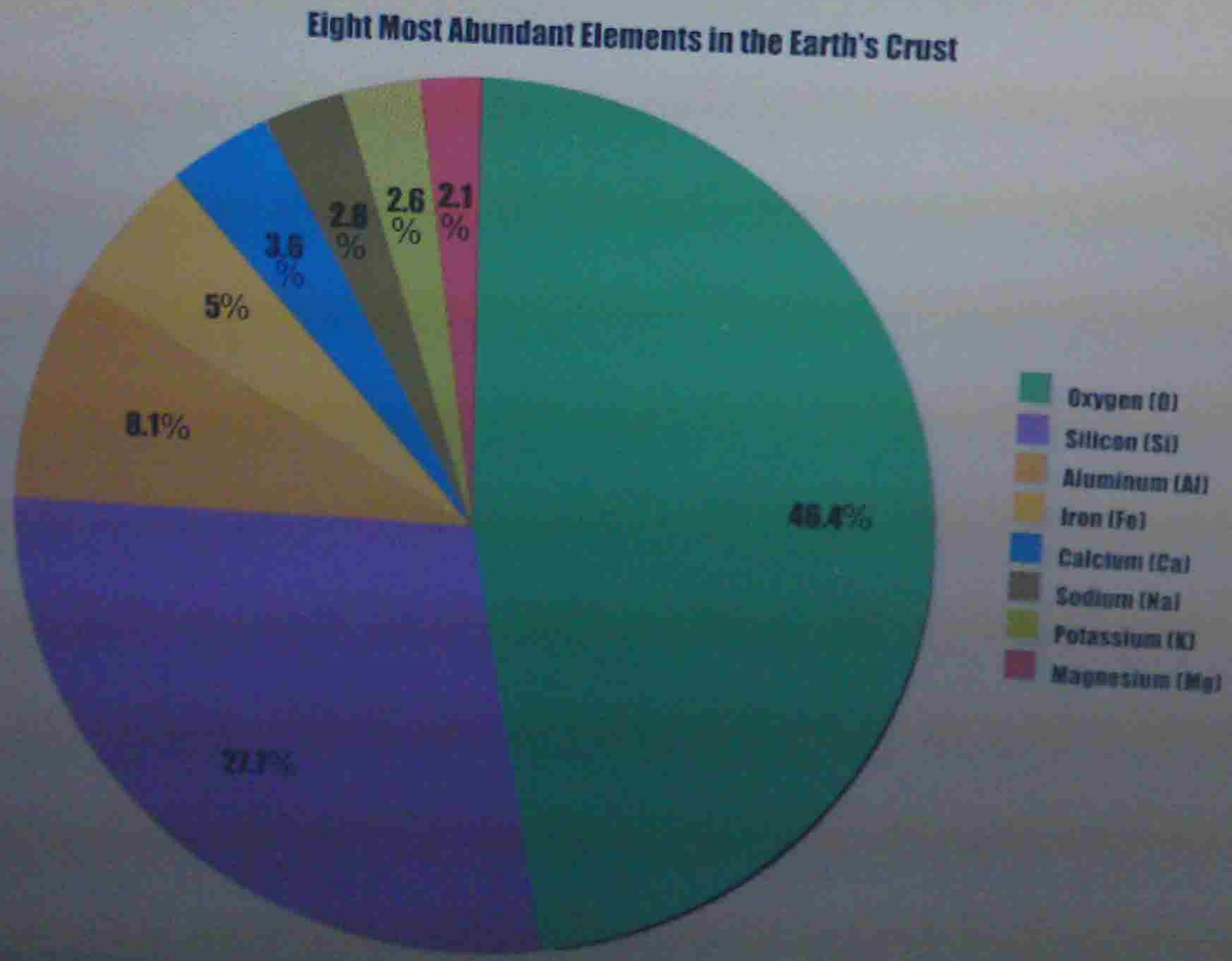
Silicates and Nonsilicates

Silicates and Nonsilicates

- Earth's crust is formed of few dozens of minerals out of the 4000 identified.
- Only eight elements make up the bulk of these minerals.

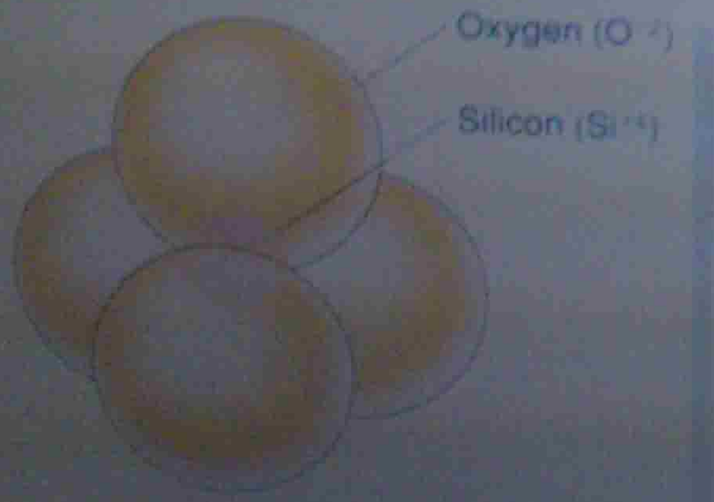


Silicates

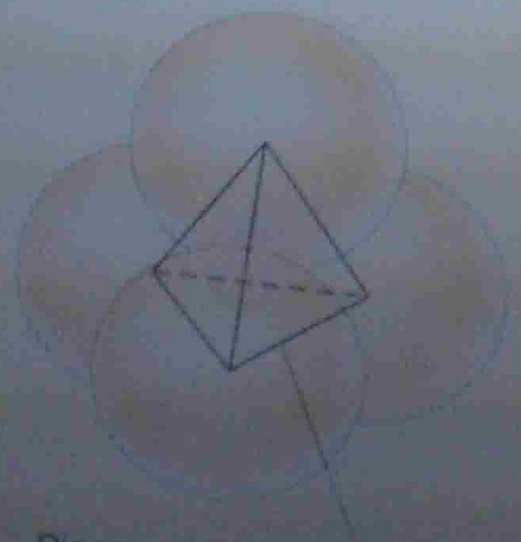
- The most common group of mineral are silicates.

Silicates

- All silicates have the same building block, the silicon-oxygen tetrahedra.
- Silicon and Oxygen are the most common elements in Earth's crust.
- These two elements readily combine to for them framework for most of the common mineral group, the silicates.



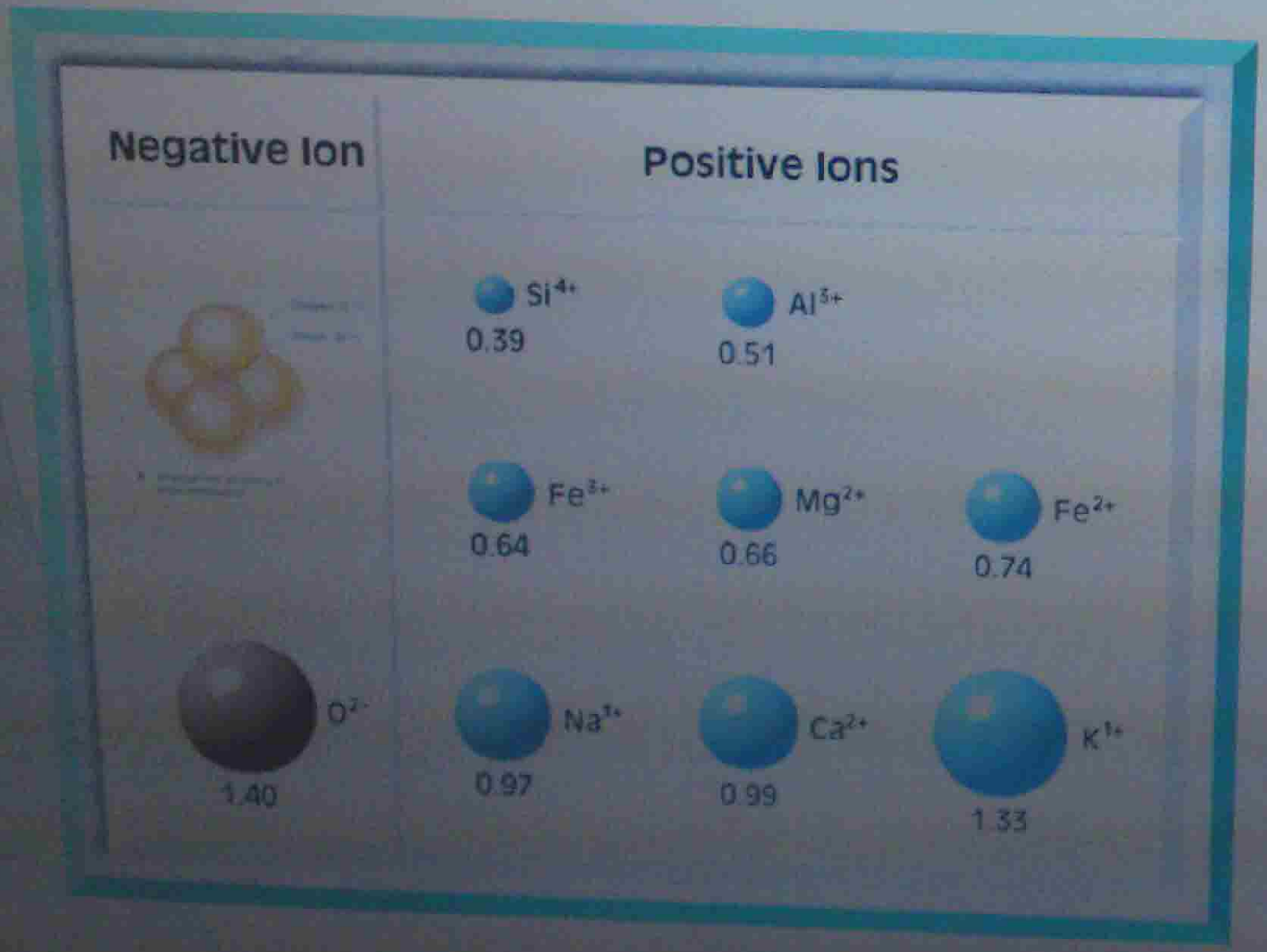
A Arrangement of atoms in silica tetrahedron



B Diagrammatic representation of a silica tetrahedron

Silicates

- The silicon-oxygen tetrahedron <u>is not a compound</u>. Rather, it is an ion $(SiO_4)^{-4}$ with a negative charge of -4.
- In nature, tetrahedra form natural chemical compounds (minerals) through the addition of positively charged ions.



- Ions of the same size substitute freely for one another.
- Example: iron (Fe^{2+}) and magnesium (Mg^{2+}); substitution occurs without altering the mineral structure; <u>but this is not always the case</u>.

Silicates

- In this way, chemically stable structures are produced, consisting of individual tetrahedra linked together by positively charged ions.

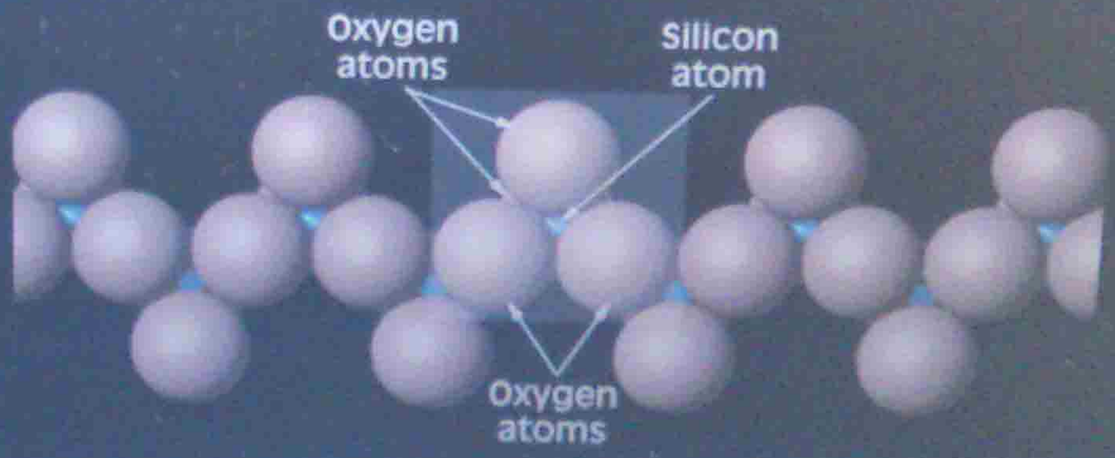
Silicates Structure

- In addition, the tetrahedra may form a verity of structures by sharing the oxygen atoms between the silicon atoms in the adjacent tetrahedra.

- Notice that in this chain structure that each silicon atom is completely surrounded by four larger oxygen atom.

Single Chains

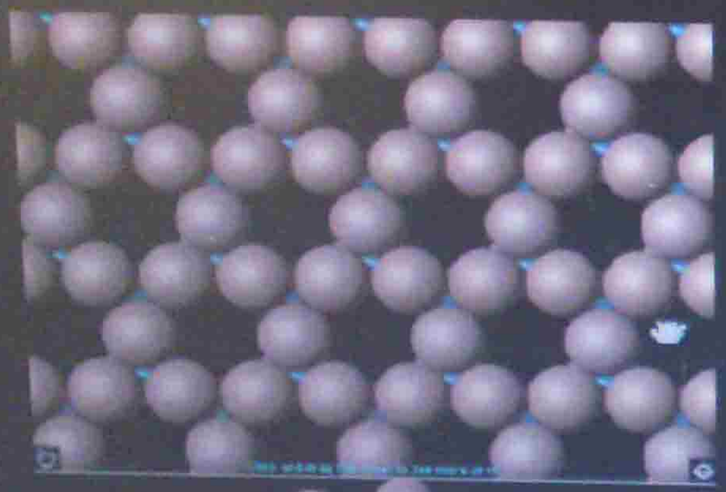
Pyroxene group (Augite)



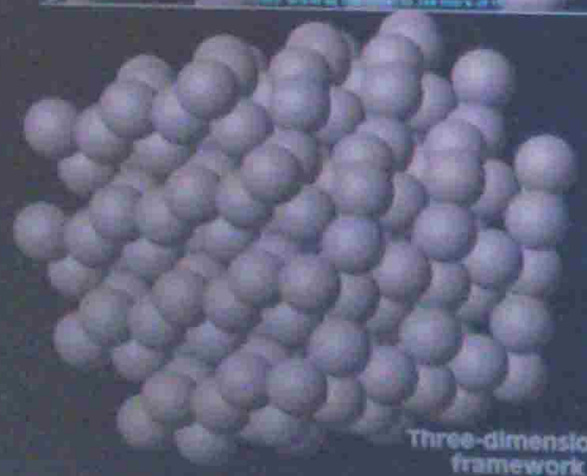
Single chain

Silicates Structure

Double Chains
Amphibole group
(Hornblende)



Sheet Structures
(Micas)



Three-dimensional framework

Three-dimensional Frameworks (or network)
(Feldspars)

Mineral	Idealized Formula	Cleavage	Silicate Structure
Olivine	$(Mg, Fe)_2SiO_4$	None	Single tetrahedron
Pyroxene group (Augite)	$(Mg,Fe)SiO_3$	Two planes at right angles	Single chains
Amphibole group (Hornblende)	$Ca_2(Fe,Mg)_5Si_8O_{22}(OH)_2$	Two planes at 60° and 120°	Double chains
Micas — Biotite	$K(Mg,Fe)_3AlSi_3O_{10}(OH)_2$	One plane	Sheets
Micas — Muscovite	$KAl_2(AlSi_3O_{10})(OH)_2$	One plane	Sheets
Feldspars — Orthoclase	$KAlSi_3O_8$	Two planes at 90°	Three-dimensional networks
Feldspars — Plagioclase	$CaNaAlSi_3O_8$	Two planes at 90°	Three-dimensional networks
Quartz	SiO_2	None	Three-dimensional networks

Common Silicates Minerals

The Light Silicates (Nonferromagnesian)	The Dark Silicates (Ferro(=*iron*)magnesian)
Generally light in color	Generally dark in color
Contain varying amounts of aluminum, potassium, calcium and sodium	Rich in iron and magnesium
Specific gravity: 2.7	Specific gravity: about 3.2 to 3.6
Main groups: Feldspar group, Quartz, Muscovite, Clay minerals	Main groups: Olivine group, Pyroxene group, Amphibole group, Biotite, Garnet

Nonsilicates

- Make up 8% of Earth's crust.
- Subdivided based on the negatively charged ion (anion) or complex anion that the members have in common.
- Some nonsilicate minerals, such as gypsum, calcite, and halite, occurs as constituents in sedimentary rocks in significant amount.
- Others are economically important.
- Some are considered as Gemstones.

TABLE 3.2 Common Nonsilicate Mineral Groups

Mineral Groups [key anion(s) or element(s)]	Mineral Name	Chemical Formula	Economic Use
Carbonates (CO_3^{2-})	Calcite	$CaCO_3$	Portland cement, lime
	Dolomite	$CaMg(CO_3)_2$	Portland cement, lime
Halides (Cl^-, F^-, Br^-)	Halite	NaCl	Common salt
	Fluorite	CaF_2	Used in steel making
	Sylvite	KCl	Fertilizer
Oxides (O^{2-})	Hematite	Fe_2O_3	Ore of iron, pigment
	Magnetite	Fe_3O_4	Ore of iron
	Corundum	Al_2O_3	Gemstone, abrasive
	Ice	H_2O	Solid form of water
Sulfides (S^{2-})	Galena	PbS	Ore of lead
	Sphalerite	ZnS	Ore of zinc
	Pyrite	FeS_2	Sulfuric acid production
	Chalcopyrite	$CuFeS_2$	Ore of copper
	Cinnabar	HgS	Ore of mercury
Sulfates (SO_4^{2-})	Gypsum	$CaSO_4 \cdot 2H_2O$	Plaster
	Anhydrite	$CaSO_4$	Plaster
	Barite	$BaSO_4$	Drilling mud
Native elements (single elements)	Gold	Au	Trade, jewelry
	Copper	Cu	Electrical conductor
	Diamond	C	Gemstone, abrasive
	Sulfur	S	Sulfa drugs, chemicals
	Graphite	C	Pencil lead, dry lubricant
	Silver	Ag	Jewelry, photography
	Platinum	Pt	Catalyst