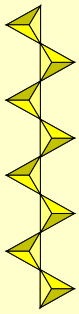
Biaxial Minerals Descriptions

- Olivine
- **Pyroxenes**
  - **Orthopyroxene**
  - **Clinopyroxene**
- Amphibole
  - Hornblende
  - Actinolite
- Micas
  - Biotite, muscovite, chlorite
- Feldspars
  - Plagioclase
  - Microcline, orthoclase, sanidine

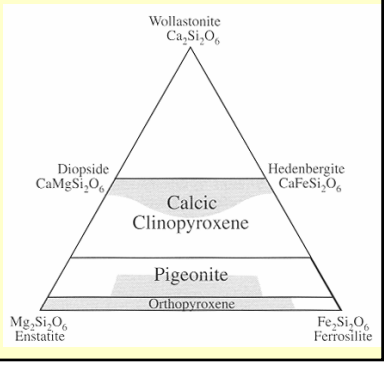
Pyroxene



- Inosilicates (single chain) – Si_2O_6
- Two groups to consider:
  - Orthopyroxenes
    - Orthorhombic
    - Ca-poor pyroxenes
  - Clinopyroxenes
    - Monclinic
    - Ca-rich pyroxenes
- Both exhibit a range of compositions and thus a range of optical properties

Pyroxene

Compositional Groups



Orthopyroxene -OPX

- General formula – $(Mg,Fe)_2Si_2O_6$
- Represented by two end member components
  - Enstatite – $MgSiO_3$
  - Orthoferrosilite – $FeSiO_3$
- Natural opx is a mixture of the two
- Variable composition = variable optical properties

Orhtopyroxene

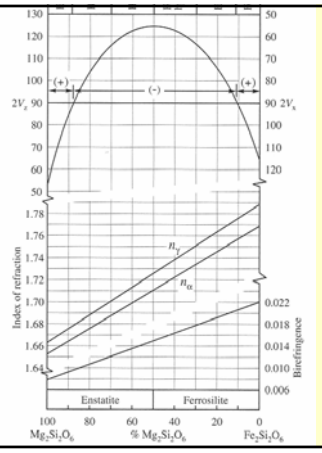
Refractive Indices

	En	OFs
n_α	1.649	1.768
n_β	1.653	1.770
n_γ	1.657	1.788

Birefringence varies from 0.007 to 0.020

$2V_Z$ angle varies from 50 to 132°, dependant on composition, so the optic sign may be -ve ($2V_Z$>90°)or +ve ($2V_Z$<90°)

Generally, natural opx is optically negative



Orthopyroxene

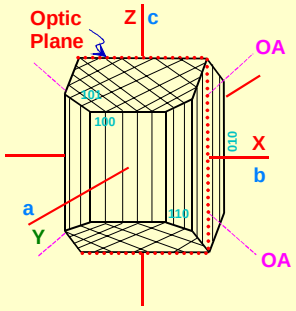
Variation in optical properties with composition

Orthopyroxene

Orthorhombic

Crystallographic axes are:

1. of unequal length
2. Mutually perpendicular
3. Coincide with indicatrix axes



Orthpyroxene

Colour and Pleochroism

May be weakly coloured – salmon pink to green

Pure En is colourless, but with the addition of Fe, coloured varieties are possible

Fe-rich samples are pleochroic

- X = pink, brown, pale yellow
- Y = light brown, yellow, pinkish yellow
- Z = light green, grey-green

Orthopyroxene

Cleavage, fracture

Sections cut parallel to c-axis will show a single cleavage

- When the cleavage is parallel to the lower polar the colour is green
- When the cleavage is perpendicular to lower polar the colour is pink

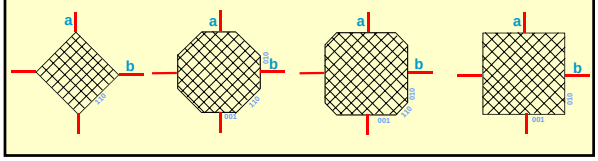
Sections cut perpendicular to c- axis will exhibit two cleavages that meet at 90°

Orthopyroxene

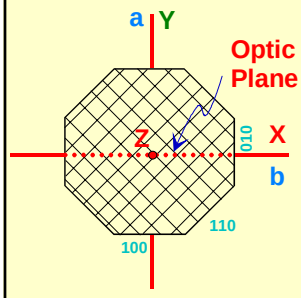
Crystal Form

Euhedral crystals generally form stubby prisms

Basal sections (those perpendicular to c-axis) are four or eight sided and will show the two cleavages at 90° to each other



Orthopyroxene



Section of OPX

perpendicular to c- axis

Exhibits:

Two cleavages at 90°

Symmetrical extinction

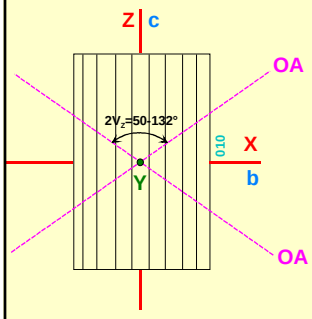
~ Bxo Figure

Orthopyroxene

Crystal Form (continued)

Longitudinal sections (those cut parallel to c-axis) are rectangular and will exhibit a single cleavage

Orthopyroxene



Section of OPX

perpendicular to a- axis

Exhibits:

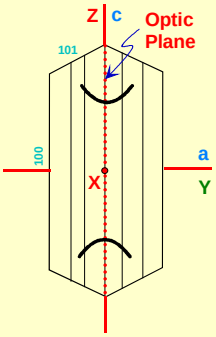
1 cleavage

Parallel extinction

Max. interference colours

Optic Normal Figure

Orthopyroxene



Section of OPX

perpendicular to b- axis

Exhibits:

1 cleavage

Parallel extinction

Bxa Figure

Orthopyroxene

Alteration

Alteration to serpentine, talc, and fine grained amphibole (actinolite)

Occurrence

Mg-rich opx is common in mafic intrusive rocks (gabbro, norite, etc.).

Fe-rich opx is found in more siliceous igneous rocks (diorite, syenite etc.)

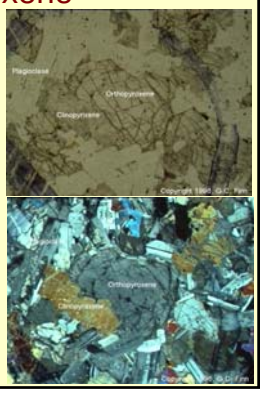
opx is common in high grade regional metamorphic rocks

Orthopyroxene

Properties

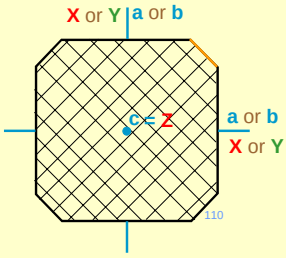
1. Low interference colours
2. Parallel extinction
3. Weakly pleochroic – pale green to pink
4. High 2V angle (>75°)
5. Optically -ve

OPX page



OPX

By Convention
X=b, Y=a, Z=c



Linking crystallographic and optic features in OPX

Questions:
1) Which axis corresponds to **a** and **b**?
2) Which axis corresponds to **X** and **Y**?

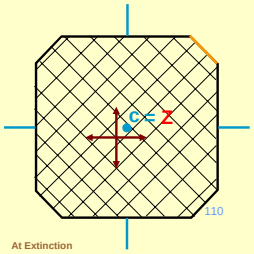
Comes down to identifying where the Optic Plane lies in this grain

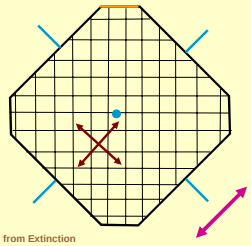
How to determine the position of the OAP?

OPX

X=b, Y=a, Z=c

Determine the vibration directions and identify the position of the fast ray (**X** indicatrix axis)



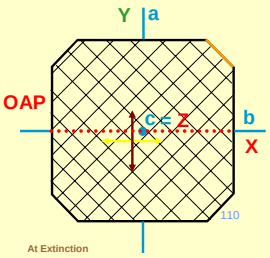


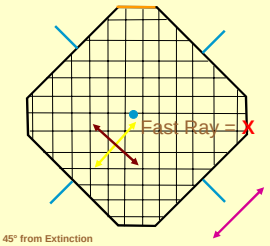
Vibration directions are parallel to crosshairs

Upon inserting the **Gypsum Plate**
Colours can either decrease or
Colours can **increase**, parallel to plate

OPX X=b, Y=a, Z=c

Determine the vibration directions and identify the position of the fast ray (X indicatrix axis)

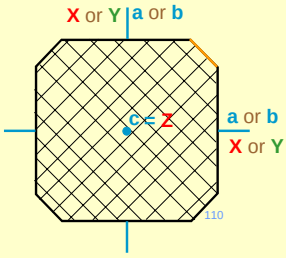




Working backwards to the grain at extinction

Upon inserting the **Gypsum Plate**
If colours decrease then **X** is parallel to plate

OPX By Convention X=b, Y=a, Z=c



Linking crystallographic and optic features in OPX

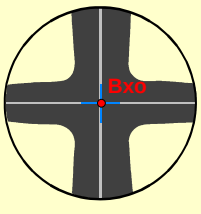
Questions:
1) Which axis corresponds to **a** and **b**?
2) Which axis corresponds to **X** and **Y**?

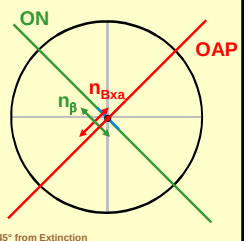
Comes down to identifying where the Optic Plane lies in this grain

Alternatively can look at the Interference Figure, Which for this orientation is a Bxo Figure

OPX By Convention X=b, Y=a, Z=c

Linking crystallographic and optic features in OPX



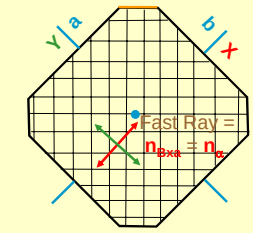


On rotation, the cross splits with the Isogyres leaving the FOV in the quadrants into which the OAP is rotating

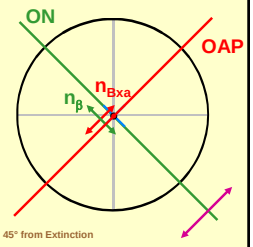
OPX

By Convention
X=b, Y=a, Z=c

Linking crystallographic and optic features in OPX



45° from Extinction



45° from Extinction

Insert the **Gypsum plate** to determine whether n_{Bxa} is n_{α} (decrease) or n_{γ} (increase)