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 Al2O3 & K2O, 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.
I- Chlorite zone

- Metapelites of the chlorite zone are very fine-grained slates, so it makes difficult to investigate under the microscope,

- They typically 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$_2$O

  Phengitic Ms + chlorite □ biotite + phengitic-poor Ms + quartz + H$_2$O

- 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:

\[
\text{Chlorite + muscovite} \rightarrow \text{garnet + biotite + quartz + H}_2\text{O}
\]

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:

\[
\text{Chld} + \text{Qtz} \to \text{St} + \text{Grt} + \text{H}_2\text{O}
\]

\[
\text{Grt} + \text{Ms} + \text{Chl} \to \text{St} + \text{Bt} + \text{Qtz} + \text{H}_2\text{O} \text{ (Grt consuming reaction)}
\]

\[
\text{Ms} + \text{Chl} \to \text{St} + \text{Bt} + \text{Qtz} + \text{H}_2\text{O}
\]

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:

\[
\begin{align*}
\text{Qtz}, & \quad \text{Ky} + \text{St} + \text{Bt} + \text{Ms} + \text{Qtz}, \\
\text{Ky} + \text{Grt} + \text{St} + \text{Bt} + \text{Ms} + \text{Qtz}, & \quad \text{Ky} + \text{Grt} + \text{Bt} + \text{Ms} + \\
\text{Ky} + \text{Grt} + \text{St} + \text{Bt} + \text{Ms} + \text{Qtz}, & \quad \text{Ky} + \text{Bt} + \text{Ms} + \text{Qtz}
\end{align*}
\]

Kyanite formed through the reaction:

\[
\begin{align*}
\text{Ms} + \text{St} + \text{Chl} & \quad \square \quad \text{Ky} + \text{Bt} + \text{Qtz} + \text{H}_2\text{O} \\
\text{Ms} + \text{St} + \text{Qtz} & \quad \square \quad \text{Ky} + \text{Bt} + \text{H}_2\text{O}
\end{align*}
\]

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\[\square\]Sill
- Sillimanite could also formed as a result of the following reaction:
  \[\text{St + Ms + Qtz} \square \text{Grt + Bt + Sill} + \text{H}_2\text{O}\]
  \[\text{Ms + St + Chl} \square \text{Bt + Sill} + \text{H}_2\text{O}\]

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