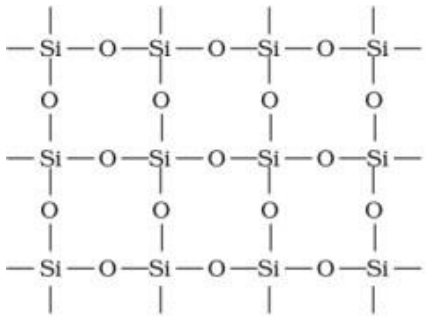
Silicon

SYLLABUS: Structure of silica, Silicates - Types of silicates with example.

Stucture of Silicon dioxide (SiO_2) or Silica :

In silica,each silicon atom is linked to four oxygen atom. The structure through in three dimensional form for convenience. It is represented by planar structure. According to orbital theory the formation of double bond between Si and O requires lateral overlapping of 3p orbital of silicon and 2p orbital of oxygen atom. Due to appreciable difference in size and energy of these orbitals 3p and 2p orbitals cannot overlap effectively to form π bonds between Si and O atom this hinders the formation of Si=O bond.The tetravalency of silicon is acquired by forming four Si-O bonds.Thus the molecule of silica is tetrahedral.



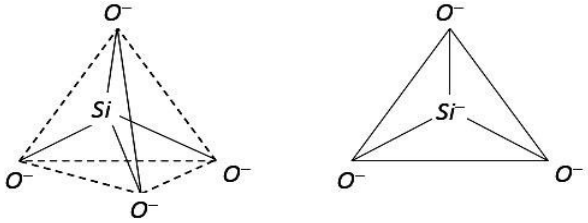
Three dimensional structure of SiO_2

Types of silicates : depending upon the linkage of SiO_4^{4-} tetrahedral units. These are classified into the following types,

1. Ortho silicates
2. Pyrosilicates
3. Chain silicates
4. Cyclic silicates
5. Sheet silicates

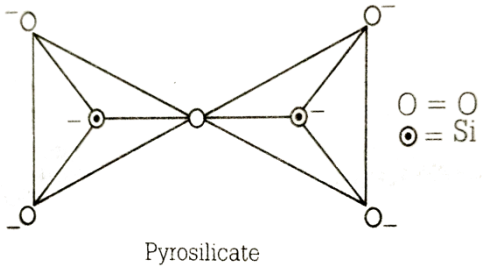
1. **Ortho silicates** : A silicate containing the group SiO_4 in which the ratio of silicon to oxygen is 1:4. A wide variety of minerals contains $(SiO_4)^{4-}$ tetrahedra. They have the general formula $M_2(II)[SiO_4]$ where 'M' may be Be,Mg,Fe,Mn or Zn. Some times $M(IV)[SiO_4]$ is general formula for example $ZrSiO_4$. Different structures are formed depending on the coordination number adopted by the metal. If the cooradination number of metal is 4 then tetrahedral structure is formed, if it is 6 then octahedral structure is formed.

Eg: ZrSiO4 (Zircon), Zn_2SiO_4(Willemite).



Structure of Ortho silicates.

2.**Pyrosilicates** : These contains anion $(Si_2O_7)^{6-}$ unit and formed by joining two tetrahedral units.Two tetrahedral units are joined by sharing the O at one corner, Thus giving the units $(Si_2O_7)^{6-}$ .This is the simplest condensed silicates ions.



Pyrosilicate

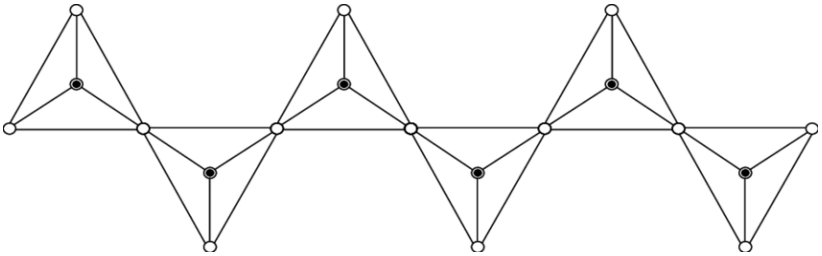
Structure of Pyrosilicates.

Eg: $Sc_2Si_2O_7$, $Ln_2Si_2O_7$.

3.**Chain silicates** : Silicate mineral with silica tetrahedra linked by shared oxygen into infinite one dimensional chain. Single chains characterize pyroxenes, double chain characterize amphiboles and wider chains grade towords sheet structure.

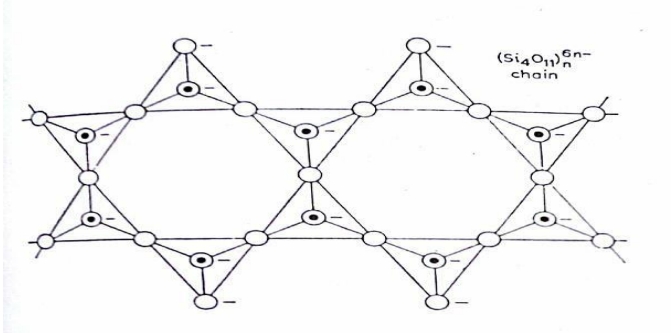
Pyroxene : Simple chain silicates or pyroxene are formed by the sharing of the O atom on two corners of each tetrahedron with other tetrahedra. This gives the formula $(SiO_3)_n^{2n-}$. The arrangements of tetrahedral structure in space may vary and thus affect the repeat distance along the chain, most repeating unit is tetrahedron.

Eg : $LiAl[SiO_3]_2$ (Spondumene), $Mg_2(SiO_3)_2$ (Estatite).



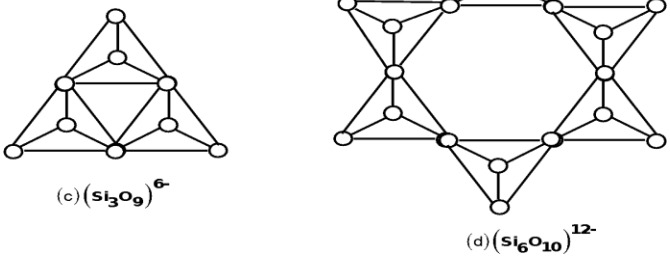
Amphiboles : Double chains can be formed when two simple chains are joined together by shared oxygens. These minerals are called amphiboles. There are several ways of forming double chains giving formulae $(Si_2O_5)_n^{2n-}$, $(Si_4O_{11})_n^{6n-}$ and others. Amphiboles always contain hydroxyl group (-OH), which are attached to metal ion.

Eg : $Ca_2Mg_5(Si_4O_{11})_2(OH)_2$ (Tremolite).



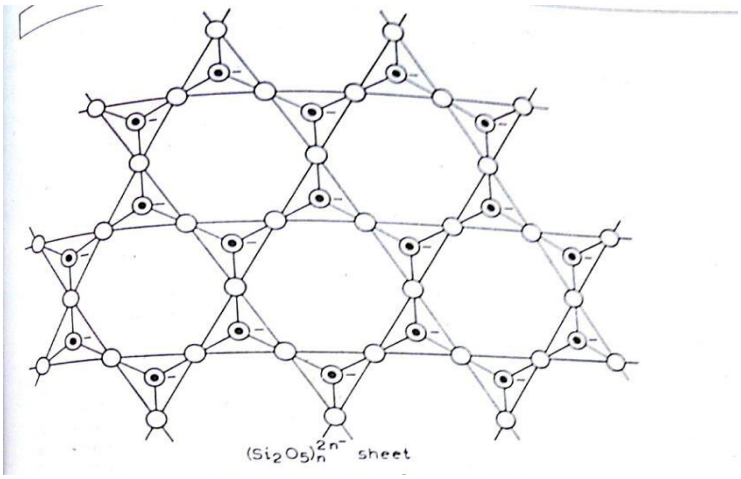
4. **Cyclic silicates** : These are formed by sharing of two oxygen atoms per tetrahedral unit and result in the formation of cyclic structure. The primary unit in this case is $(SiO_3)^{2n-}$. Rings containing 3,4,6 and 8 tetrahedral units are known.But those with 3 and 6 are most common.

Eg: Benitoite- $BaTi(SiO_3)_3$.



5. **Sheet silicates** : These are formed by sharing of three oxygen atom and result in the formation of infinite two-dimensional sheets each silicate tetrahedron shares 3 corner oxygen atom with other tetrahedron. Empirical formula $(Si_2O_5)^{2n-}$.

Eg: Kaolinite $Al(OH)_4(Si_2O_5)$.



6. **Three dimensional silicates**: Which are the extreme cases in which four oxygen atom per unit of tetrahedral which results in three dimensional structure.

Eg: Feldspar, Zeolite ($NaAlSi_2O_6.H_2O$).