GLY 4310C
LAB EXERCISE 1 SILICATES: PART 1

CLASS : SILICATES

Silicate minerals are formed when silicon combines with four oxygens in a tetrahedral configuration. Other cations, commonly Fe, Mg, Mn, Ca, Al, and Na, and other rarer cations, may also enter the structure. The silicates form about half of all known minerals, and most of the important rock-forming minerals. There are six sub-classes of the silicate minerals. Three subclasses and part of a fourth will be examined in the first laboratory.

For the laboratory final you are expected to be able to identify each mineral. If the mineral name appears in CAPS, you need to know the cations present, as well as the subclass, family (if any), group (if any), and varieties (if any). If the mineral name has only the first letter capitalized, you should know the subclass, family (if any), group (if any), and varieties (if any).

Mineral Nomenclature

Minerals are divided into classes, such as silicates, oxides, phosphates, etc. The silicates are further subdivided into subclasses, which are discussed below and in following laboratory handouts. Classes or subclasses may be further subdivided into families on the basis of chemical type. For example, hydroxides are properly regarded as a family of the class oxide. Families may be divided into groups on the basis of similarities in structure. Groups are composed of species (individual minerals) which may form series with each other. The class carbonate is divided into the calcite and dolomite groups. In the nesosilicate olivine group (below), solid solution exists between forsterite ($MgSiO_4$) and fayalite ($FeSiO_4$), thus forming a solid solution series. Some species are further divided into varieties. An example would be gypsum, variety selenite.

SUBCLASS : NESOSILICATES

In this subclass the silicon atoms are combined with four oxygens in a tetrahedral configuration. The tetrahedra are not connected directly. Instead some of the oxygens are linked by ionic bonds to non-quadravalent cations. These cations are in turn bonded to an oxygen on another tetrahedra, thus linking the structure together. The Si:O ratio is 1:4.

This subclass contains several important groups of minerals. Perhaps the best known group are the garnets. These are isometric and extensive substitution of the cations is possible. Garnets are most often found in metamorphic rocks. Another group is the olivine group. Olivine minerals are orthorhombic with small divalent cations holding the SiO_4 tetrahedra together.

Willemite from Franklin, New Jersey is usually fluorescent (green). The mineral itself may be yellow-green, flesh color, brown, or white if pure. It is usually found with zincite (deep red to orange-yellow oxide), franklinite (iron black mixed oxide), and sometimes with calcite. The latter often fluoresces red, thus forming "Christmas-tree ore".

Specimens:

OLIVINE GROUP- $(Mg,Fe)_2SiO_4$ Endmembers are:

FORSTERITE Mg_2SiO_4

FAYALITE Fe_2SiO_4

WILLEMITE - Zn_2SiO_4

Al_2SiO_5 GROUP

KYANITE

SILLIMANITE

ANDALUSITE

TOPAZ - $Al_2SiO_4(OH,F)_2$

Staurolite - $Fe_2^{2+}Al_9O_6(SiO_4)_4(O,OH)_2$

GARNET GROUP - $R_3^{2+}R_2^{3+}(SiO_4)_3$

ALMANDINE (=Almandite) $Fe_3Al_2Si_3O_{12}$

GROSSULAR $Ca_3Al_2Si_3O_{12}$

ANDRADITE $Ca_3Fe_2Si_3O_{12}$

SUBCLASS : SOROSILICATES

Sorosilicates are characterized by two SiO_4 tetrahedra sharing a corner. The resulting Si_2O_7 groups are isolated from one another and are held together by bonds to non-quadravalent cations. There are over seventy minerals in this subclass, but most are rare. The most important are the members of the epidote group and vesuvianite, formerly known as idocrase. Clinozoisite and zoisite are very similar in appearance, but differ in structure. (Clinozoisite is monoclinic, zoisite is orthorhombic).

Specimens:

EPIDOTE GROUP:

Epidote $Ca_2(Al, Fe)Al_2O(SiO_4)(Si_2O_7)(OH)$

Clinozoisite-Zoisite $Ca_2Al_3O(SiO_4)(Si_2O_7)(OH)$

Vesuvianite $Ca_{10}(Mg, Fe)_2Al_4(SiO_4)_5(Si_2O_7)_2(OH)_4$

Hemimorphite $Zn_4(Si_2O_7)(OH)_2.H_2O$

SUBCLASS : CYCLOSILICATES:

Cyclosilicates consist of rings of SiO_4 tetrahedra, each of which shares two corners with adjacent tetrahedra. The rings are held together by oxygens bonded to non-quadravalent cations. The most common number of tetrahedra in a ring is six, but three and four-membered rings are also known. None of these minerals are common but some do occur often enough that we need to be familiar with them. The Si:O ratio in all cyclosilicates is 1:3.

Specimens:

Six-membered rings:

BERYL - $Be_3Al_2Si_6O_{18}$

Cordierite - $(Mg,Fe)_2Al_4Si_5O_{18}.nH_2O$

Tourmaline - $(Na, Ca)(Li, Mg, Al)(Al, Fe, Mn)_6(BO_3)_3(Si_6O_{18})(OH)_4$

Four-membered rings:

Axinite - $(Ca, Fe, Mn)_3Al_2(BO_3)(Si_4O_{12})(OH)$

SUBCLASS:INOSILICATES

Inosilicates are chain silicates. The SiO_4 tetrahedra share corners (two in a single chain, three in a double chain). The single chain structures appear in the pyroxenes and pyroxenoids groups. The Si:O ratio is 1:3 in both groups. The double chain structure occurs in the amphibole group where the Si:O ratio is 4:11. Both the amphibole and the pyroxene groups are composed of rock-forming minerals.

Specimens:

PYROXENE GROUP - In this group the chains of silicon tetrahedra run parallel to the crystallographic **z** axis (unit vector **c**). The pyroxenes are anhydrous minerals.

ENSTATITE - $MgSiO_3$ This mineral has orthorhombic symmetry, and is called an orthopyroxene.

DIOPSIDE - $CaMgSi_2O_6$ Diopside and Hedenbergite form a complete solid solution series. Their physical and optical properties vary linearly with composition. These minerals have monoclinic symmetry and are called clinopyroxenes, as are the following minerals.

HEDENBERGITE - $CaFeSi_2O_6$

AUGITE - $(Ca,Na)(Mg,Fe,Al)(Si,Al)_2O_6$

Spodumene - $LiAlSi_2O_6$

PYROXENOID GROUP - In this group the chains run parallel to the crystallographic **y** axis (unit vector **b**). Like the pyroxenes, the pyroxenoids are anhydrous.

WOLLASTONITE - $CaSiO_3$

RHODONITE - $MnSiO_3$

Pectolite - $Ca_2NaH(SiO_3)_3$

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