	Topaz ($Al_2SiO_4(OH\text{-},F\text{-})_2$)	200	
9	Corundum (Al_2O_3)	400	
10	Diamond (C)	1600	

Identification of minerals

- **Other Characteristics:**
  - **Crystal Form: Internal atomic arrangement in definite geometric patterns is sometimes outwardly expressed in crystal form.**
  - **Specific Gravity is meant the weight of a substance compared with the weight of an equal volume of water. The specific gravity of quartz is 2.65. Some minerals are heavy than the others. The specific gravity of majority minerals range from 2.55 to 3.2.**
  - **Magnetism: A few minerals are attracted by a magnet. Of these minerals, magnetite, and pyrrhotite are the most common examples.**
  - **Other properties:**
    - Fluorescence (response to ultraviolet light),
    - Radioactivity, tenacity (response to mechanical induced changes of shape or form),
    - Piezoelectricity (Can generate electric fields) and
    - Reactivity to dilute acids.

Quartz- Carbonate class



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Hallite- Oxide class

Rock Forming Minerals

- **Feldpars:**
  - **Feldspar is the most abundant minerals. There are two types. Orthoclase feldspars contain potassium ($KalSi_3O_8$) and usually range from white to pink. Plagioclase feldspars contain sodium ($NaAlSi_3O_8$), calcium ($CaAl_2Si_2O_8$) or both, and range from white to gray to black,. Feldspars have moderate hardness.**
  - **Quartz is also very common ingredient in many kinds of rock. It is silicate (SiO_2), and usually has a translucent to milky white color. The luster is vitreous. Quartz is harder than most minerals (hardness 7), and thus is very resistant to weathering. Chert is a type of quartz sometimes found in sedimentary rocks. It can cause problem when used as concrete aggregate.**

- **Mica:** **Translucent thin sheets or flakes. There are two common varieties. Muscovite is potassium aluminum silicate of colorless or silvery tint, pearly luster and especially one very perfect cleavage which permits the mineral to be split into thin elastic sheets that when bent spring back to shape. Biotite, the other common variety, is a complex silicate of potassium, magnesium and iron and aluminum.**

Rock Forming Minerals

- **Mica: Biotite and muscovite are similar in physical properties. Both are soft, 2.5-3, with one perfect cleavage. The sheets of mica have very low coefficient of friction, which can produce shear failure in certain rocks, such as schist.**

- **Ferromagnesian minerals: A class of minerals, all of which contain both iron and magnesium. This class includes pyroxene, amphibole, hornblende and olivine. These minerals are dark color and a moderate hardness.**

Rock Forming Minerals

- Calcite: A mineral made of calcium carbonate ($CaCO_3$). It is usually white, pink or gray. It is soluble in water, and thus can be transported by ground water into cracks in rock where it precipitate out of solution. It also can precipitate in soil, becoming a cementing agent. Calcite is much softer then quartz or feldspar. The hardness is 3. Have vigorous reaction to hydrochloric acid.

- Dolomite: Similar to calcite with magnesium added. Less vigorous reaction to dilute hydrochloric acid.

Rock Forming Minerals

- **Iron Oxides:** Another class of minerals, all of which contain iron (FeO3). The most common iron oxides are hematite, Fe_2O_3; hydrous iron oxide that are often called limonite and magnetite. Although less common, these minerals give a distinctive rusty color to some rocks and soils and can act as cementing agents. The compact varieties have a hardness of 5.5-6, but earthy form are soft. The luster is sub-metallic.

- **Gypsum**: A soft minerals often occurring as a precipitate in sedimentary rocks. It is colorless to white and has economic value when found in thick deposits. For example, it is used to make drywall. Gypsum is water soluble and thus can dissolve under the action of ground water, which can lead to other problems.