Pyroxenes

- http://www.es.mq.edu.au/ndaczko/Web/GEOS254/GEOS254.html
- Pyroxenes are a major component of the mantle (peridotite is olivine plus pyroxene) and the oceanic crust (basalt, dolerite, gabbro are mainly calcium-rich plagioclase plus pyroxene).
- Pyroxenes are also present in many high grade (high temperature) metamorphic rocks. The calcium magnesium pyroxene diopside forms in meta-limestone even at low temperature.
- Fragments of pyroxene are present in many volcaniclastic sandstones.

PYROXENES $X\ Y\ Z_2O_6$

(X=Ca,Mg,Fe,Na); Y= Mg,Fe,Al,Ti0; Z=Si)

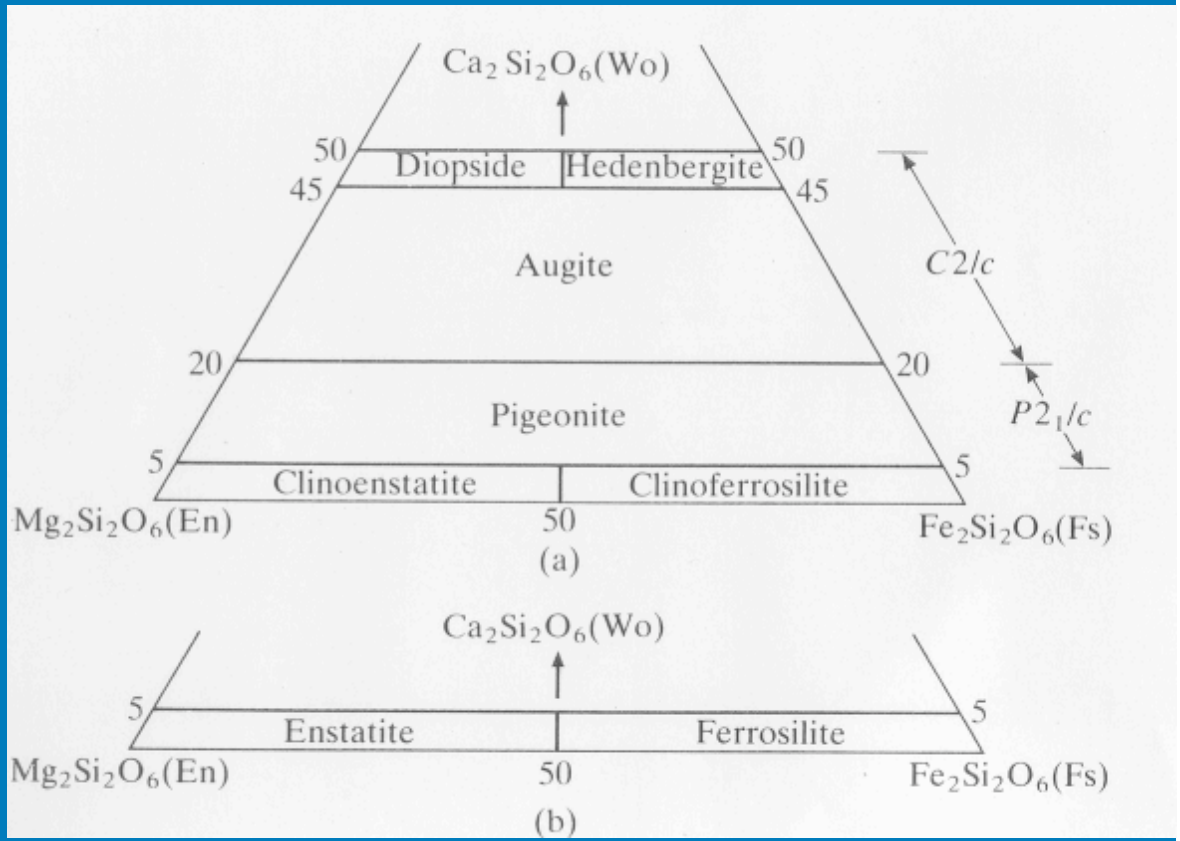
- Most common pyroxenes are solid solutions of
- Diopside $CaMgSi_2O_6$ Hedenbergite $CaFeSi_2O_6$
- Enstatite $MgMgSi_2O_6$ Ferrosilite $FeFeSi_2O_6$

Two other important pyroxene end-members are
Jadeite $NaAlSi_2O_6$ Aegirine $NaFe^{3+}Si_2O_6$

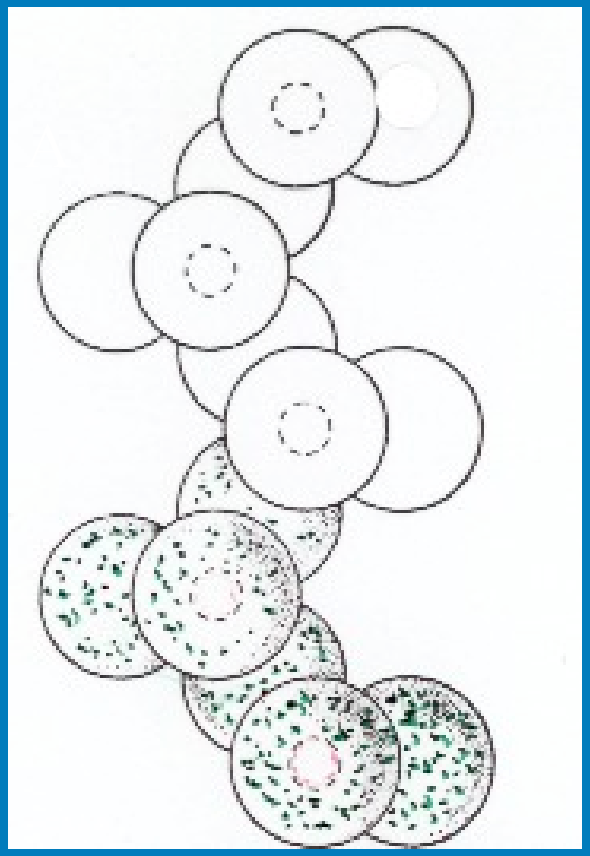
3 other well recognised pyroxenes are:
Omphacite (about half augite/half jadeite) in eclogites.
Aegirine-augite (about equal amounts of both) in trachytes (green)
Titan-augite (Ti replaces Fe) in intra-plate basalts (pink/mauve)

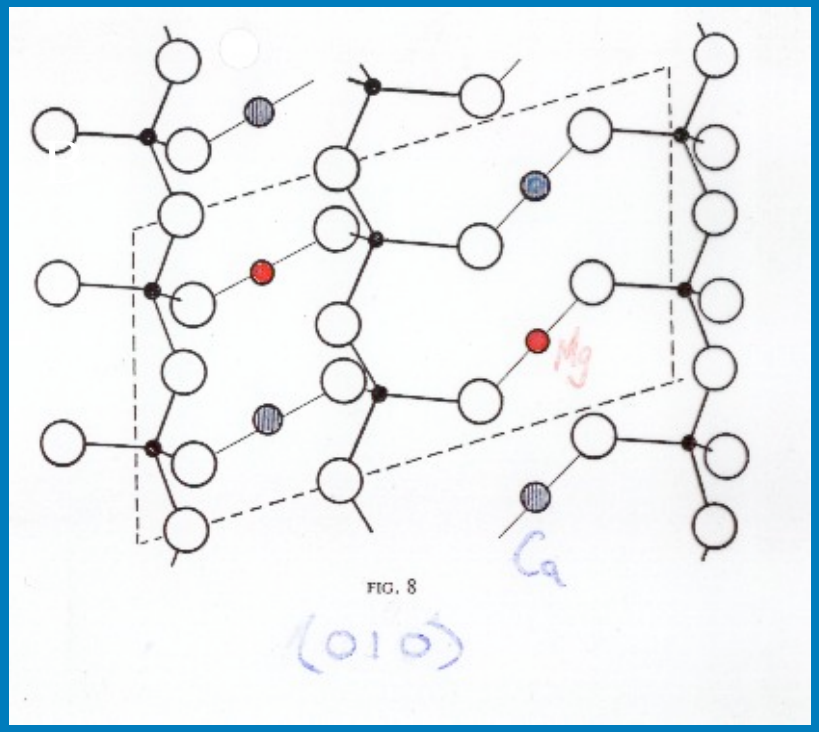
The pyroxene quadrilateral

- Most monoclinic or “clino”-pyroxenes are close to the Di –He join.
- Most orthorhombic or “ortho”-pyroxenes are close to the En – Fs join.
- Pigeonite is a calcium-poor clinopyroxene that occurs in some dolerites.
- Augite is a common igneous clinopyroxene.



PYROXENE STRUCTURE

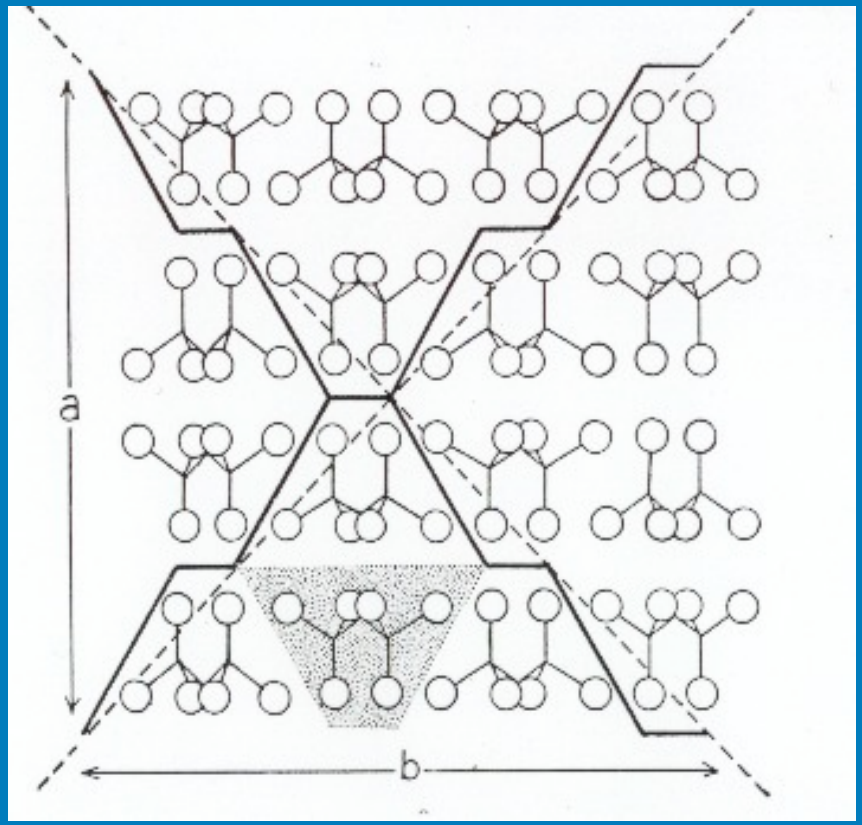




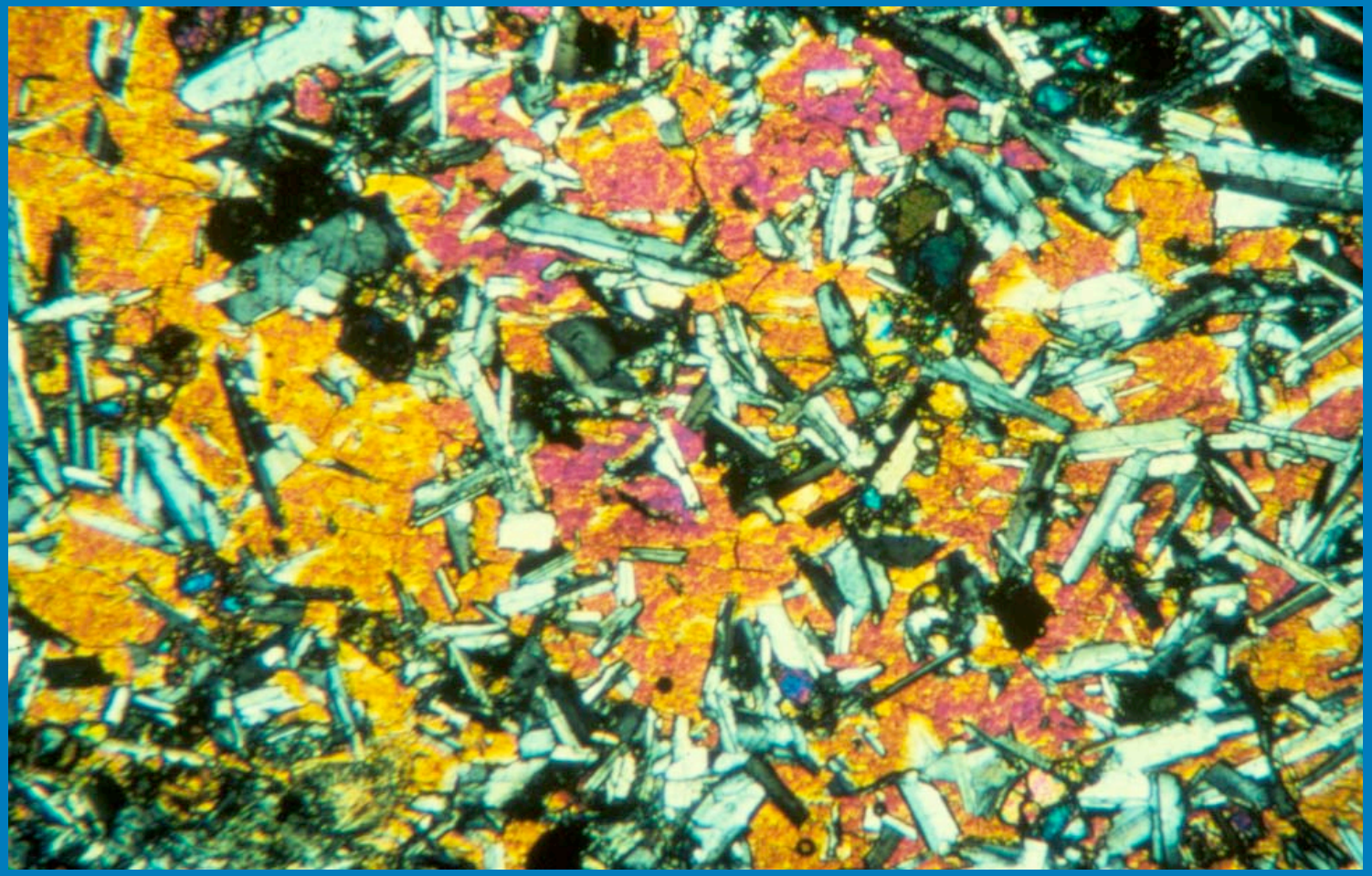
- A: Single chain parallel to c-axis.
- Looking along the b-axis of diopside (clinopyroxene). Red atoms are Mg, grey are Ca.

Pyroxene cleavage

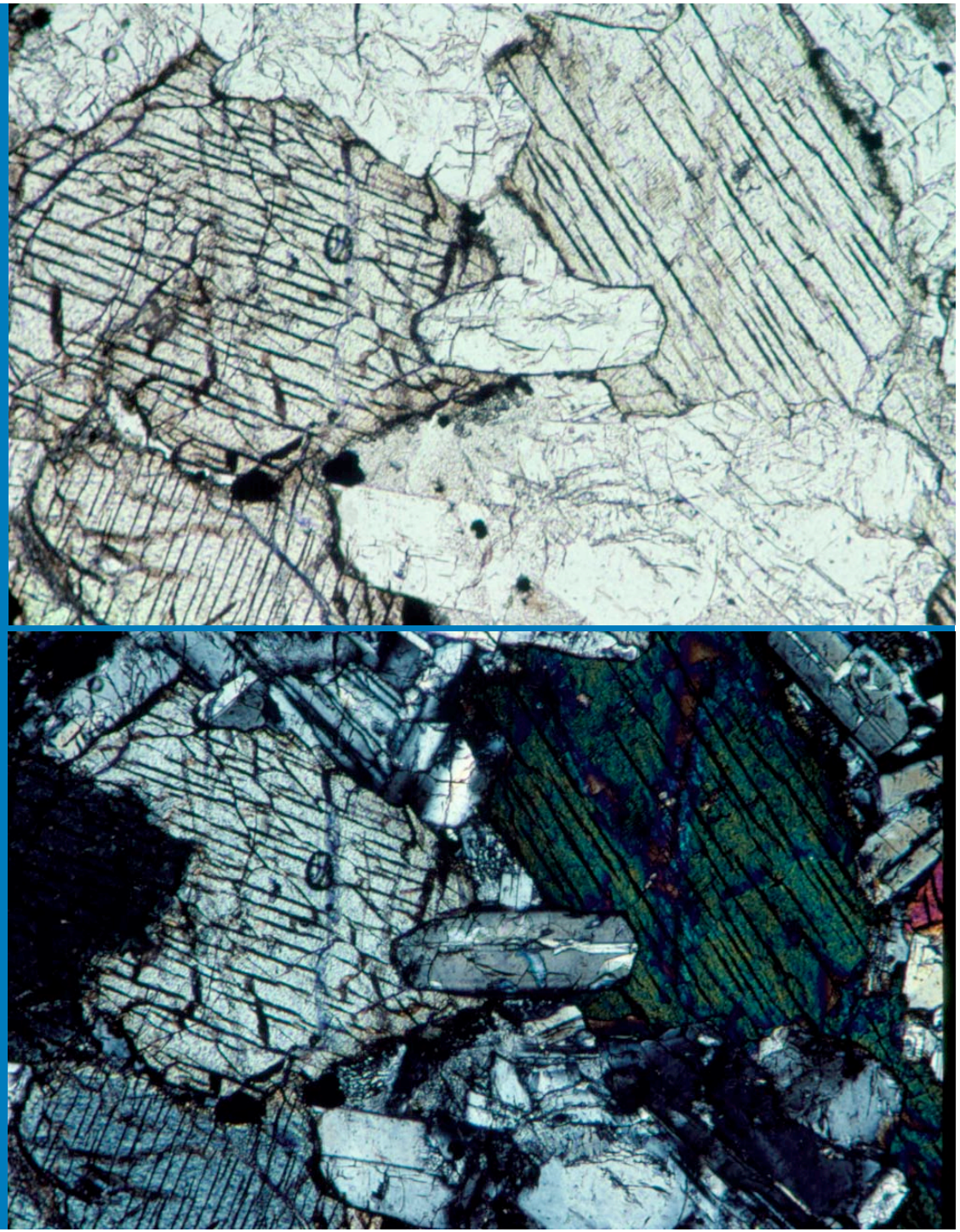
- Pyroxene has two cleavages at 87°. True angle seen in sections cut normal to the c-axis.
- Sections cut parallel to the C-axis will show one direction of cleavage.



Ophitic microstructure (dolerite) plagioclase is included in large pyroxene crystals.

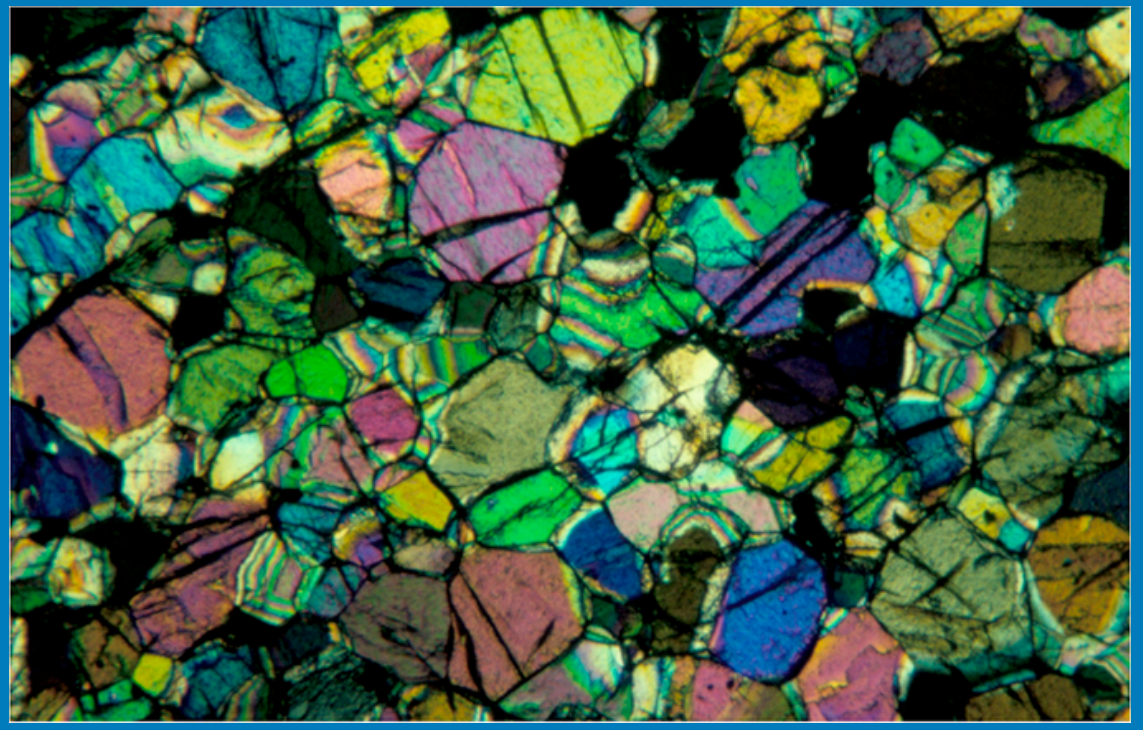


Close up of plagioclase partly included in pyroxene in sub-ophitic dolerite.
Top PPL,bottom is XP
This pyroxene is colourless with high relief (cleavage shows clearly).
The two grains on the left have interference colours towards the lower end of the range.



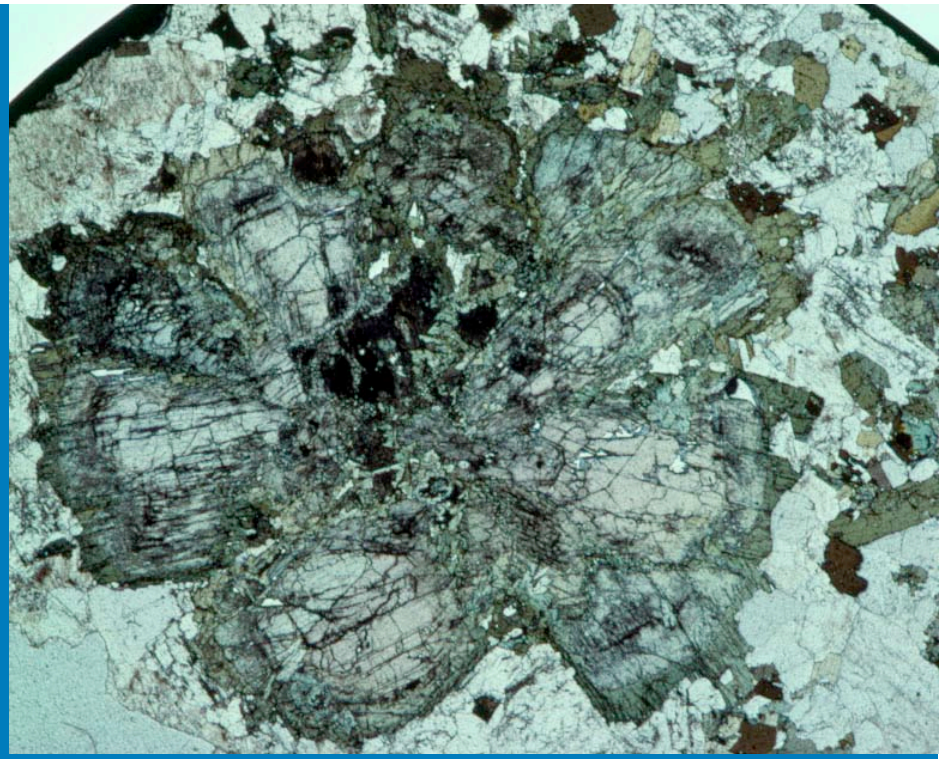
Eclogite (ultra high grade meta-basalt) with pyroxene and garnet (black)

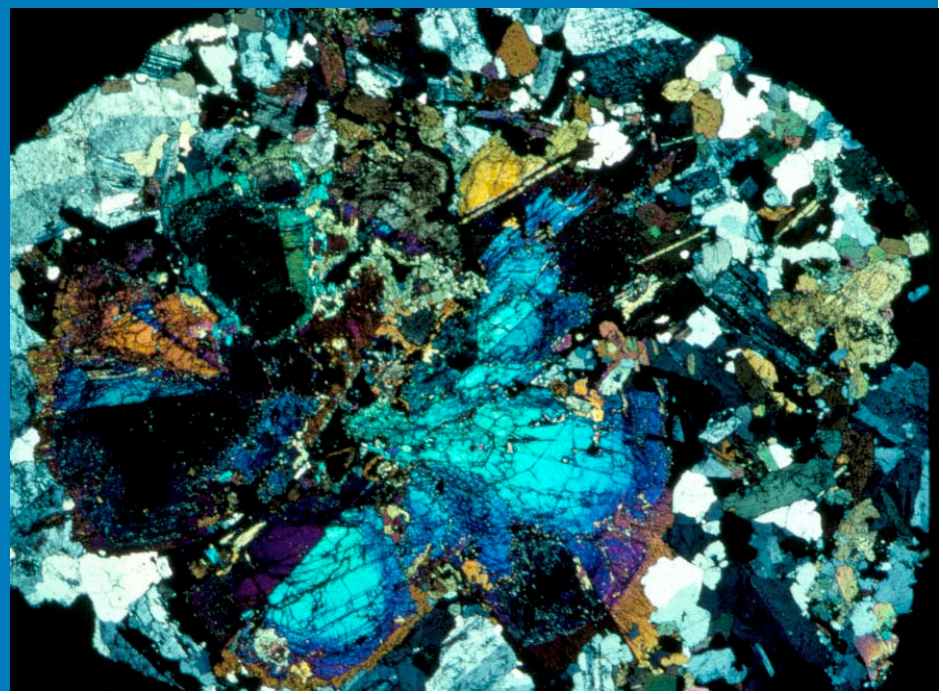
The pyroxene in eclogite is A solid solution between Augite and jadeite



Radiating aggregate of pyroxene in quartz monzonite with hornblende forming a rim around the pyroxene. Typical bright interference colours of clinopyroxene.

Clinopyroxene exhibits inclined extinction for most grains with one cleavage. Most orthopyroxene grains show straight or parallel extinction (black under X-polars) when cleavage (one) is N-S or E-W





Pyroxene in Meta-basalts.

- At Broken Hill some metabasalts in zone 2 have clinopyroxene but it is only at the highest grade (Zone 3) that hornblende starts to react out to produce orthopyroxene and clinopyroxene.

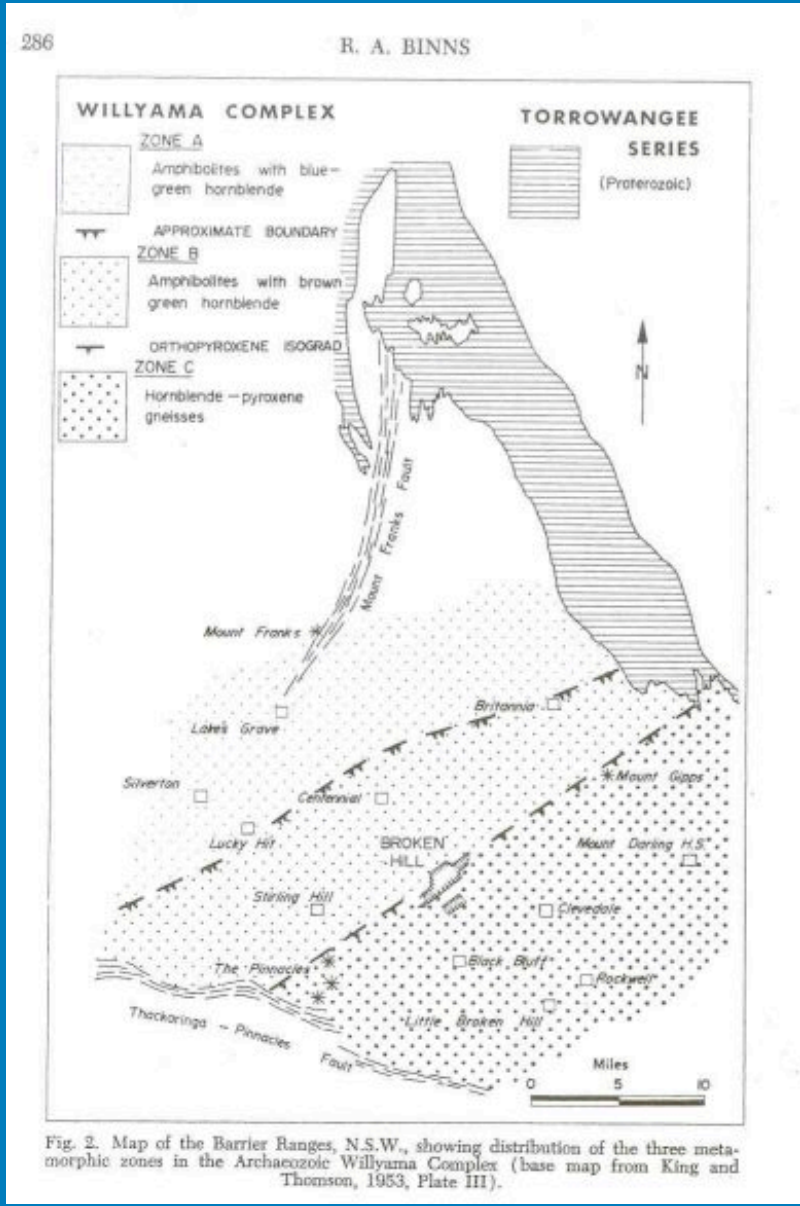


Fig. 2. Map of the Barrier Ranges, N.S.W., showing distribution of the three metamorphic zones in the Archaeozoic Willyama Complex (base map from King and Thomson, 1953, Plate III).

Olivine $(Mg,Fe)_2SiO$

- Mg_2SiO_4 is forsterite (Fo); Fe_2SiO_4 is fayalite (Fa).Complete solid solution.
- Mantle olivine is about Fo90-93.
- Basalts, gabbros have olivine Fo80-40.
- Rare dolerites, ferrogabbros and syenites have fayalite (pale yellow in thin section).
- Meta-dolomitic limestone has Fo100 (dolomite + quartz → forsterite + calcite + CO_2)
- Meta banded iron formations Fa100,
- Fo-rich olivine does not co-exist with quartz. Fa-rich does.
- Olivine is not stable in a low temp. wet environment and is replaced by serpentine. This replacement is commonly pseudomorphous (cracks).