

## Pyroxene Group

$XYZ_2O_6$

Pyroxenes are classified based on the occupancy of the M1 and M2 site. In orthopyroxenes the M2 site is usually octahedral and commonly contains Fe and Mg. In clinopyroxenes, larger cations (such as Li and Na) are in eightfold coordination in the M2 site (the larger cations need a different geometry to accommodate them, which reduces the symmetry to monoclinic). Figure 13.2 shows the Pyroxene classification.

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For more information, see the lecture notes section.

### Identification:

#### Orthopyroxene

-Enstatite-  $(Mg,Fe)_2Si_2O_6$  – **Thin section:** Plane light: Pale colored with greenish to pinkish pleochroism. Pure enstatite can be colorless, higher Fe contents correspond to darker colors. High positive relief. Euhedral crystals will be stubby prisms. Anhedral grains may fill the space between other grains. Crossed Polars: Biaxial (+) or (-). First order yellow or below. Higher Fe contents correspond to higher birefringence, up to lower second order. Longitudinal sections will show parallel extinction. Basal sections will show symmetrical extinction.

**Hand sample:** Two cleavage planes perpendicular to each other. Cleavage is good. Will have a vitreous to pearly luster on the cleavage surface. Color can be from yellowish or greenish white to olive-green. High Fe contents can also cause the color to be black and in this case it is hard to tell from augite.

#### Clinopyroxene

-Pigeonite-  $(Mg, Fe^{2+}, Ca)_2Si_2O_6$  – **Thin section:** Plane light: Colorless to pale brownish green. Generally not pleochroic. High positive relief. Basal sections show two cleavages at  $87^\circ$ . Longitudinal sections will show only one cleavage direction.

Crossed Polars: Biaxial (+),  $2V = 0-32^\circ$ . First order yellow or red common, up to lower second order is possible. Basal sections will show symmetrical extinction; longitudinal sections will have parallel or slightly inclined extinction.

Lamella of augite are common in pigeonite of intrusive rocks and will be parallel to  $\{001\}$ . Pigeonite is distinguished from other pyroxenes by its low  $2V$  angle.

**Hand sample:** Displays good cleavage and will have a brown, greenish-brown to black color. Can only be distinguished from other pyroxenes by optical tests.

-Augite-  $(Mg, Fe, Ca, Al)_2(Si, Al)_2O_6$  – **Thin section:** Plane light – Colorless, grey, pale green, pale brown, or brownish green. (again, darker colors corresponding to higher Fe content). Can be weakly pleochroic. High positive relief. Typical pyroxene cleavage.

Crossed polars: Biaxial (+),  $2V = 25-70^\circ$ . Lower to middle second order colors. Basal sections will show symmetrical extinction, longitudinal sections will have inclined extinction and be length slow.

Distinguished from orthopyroxenes by inclined extinction and higher birefringence and from pigeonite by larger  $2V$ .

**Hand sample:** Imperfect cleavage. Two planes intersecting at  $87^\circ$  and  $93^\circ$ .

Augite has a vitreous luster and is black. Its crystal form and imperfect cleavage are diagnostic.

#### **Other pyroxenes to watch out for:**

-Aegirine, Aegirine-Augite-  $(Na, Ca)(Fe^{3+}, Fe^{2+}, Mg, Al)Si_2O_6$  – **Thin section:** Brown to dark green in plane light and distinctly pleochroic – emerald green to yellowish green. **Hand sample:** Cleavage and crystal form similar to augite. Brown or green in color. Slender prismatic crystals and association are diagnostic, however it is difficult to conclusively identify without optical tests. See hand sample 846. Found in alkali granites, and glaucophane- or riebeckite-bearing schists.

-Omphacite-  $(Ca, Na)(Mg, Fe^{2+}, Fe^{3+}, Al)Si_2O_6$  – **Thin section:** Colorless to pale green in plane light and weakly pleochroic. **Hand sample:** Green to dark green in color with a vitreous luster. Association is diagnostic. Commonly occurs in eclogites in association with garnet.

-Jadeite-  $NaAlSi_2O_6$  – **Thin section:** Jadeite with high  $Fe^{3+}$  content may show anomalous interference colors. **Hand sample:** Usually light to medium green in color with a vitreous luster. Occurs only in metamorphic rocks that have been subjected to high pressures and moderate temperatures.

-Spodumene-  $LiAlSi_2O_6$ - **Hand sample:** white, grey or pink in color. Prismatic cleavage and color are diagnostic. Only occurs in pegmatites.