Regional Metamorphism of pelitic rocks

- Pelites are derived from clay rich sediments and are of significant importance because they develop wide range of distinctive minerals

Shales and Mudstones

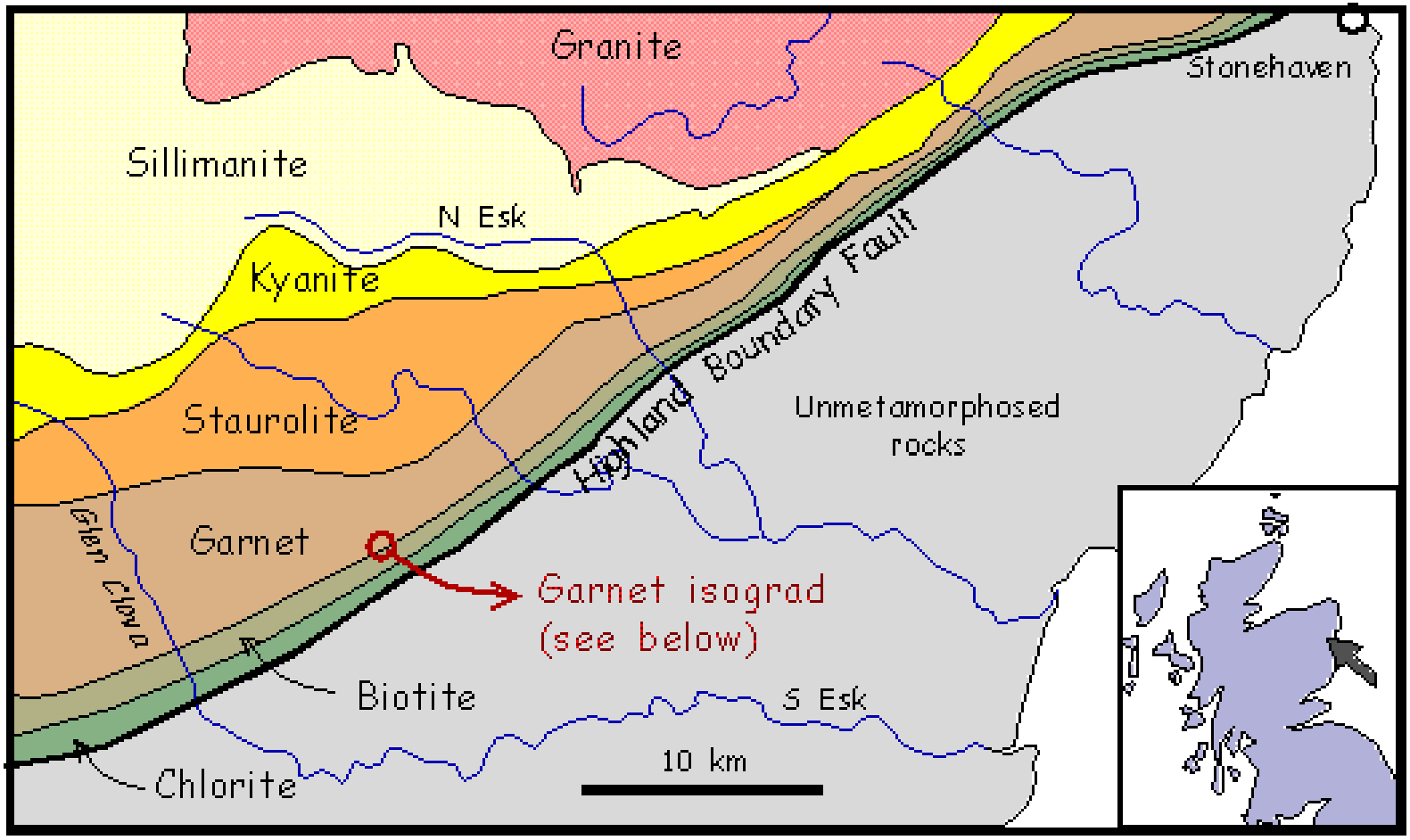
- Very fine grained mature clastic sediments derived from continental crust. Although begin as humble mud, metapelites represent a distinguished family of metamorphic rocks, because the clays are very sensitive to variations in temperature and pressure,

- Mineralogy of pelitic sediments is dominated by fine Al-K-rich phyllosilicates, such as clays (montmorillonite, kaolinite, or smectite), fine white micas and chlorite, all of which may occur as detrital or authigenic grains
- Phyllosilicates may compose more than 50% of the original sediment
- Fine quartz constitutes another 10-30%
- Other common constituents include feldspars (albite and Kfeldspar), iron oxides and hydroxides, zeolites, carbonates, sulfides, and organic matter
- Distinguishing chemical characteristics: high Al_2O_3 & K_2O, and low CaO

Metapelites contain the following mineral assemblage:

- **Mica (Muscovite, biotite), pyrophyllite, chlorite, chloritoid,**
- **Feldspars (plagioclase and K-feldspars)**
- **Garnet, staurolite, cordierite**
- **Al-silicate (andalusite, Kyanite, and sillimanite)**
- **Quartz, orthopyroxene, spinel**

The classical zones of metamorphism in the Scottish Highlands and many other parts of the world include six distinct mineral assemblages that occur in the metapelites.



Metamorphic mineral zones in NE Scotland, after Barrow and Tilley

I- Chlorite zone

- Metapelites of the chlorite zone are very fine-grained slates, so it makes difficult to investigate under the microscope,
- They tyically contain mineral assemblage: chlorite + Mg-Fe-bearing muscovite (phengitic) + quartz + Na-plagioclase (albite) ± K-feldspars ± stilpnomelane ± calcite.

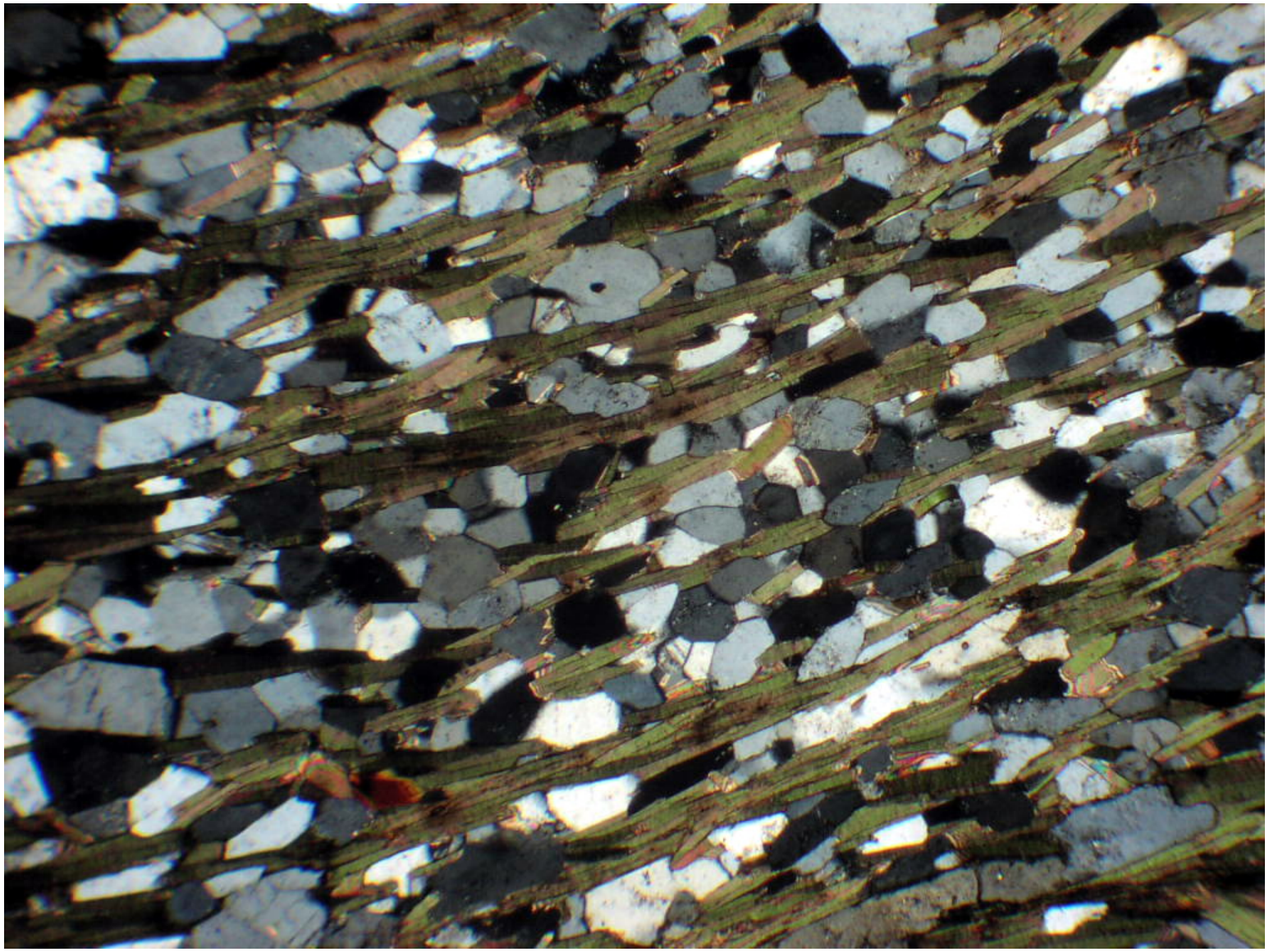
II- Biotite zone

- Metapelites of the biotite zone are defined by first appearance of biotite through one of two mineral reactions (depending upon the presence or absence of K –feldspar):

K-feldspar + chlorite ☐ biotite + muscovite + quartz + H_2O

Phengitic Ms + chlorite ☐ biotite + phengitic-poor Ms + quartz + H_2O

- They are typically Phyllite and contain mineral assemblage: chlorite + muscovite + biotite + quartz + Na-plagioclase (albite) ± calcite.

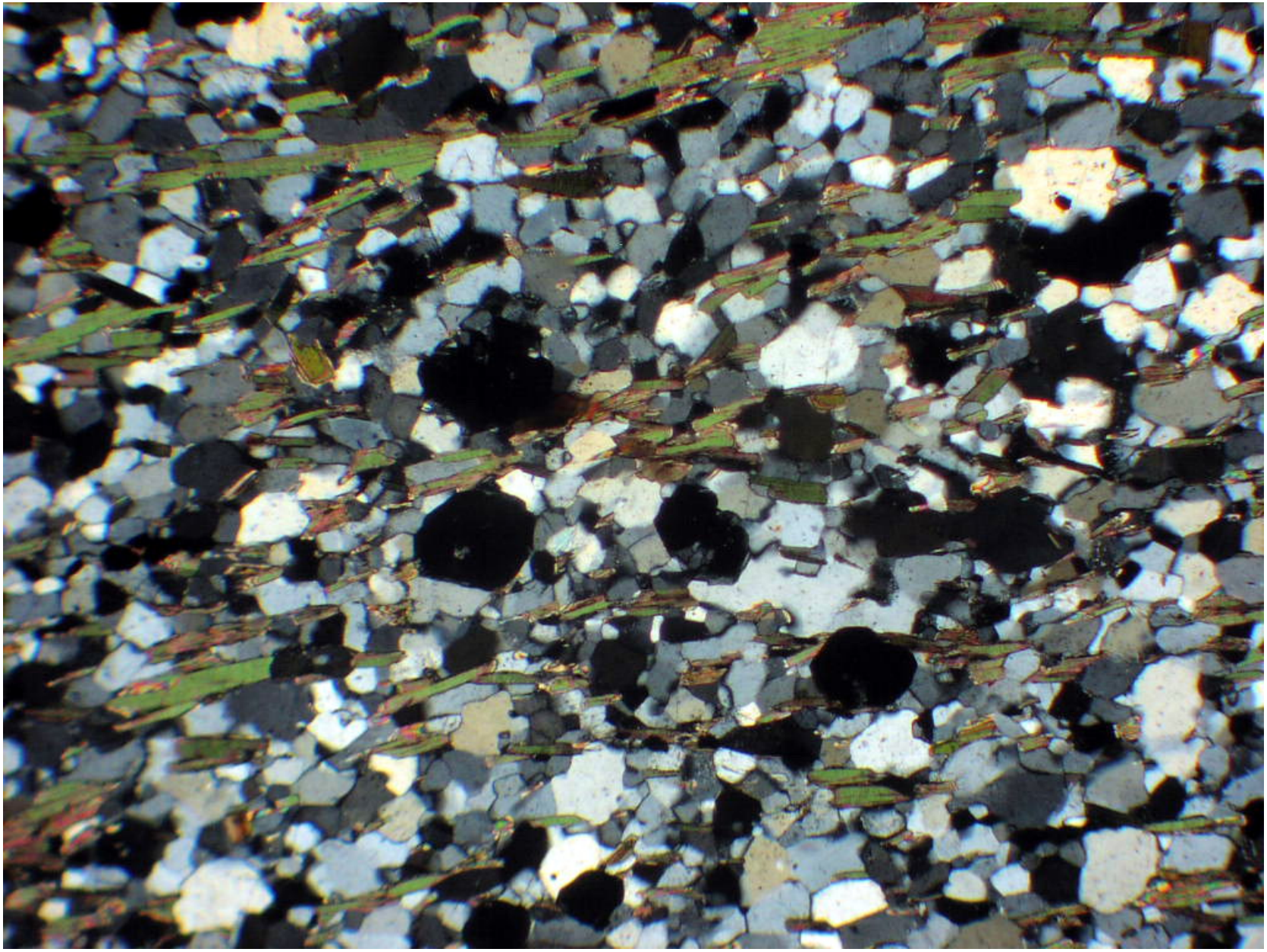


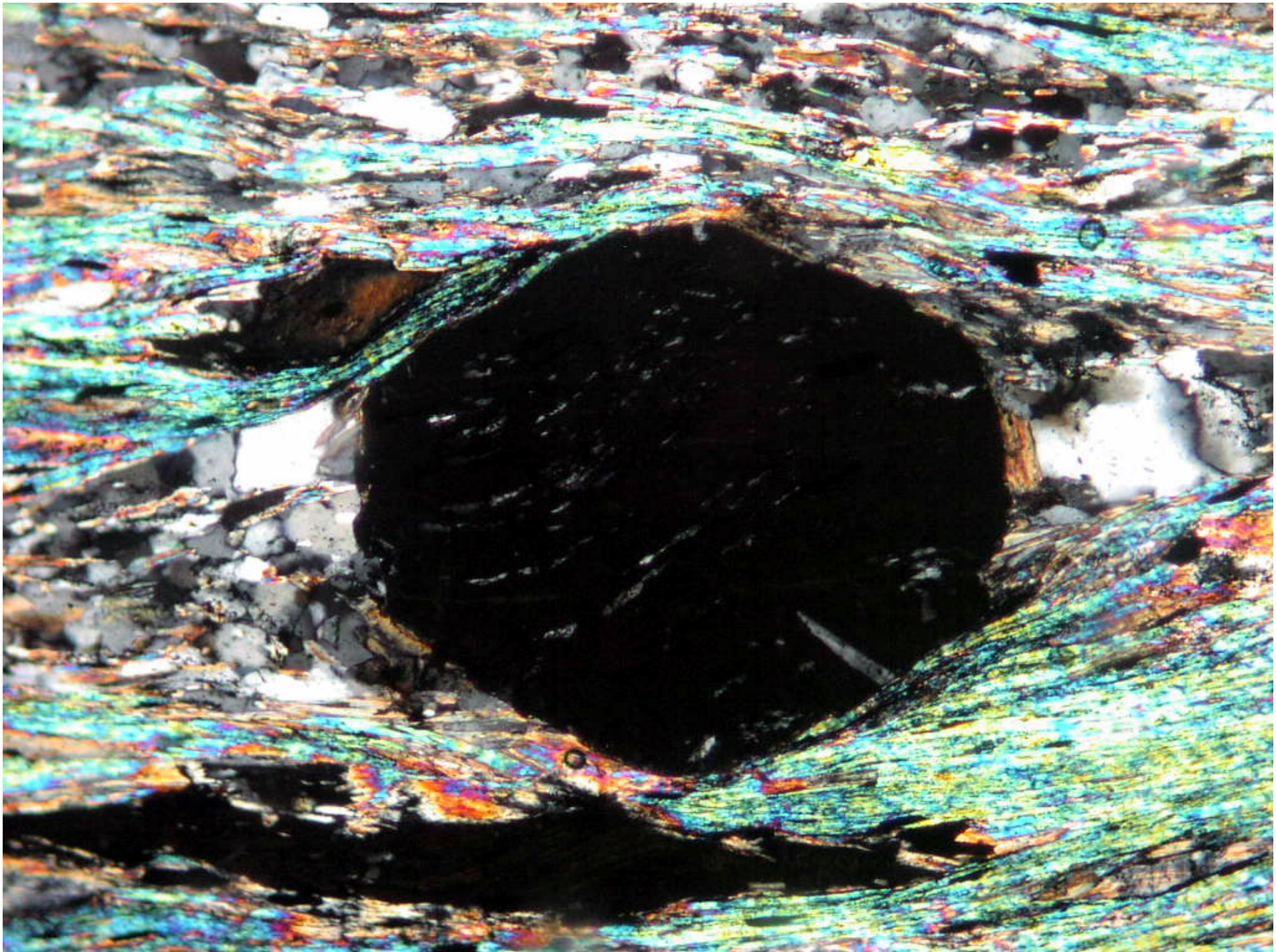
III- Garnet zone

Metapelites of the garnet zone are defined by first appearance of garnet porphyroblasts (Fe-rich almandine) through the following mineral reaction:

Chlorite + muscovite □ garnet + biotite + quartz + H_2O

They are typically medium to coarse grained schists and contain mineral assemblage: garnet + biotite + chlorite + quartz + Na-plagioclase (albite) ± epidote.





IV- Staurolite zone

- **Staurolite is only form in Al-rich, Ca-poor pelites.**
- **staurolite forming through the following mineral reaction:**

Chld + Qtz ☐ St + Grt + H_2O

Grt + Ms + Chl ☐ St + Bt + Qtz + H_2O (Grt consuming reaction)

Ms + Chl ☐ St + Bt + Qtz + H_2O

They are typically medium to coarse grained schists and contain mineral assemblage: staurolite + garnet + biotite + muscovite + quartz + plagioclase ± chlorite (retrograde).

V- Kyanite zone

- **Kyanite zone is typified by the range of the assemblages:**

Ky + St + Bt + Ms + Qtz, Ky + Grt + Bt + Ms + Qtz,

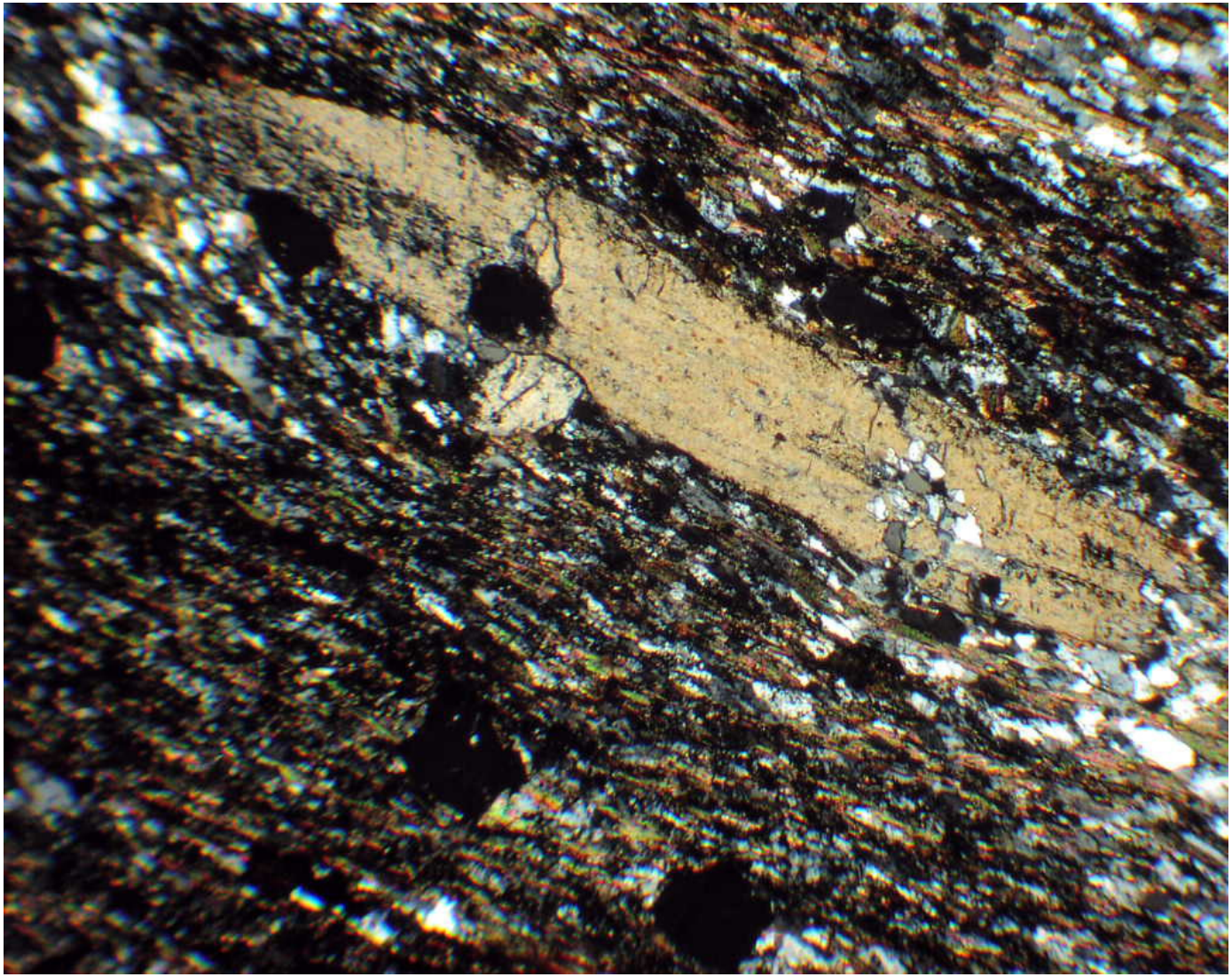
Ky + Grt + St + Bt + Ms + Qtz, Ky + Bt + Ms + Qtz

Kyanite formed through the reaction:

$$Ms + St + Chl \square Ky + Bt + Qtz + H_2O$$

$$Ms + St + Qtz \square Ky + Bt + H_2O$$

They are typically coarse grained schists and contain above mentioned diagnostic mineral assemblage.



V- Sillimanite zone

- this zone is the highest zone in the Barrovian series
- It characterize by presence of Sillimanite in the form of fibrolite, and/or coarse prismatic crystals. It could form as Psedudomorph of andalusite via solid-solid reaction And□ □Sill
- Sillimanite coud also formed as a result of the following reaction:

$$St + Ms + Qtz \square Grt + Bt + Sill + H_2O$$

$$Ms + St + Chl \square Bt + Sill + H_2O$$

They are typically coarse grained schists/gneisses and contain mineral assemblage of Sill ± St + Grt + Bt + Ms + Qtz + Pl ± Ky.