

April 26, 2021

**Pyroxene Group**



**Figure 1 - Pyroxene Crystal**

**Credit: Rob Lavinsky, [iRocks.com](http://iRocks.com) – CC-BY-SA-3.0**

Unless you are a geologist or are familiar with geology you may not have heard about the pyroxene group of minerals. However, they are an important and widespread group of minerals found in many igneous and metamorphic rocks. Among aggregate rocks used for construction materials, dark coloured (mafic) rocks called [trap rocks](#) are rich in pyroxene minerals.

To put their importance into context, Figure 2 shows the relative abundance of various rock forming minerals, pyroxenes make up around 11% of the minerals in the Earth's crust.

Most Abundant Minerals in Earth's Crust

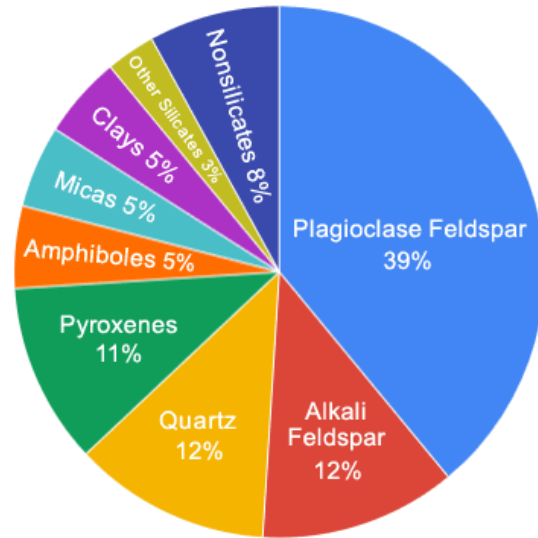


Figure 2 - Mineral Abundance

### Characteristics of Pyroxenes

Pyroxene are considered "[chain silicate](#)" minerals. Figure 3, shows the crystal structure of pyroxenes

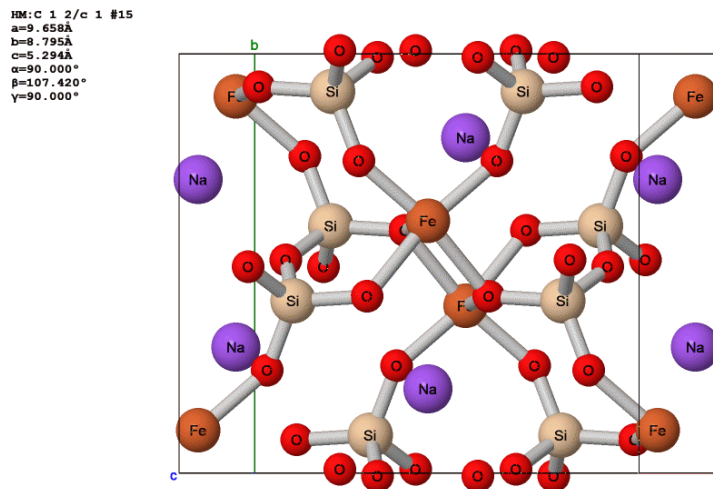


Figure 3 - Crystal Structure of Pyroxene

Credit: [American Mineralogist Crystal Structure Database](#)

Pyroxenes are commonly divided into two subgroups: [clinopyroxenes](#) and [orthopyroxenes](#) subgroup. Clinopyroxenes show [monoclinic](#) crystals whereas orthopyroxenes have [orthorhombic](#) crystals.

Chemically, pyroxenes have the following general chemical formula:



- Where **A** can be one or more of the following: Ca, Na, Fe<sup>++</sup>, Mg, Zn, Mn, or Li;
- Where **B** can be one or more of the following: Mg, Fe<sup>+++</sup>, Fe<sup>++</sup>, Cr, Al, Co, Mn, Sc, Ti, or Vn; and
- Where **C** can be Si, Al, or a combination of both

Many [cation](#) substitutions can occur in the A and B positions.

Figure 4, is a ternary diagram showing the relationship between various types of pyroxene

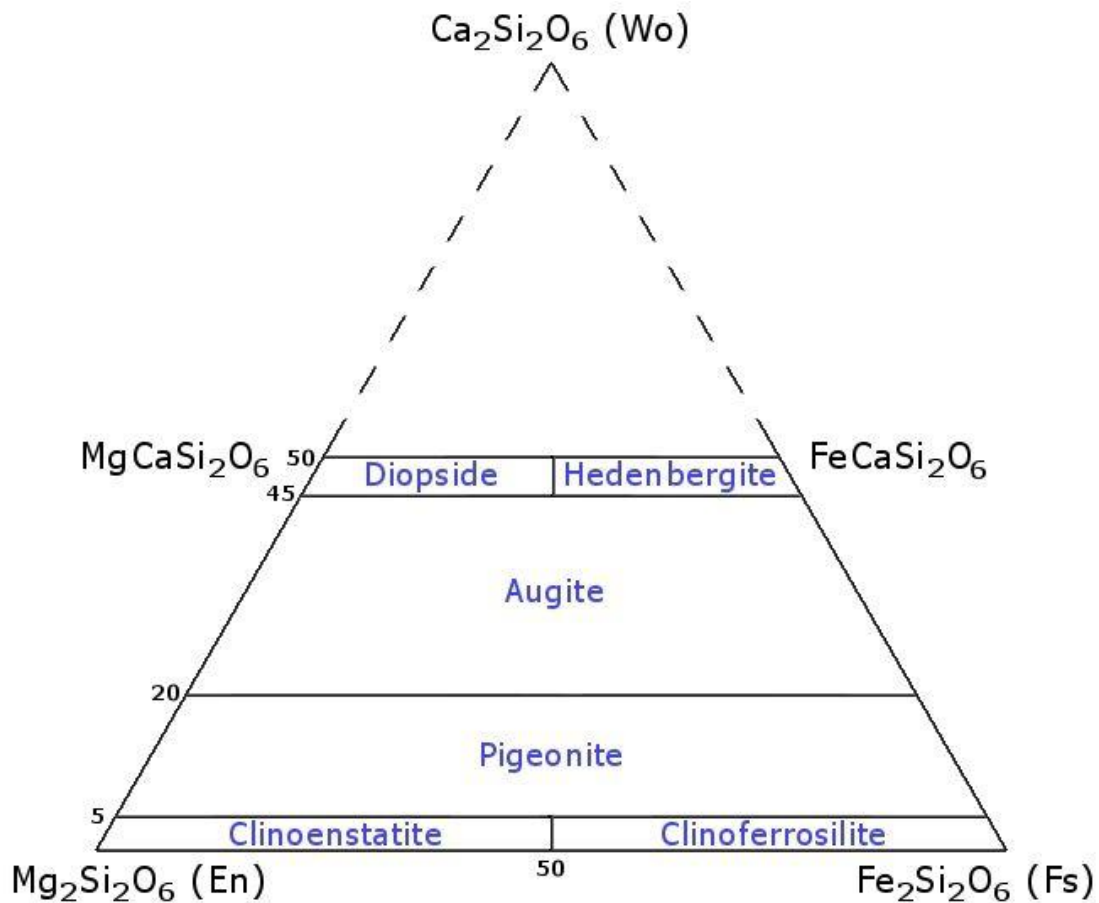


Figure 4 - Ternary Diagram, Pyroxene Group

Credit: [Wiring Diagrams Free](#)

Table 1, below, lists the pyroxene minerals and their chemical compositions

Monoclinic Pyroxenes (Clinopyroxenes)		Orthorhombic Pyroxenes (Orthopyroxenes)	
Aegirine	$\text{NaFe}^{+++}\text{Si}_2\text{O}_6$	Hypersthene	$(\text{Mg,Fe})\text{SiO}_3$
Augite	$(\text{Ca,Na})(\text{Mg,Fe,Al,Ti})(\text{Si,Al})_2\text{O}_6$	Donpeacorite	$(\text{MgMn})\text{MgSi}_2\text{O}_6$
Burnettite	$\text{CaVA}\text{SiO}_6$	Enstatite	$\text{Mg}_2\text{Si}_2\text{O}_6$
Clioenstatite	$\text{MgSiO}_3$	Ferrosillite	$\text{Fe}_2\text{Si}_2\text{O}_6$
Clinoferrosillite	$\text{Fe}^{++}\text{SiO}_3$	Nchwangite	$\text{Mn}^{2+}_2\text{SiO}_3(\text{OH})_2 \cdot (\text{H}_2\text{O})$
Davsite	$\text{CaScAlSiO}_6$	Protoenstatite	$\text{Mg}_2\text{Si}_2\text{O}_6$
Diopside	$\text{CaMgSi}_2\text{O}_6$		
Esseneite	$\text{CaFe}^{+++}[\text{AlSiO}_6]$		
Grossmanite	$\text{CaTi}^{+++}\text{AlSiO}_6$		
Hedenbergite	$\text{CaFe}^{++}\text{Si}_2\text{O}_6$		
Jadeite	$\text{Na}(\text{Al,Fe}^{+++})\text{Si}_2\text{O}_6$		
Jervisite	$(\text{Na,Ca,Fe}^{++})(\text{Sc,Mg,Fe}^{++})\text{Si}_2\text{O}_6$		
Johannsenite	$\text{CaMn}^{++}\text{Si}_2\text{O}_6$		
Kanoite	$\text{Mn}^{++}(\text{Mg,Mn}^{++})\text{Si}_2\text{O}_6$		
Kosmochlor	$\text{NaCrSi}_2\text{O}_6$		
Kushiroite	$\text{CaAl}[\text{AlSiO}_6]$		
Namansilite	$\text{NaMn}^{+++}\text{Si}_2\text{O}_6$		
Natalyite	$\text{NaV}^{+++}\text{Si}_2\text{O}_6$		
Omphacite	$(\text{Ca,Na})(\text{Mg,Fe}^{++},\text{Al})\text{Si}_2\text{O}_6$		
Petedunnite	$\text{Ca}(\text{Zn,Mn}^{++},\text{Mg,Fe}^{++})\text{Si}_2\text{O}_6$		
Pigeonite	$(\text{Ca,Mg,Fe})(\text{Mg,Fe})\text{Si}_2\text{O}_6$		
Spodumene	$\text{LiAl}(\text{SiO}_3)_2$		

**Table 1 - Pyroxene Minerals**

## Common Pyroxenes and their Occurrence

### Spodumene - $\text{LiAl}(\text{SiO}_3)_2$



**Figure 5 - Spodumene**

Credit: Rob Lavinsky, [iRocks.com](http://iRocks.com) – CC-BY-SA-3.0

Found mostly in granitic pegmatites, [spodumene](#) is an ore of lithium. Some varieties of spodumene are gemstones; pink to purple spodumene is known as [kunzite](#), green spodumene is known as [hiddenite](#), and yellow spodumene is known as [triphane](#).

**Jadeite -  $\text{Na}(\text{Al},\text{Fe}^{+++})\text{Si}_2\text{O}_6$**



**Figure 6 - Jadeite from Burma**

**Credit:** [Jsj1771](#) [Creative Commons Attribution-Share Alike 3.0 Unported](#)

[Jadeite](#) comes in many colours including green, greenish white, purplish blue, blue-green, violet, white and black. Jadeite is famous for its use in jewelry and ornamentation. It is also a tough, resilient mineral that resists fracturing and was used for [stone axes in the Neolithic](#). Jadeite is typically found in metamorphic rocks, especially in [glaucophane schists](#).

**Diopside -  $\text{CaMgSi}_2\text{O}_6$**



**Figure 7 - Faceted Diopside**

**Credit:** [Didier Descouens](#), [Creative Commons Attribution-Share Alike 4.0 International](#)

Another green coloured pyroxene, [diopside](#) is one of the most common members of the pyroxene group. It often occurs as generally pale greenish to greyish green crystals in metamorphosed limestones (marbles). It is mostly used for jewelry.

**Enstatite -  $Mg_2Si_2O_6$**

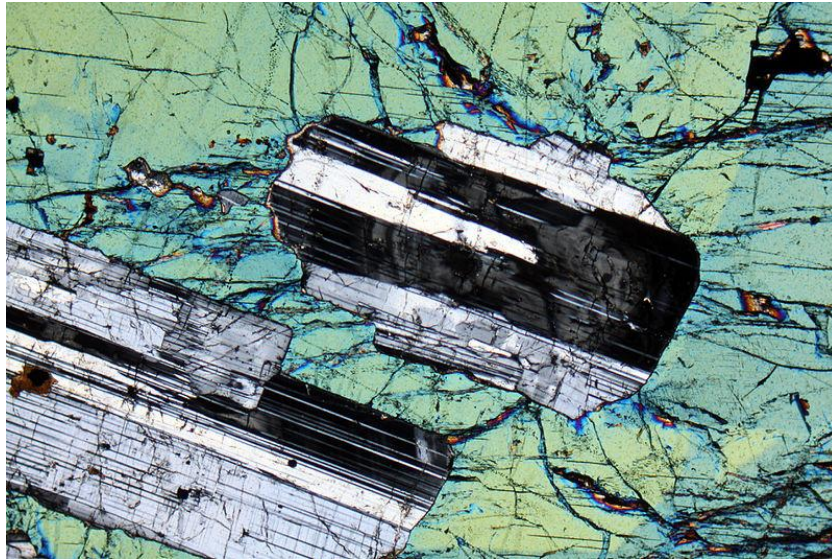


**Figure 8 - Enstatite**

**Credit:** Rob Lavinsky, [iRocks.com](#) – CC-BY-SA-3.0

Found in magmatic [mafic rocks](#), [enstatite](#) (also called clinoenstatite) is generally olive green to brown in colour, occasionally white or yellow. Enstatite is occasionally used as a gemstone called [bronzite](#).

**Augite -  $(\text{Ca},\text{Na})(\text{Mg},\text{Fe},\text{Al},\text{Ti})(\text{Si},\text{Al})_2\text{O}_6$**

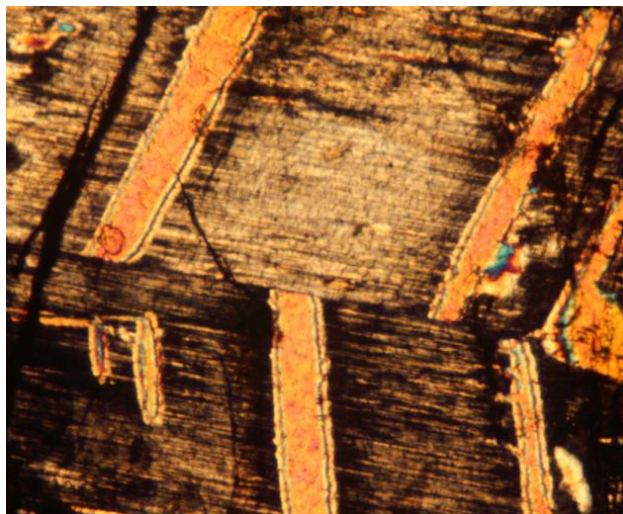


**Figure 9 - Augite in [Thin Section](#)**

**Credit:** [Strekeisen](#), [Creative Commons Attribution-Share Alike 4.0 International](#)

A major subgroup within the clinopyroxenes, [augite](#) varies in proportions of Ca, Mg, and Fe. The colour of augite also varies and includes Brown-green, black, green-black, brown, and purplish brown. It is a major rock forming mineral found in mafic igneous rocks, ultramafic rocks, and some high-grade metamorphic rocks. It is one of the few minerals that has no commercial use.

**Pigeonite,  $(\text{Ca},\text{Mg},\text{Fe})(\text{Mg},\text{Fe})\text{Si}_2\text{O}_6$**

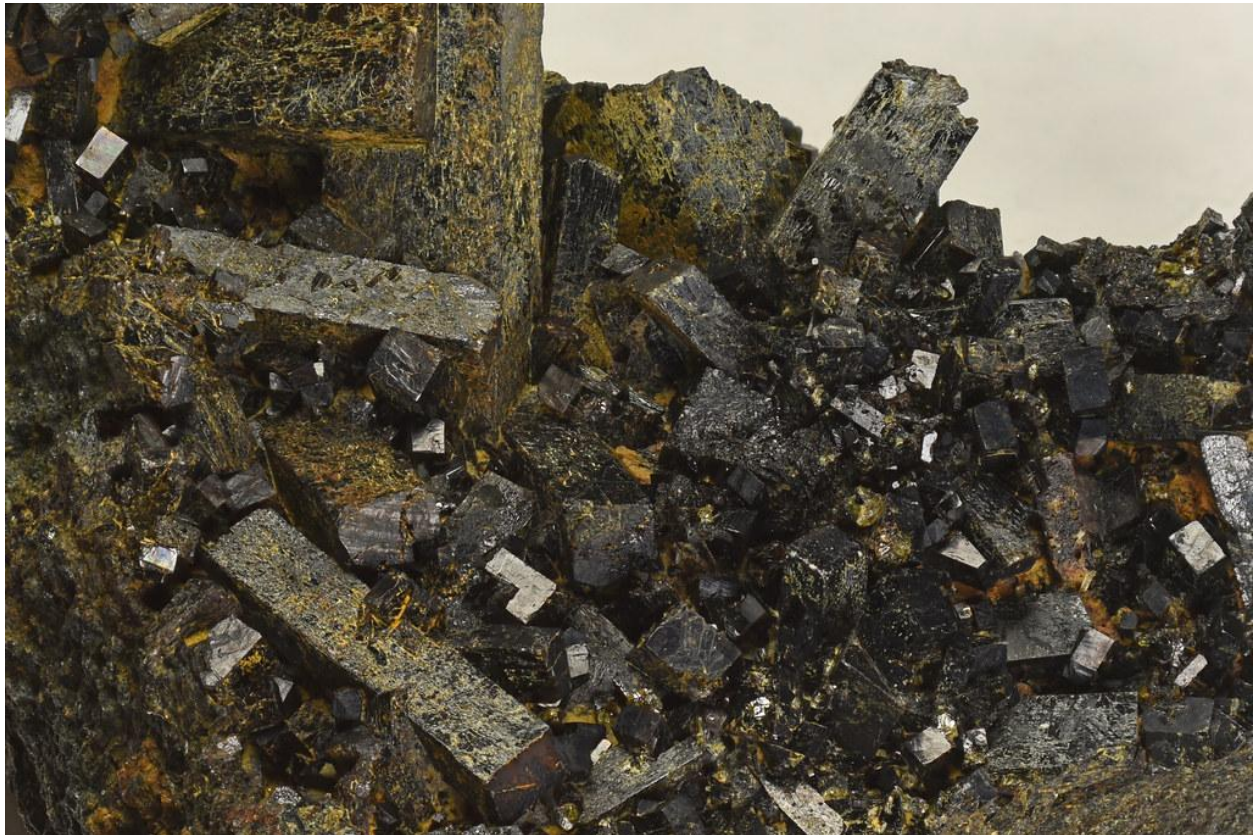


### Figure 10 - Pigeonite in Thin Section

Credit: [user:Omphacite, Public domain, via Wikimedia Commons](#)

Named for the type locality of Pigeon Point, Minnesota, [pigeonite](#) varies in colour from black to brown to greenish brown. It is mostly found in igneous rocks like basalts and dolerite.

**Hedenbergite -  $\text{CaFe}^{++}\text{Si}_2\text{O}_6$**



**Figure 11 - Hedenbergite**

Credit: [Robert M. Lavinsky, Creative Commons Attribution-Share Alike 3.0 Unported](#)

Hedenbergite is a brown to black clinopyroxene found in a variety of environments including metamorphosed iron formations, iron-magnesium [skarns](#), granites, and as [xenoliths](#) in [kimberlite](#).

**Wollastonite -  $\text{Ca}_2\text{Si}_2\text{O}_6$**





**Figure 12 - Wollastonite**

**Credit:** [AyselkaDjabrailova](#), [Creative Commons Attribution-Share Alike 4.0 International](#)

At the top of the ternary diagram in figure 4 is a mineral called [Wollastonite](#). While not generally considered a member of the pyroxene group, I am including it here because it is so often shown in the ternary diagrams that illustrate the chemistry of pyroxene. Wollastonite is a light coloured (felsic) mineral: white, gray-white, light green, pinkish, brown, red, and yellow. It is found in igneous rocks, in metamorphic siliceous carbonates rocks, and as a skarn deposit. Among others, wollastonite is used in ceramics, for brakes and clutches, metal refining, as a paint filler, and in plastics.

### **Standard Caveat**

The purpose of my weblog postings is to spark people's curiosity in geology. Don't entirely believe me until you've done your own research and checked the evidence. If I have sparked your curiosity in the subject of this posting, follow up with some of the links provided here. If you want to, go out into the field and examine some rocks on your own with the help of a good field guide. Follow the evidence and make up your own mind.

**In science, the only authority is the evidence.**