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**ASAC 1101 : FUNDAMENTALS OF SOIL SCIENCE (2+1)**

**Level : B.Sc (Ag), I semester**

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**Topic**

**Soil Minerals, formation and  
classification**

# Minerals

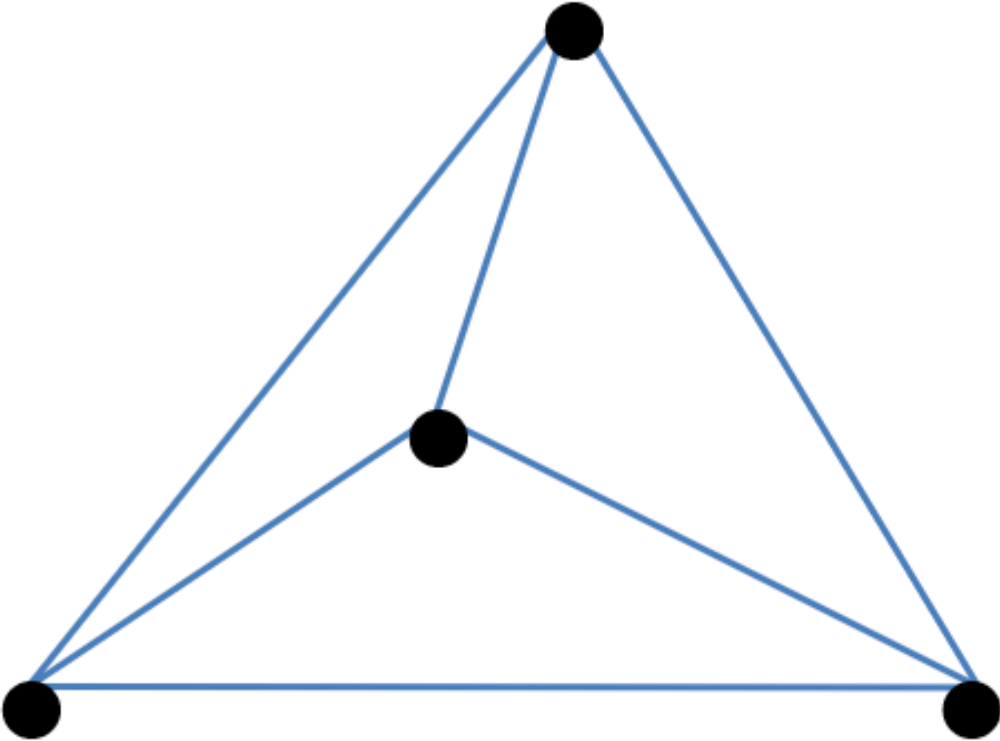
- ❖ Minerals are solid substances and composed of atoms having an **orderly and regular arrangements**.
- ❖ It is a naturally-occurring homogeneous solid substance of inorganic origin having **definite** chemical composition and **ordered atomic arrangement**.

## Formation of Minerals

- ❖ When the molten magma solidifies, the different elements present therein freely arrange themselves in accordance with the attractive forces and geometric forms.
- ❖ Geometrically, it is possible to arrange only 4 oxygen anions around a central Silicon cation so that all are touching each other. This is the arrangement of a tetrahedron. **The silicate tetrahedron is the fundamental building block of all the silicate minerals of the Earth's crust.**

- ❖ The amount of charge carried by 'Si'-ion is  $4^+$  and by 'O' is  $2^-$ . In order to attain neutrality, one  $\text{Si}^{4+}$  ion would combine with two oxygen ions ( $2 \times 2^-$ ) to form  $\text{SiO}_2$ , but geometrically stable structure is formed when one  $\text{Si}^{4+}$  ion combines with  $4\text{O}^{2-}$  to form a tetrahedron  $(\text{SiO}_4)^{4-}$  which carries a net -ve charge of 4.
- ❖ In nature, the geometry and valency constraints are reconciled; first by linking together tetrahedra so that oxygen ions are shared between neighboring silicon, thus reducing the -ve charge deficit, second, by making use of the positive charges of other metal cations to balance the -ve charge. Both these occur together to produce a neutral mineral.
- ❖ As a result of this, the basic tetrahedron arrange themselves in an orderly manner according to a fixed plan, forming different minerals which are called primary minerals.

# Basic Structural Unit



**silicate tetrahedra**

<b>Silicate class</b>	<b>Formula</b>
<b>Nesosilicates</b>	$(\text{SiO}_4)^{-4}$
<b>Sorosilicates</b>	$(\text{Si}_2\text{O}_7)^{-6}$
<b>Cyclosilicates</b>	$(\text{Si}_6\text{O}_{18})^{-12}$
<b>Inosilicates (Single chain)</b>	$(\text{SiO}_3)^{-2}$
<b>Inosilicates (Double chain)</b>	$(\text{Si}_4\text{O}_{11})^{-6}$
<b>Phyllosilicates</b>	$(\text{Si}_2\text{O}_5)^{-2}$
<b>Tectosilicate</b>	$(\text{SiO}_2)$

# Classification of minerals based on Quantity (amount present)

## A. Essential Minerals:

- ❖ Form the major part of rock and are instrumental in nomenclature of rocks .
- ❖ Occur in quantities varying from **95-98%**.
- ❖ **Calcite, silicate minerals** etc.

## B. Accessory Minerals:

- ❖ Occur in subsidiary amount (**2-5%**).
- ❖ **Apatite, pyrite, magnetite.**

# Classification of minerals based on Mode of Origin

## A. Primary Minerals:

- ❖ These minerals are formed due to **crystallization** of molten magma.
- ❖ This is the original mineral component of rock.
- ❖ These are formed at elevated temperature.
- ❖ **Mica, hornblende, quartz, feldspar.**

## B. Secondary Minerals:

- ❖ These minerals are formed by **alteration** of the primary minerals and by **resynthesis and recrystallization** during weathering.
- ❖ The clay fraction of the soil is constituted primarily of secondary minerals.
- ❖ Being fine sized, the inorganic fraction is physico-chemically the most reactive.
- ❖ Clay minerals (**Kaolinite, smectites, vermiculites etc.**), **serpentine, gypsum** etc.

# Occurrence of Important Rock-forming Minerals and their relative abundance

Minerals (arranged in order of their crystallization)	Important constituents other than 'Si' & 'O'	Percent distribution
<b>A. Primary Minerals</b>		
<b>Ferromagnesians</b>		
• Ortho or Inosilicales:		
Olivines	Fe, Mg	<b>16.8</b>
Pyroxenes	Ca, Na, Fe, Mg	
Amphiboles, etc.	Ca, Na, Fe, Mg, Al, OH	
• Phyllosilicates:		
Biotite ( black mica)	K, Fe, Mg,	<b>3.6</b>
Muscovite* (white mica)	K,	
<b>Non-ferromagnesians</b>		
• Tectosilicates:		
<b>Feldspars</b>		
Anorthite	Ca, Al	<b>61.0</b>
Albite	Na, Al	
Orthoclase	K, Al	
• Quartz	-	<b>11.6</b>
<b>B. Secondary (Clay) Minerals</b>	Na, K, Ca, Mg, Fe, Al, OH	<b>6.0</b>
<b>C. Others</b>		<b>1.0</b>



# Classification of minerals based on Specific Gravity

## A. Light Minerals:

- ❖ Minerals having specific gravity **below 2.85** are called as light minerals.
- ❖ **Quartz, feldspar, muscovite.**

## B. Heavy Minerals:

- ❖ Minerals having specific gravity **more than 2.85** are called as heavy minerals.
- ❖ **Haematite, pyrite, pyroxene, amphiboles, olivine.**

# Classification of minerals based on Chemical composition

Group	Examples
Native elements	Graphite, gold, copper, sulphur etc.
Oxides and Hydroxides	Haematite, goethite, limonite etc.
Sulphates	Gypsum
Sulphides	Pyrite ( $\text{FeS}_2$ )
Carbonates	Calcite
Halides	Rock salt, NaCl
Phosphates	Apatite
Silicates	Orthoclase, micas, olivine etc.

# Hardness of minerals as expressed in Moh's scale

		<b>1. Talc</b>
<b>2. Gypsum</b>		<b>3. Calcite</b>
		<b>5. Apatite</b>
<b>4. Fluorite</b>		<b>7. Quartz</b>
<b>6. Orthoclase</b>		<b>9. Corundum</b>
<b>8. Topaz</b>		
<b>10. Diamond</b>		

**THANK YOU**