Practical Igneous rocks(II) course

For

3rd-year Geology, Geophysics, and Geology& Chemistry students

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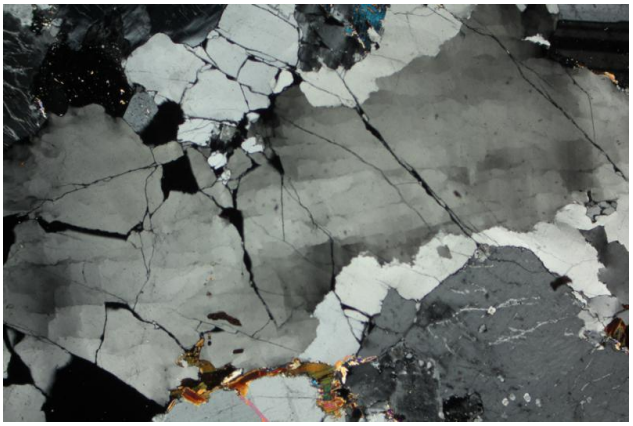
Timetable of course

Week	content
1	Revision on characteristic minerals of igneous rocks
2	Revision on characteristic textures of igneous rocks
3	Study of igneous rocks Handspecimens
4	Petrographic study of Plutonic acidic igneous rocks (Granites)
5	
6	Petrographic study of volcanic acidic igneous rocks (Rhyolites and dacites)
7	Petrographic study of intermediate igneous rocks (diorites and andesites family)
8	
9	Petrographic study of intermediate igneous rocks (syenites and trachytes)
10	Petrographic study of mafic igneous rocks (Gabbros and basalts)
11	Petrographic study of ultramafic igneous rocks (Peridotites)
12	Revision

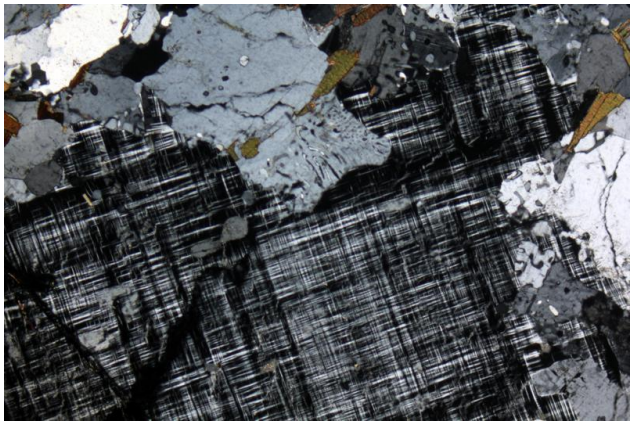
Week (1)

The characteristic minerals of igneous rocks



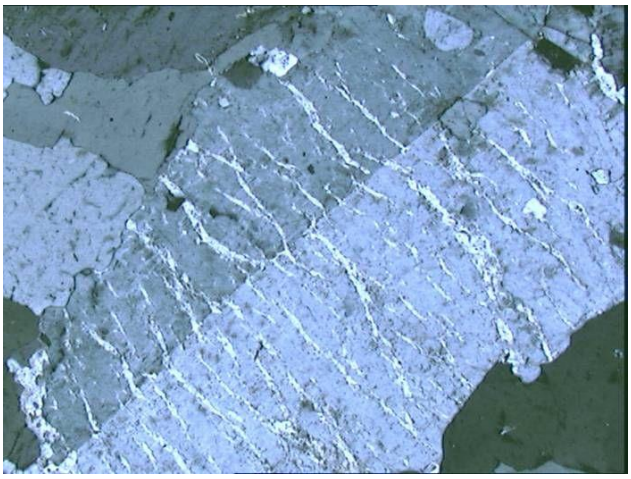
Quartz in granite. XPL image , 10x (Field of view = 2mm)

Plagioclase in andesite. XPL image , 10x (Field of view = 2mm)



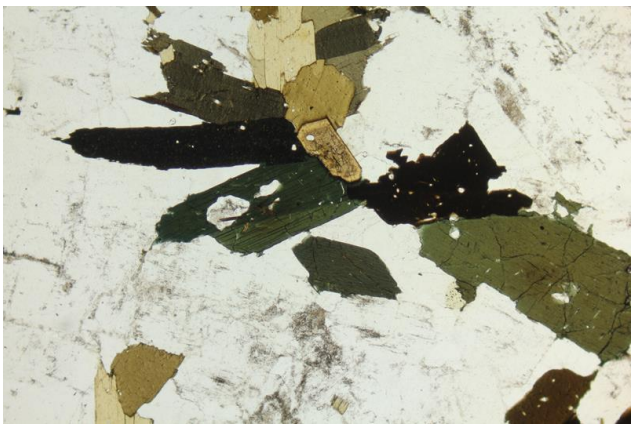
Cross-hatched twinning in microcline. XPL image, 10x (Field of view = 2mm)

orthoclase (perthitic) crystals in granite. XPL image , 2x (Field of view = 7mm

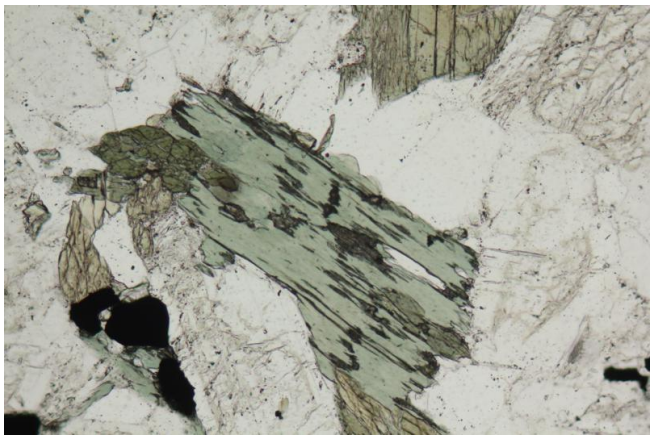


Sanidine crystals in a Trachyte. XPL image , 2x (Field of view = 7mm

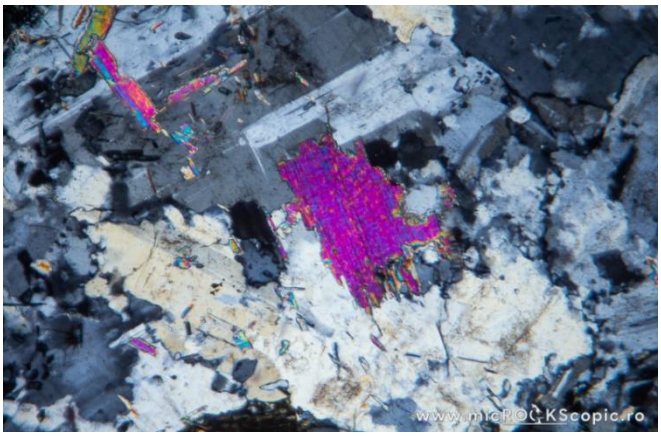
Hornblende (green) and biotite (brown) crystals in granite. PPL image , 2x (Field of view = 7mm)



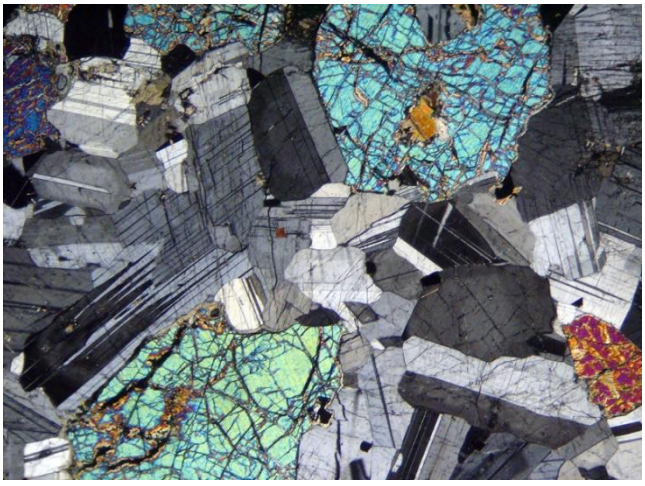
Biotite was replaced by chlorite (pale green). PPL image, 2x (Field of view = 7mm)



Muscovite crystal with high interference color in the granite. XPL image, 2x (Field of view = 7mm)



Olivine and plagioclase in a troctolite. XPL image , 2x (Field of view = 7mm)



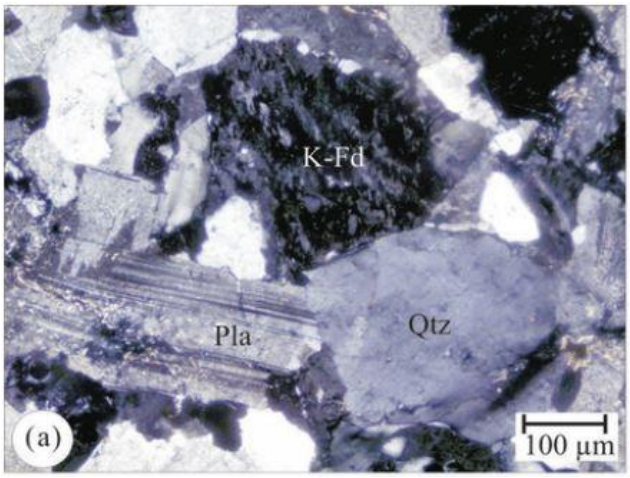
orthopyroxene in a gabbro. XPL image

Clinopyroxene crystals in a gabbro. XPL image, 2x (Field of view = 7mm)

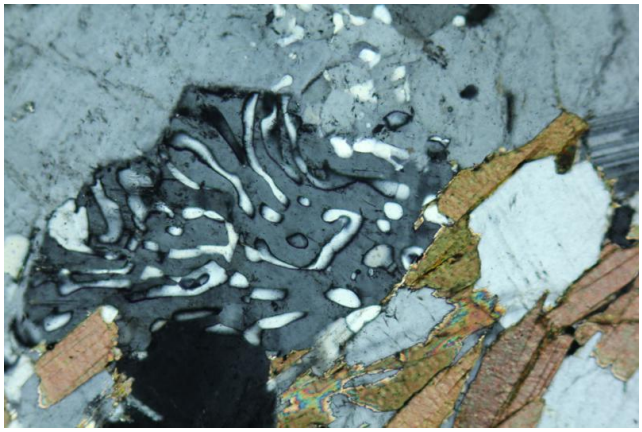
Week (2)

The characteristic textures of igneous rocks

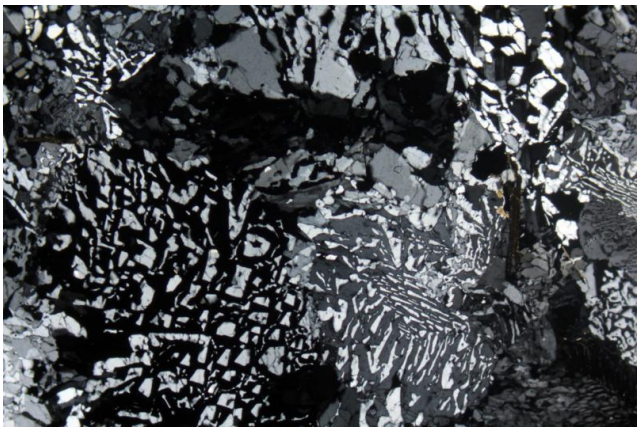
Hypidomorphic texture:- **most of the grains are subhedral - that is they are bounded by only a few well-formed crystal faces.**



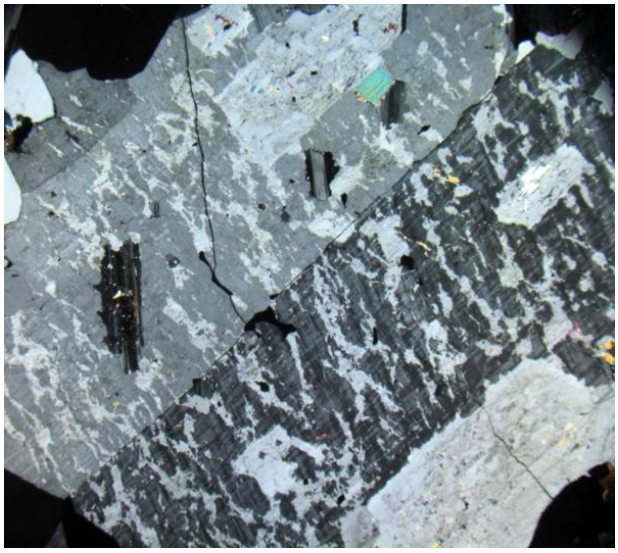
Myrmekite texture:- **an intergrowth of worm-like quartz crystals in a single crystal of plagioclase. XPL image. 10x (Field of view = 2mm)**



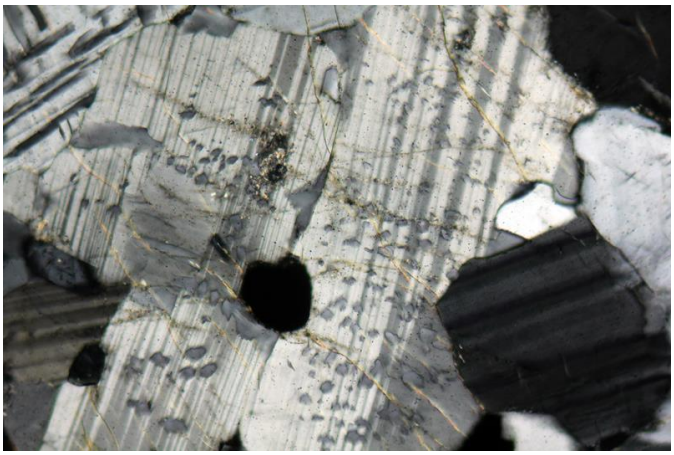
Granophyric texture:- **intergrowths of quartz and alkali feldspar as runic inscriptions on the feldspar. XPL image. 2x (Field of view = 7mm)**



Perthitic texture:- **A perthite occurs as blebs or irregular lamellae resulting from the exsolution (unmixing) of sodic feldspar on the background of potassic alkali feldspar. XPL image. 10x (Field of view = 2mm)**



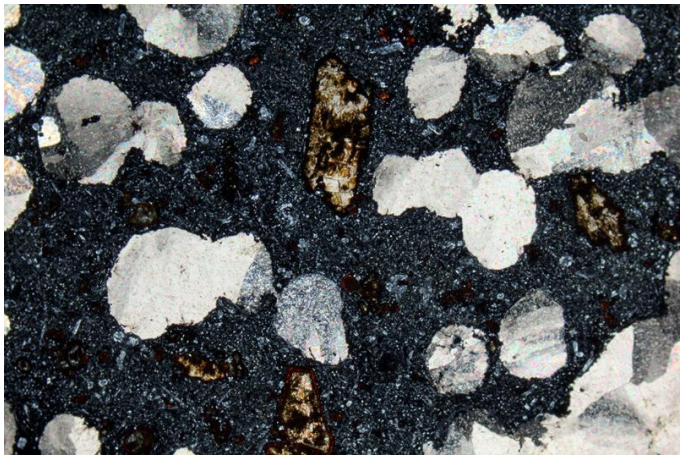
Antiperthitic texture:- **an intergrowth of orthoclase (often as lamellae) enclosed in a plagioclase host also resulted from minerals unmixing. XPL image. 10x (Field of view = 2mm)**



Porphyritic texture:- **coarse-grained crystals called phenocrysts existed in the fine-grained or glassy groundmass. XPL image, 2x (Field of view = 7mm).**

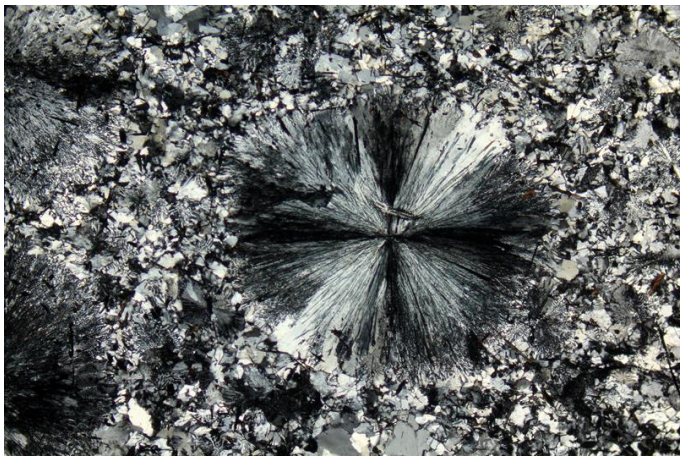
Amygdaloidal texture:- **Amygdales occur when the gas bubbles or vesicles are infilled with a number of different secondary minerals.**

Ex. Calcite filling amygdales in a Basalt. XPL image, 2x (Field of view = 7mm).



Spherulitic texture:- **spherulites are radiating arrays of fibrous, needle-like, or acicular crystals that are common in glassy felsic volcanic rocks. Spherulites are typically two-mineral aggregates (mainly quartz and feldspar).**

XPL image, 2x (Field of view = 7mm)

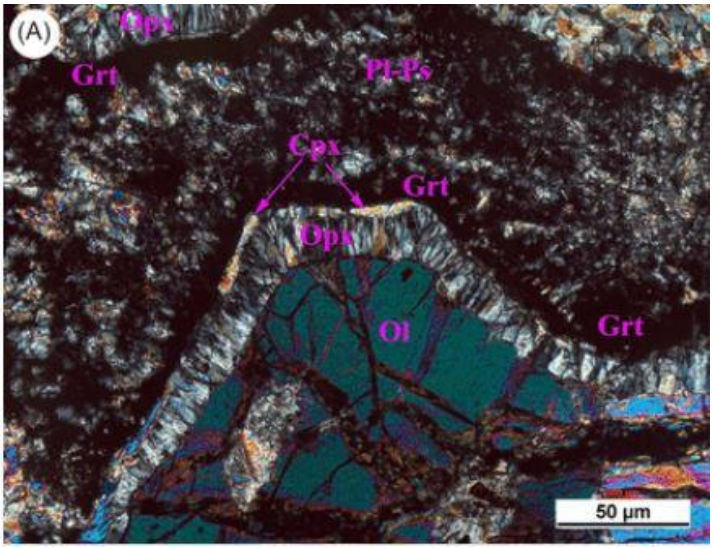


Trachytic texture:- **is a characteristic texture of trachytes in which the fine crystals of groundmass were arranged along the directions of the lava flow.**

XPL image, 10x (Field of view = 2mm)

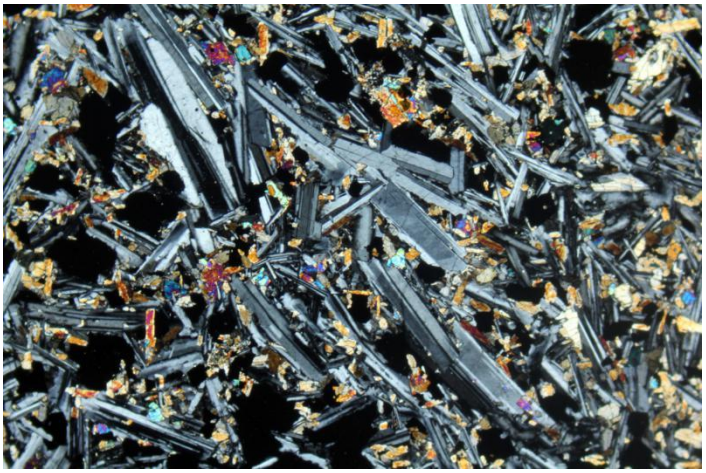
Corona texture:- it is several concentric rims of one or more minerals completely encircling an older phase. These rims represent a sequence of reactions that have taken place (none to completion) to replace the mineral in the core or center of the corona.

The image shows rims of Cpx and Opx minerals surrounding olivine around the igneous olivine.

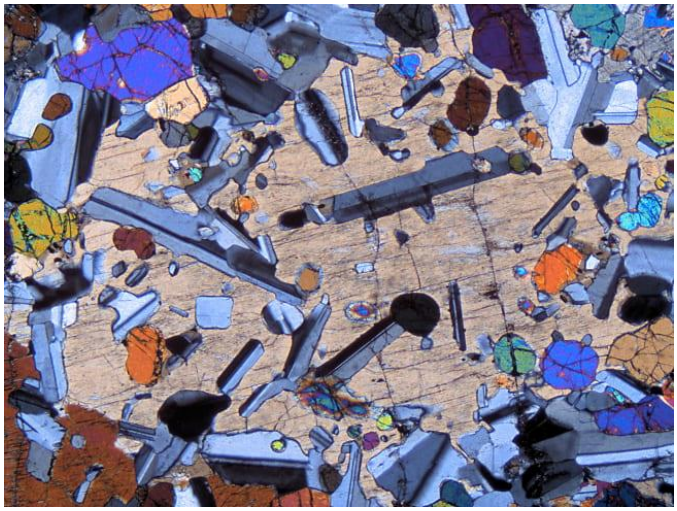


intergranular texture:- when the spaces between the angular interstices of plagioclase laths are occupied by ferromagnesian minerals, the texture is called intergranular, but if they are occupied by a glassy matrix called intersertal.

Both the intergranular and intersertal texture of basalt. XPL image , 2x (Field of view = 7mm)



Ophitic & subophitic:- ophitic texture occurs when plagioclase laths are completely enclosed by pyroxene or olivine. If they are partially enclosed by olivine or pyroxene, they form a subophitic texture.



Week (3)

Study of igneous rocks Handspecimens

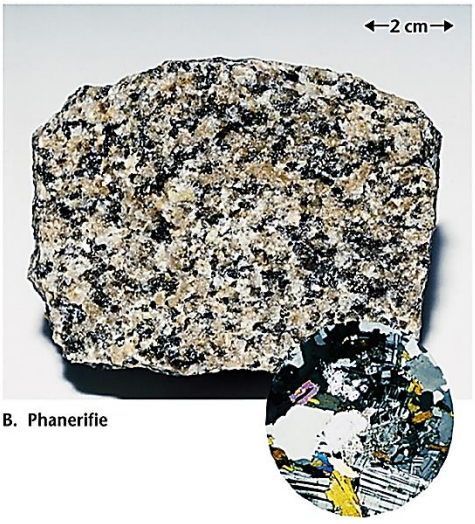
1. Grain sizes of igneous rocks

- Aphanitic ⟶ fine-grained
- Phaneritic ⟶ coarse-grained
- Porphyritic ⟶ coarse-grained crystals in a fine-grained groundmass
- Pegmatitic ⟶ very coarse-grained (grain size > 2 cm)
- Glassy ⟶ natural glass
- Vesicular ⟶ the rock consists of spherical or elliptical empty spaces.

- Aphanitic

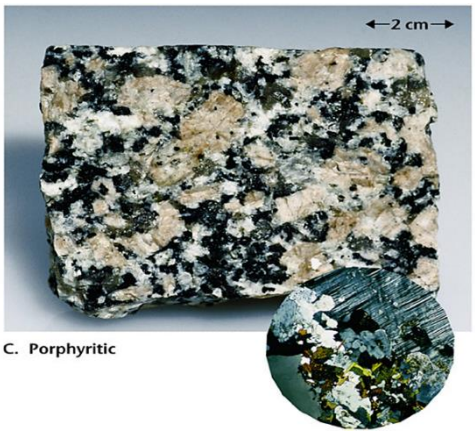
A. Aphanitic

- Phaneritic



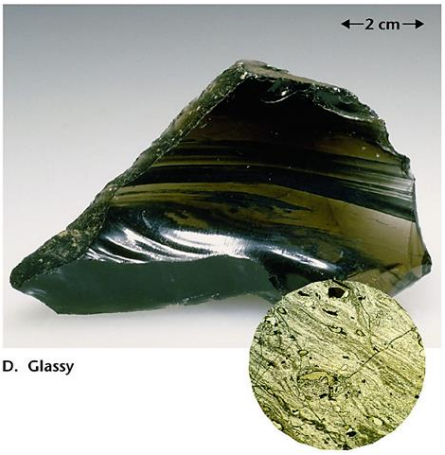
B. Phanerifie

- Porphyritic



C. Porphyritic

Glassy



D. Glassy

Pegmatitic

Vesicular

2. Rate of cooling

- Fast rate ⟶ Aphanitic
- Slow rate ⟶ Phaneritic
- Slow / Fast ⟶ Porphyritic
- Very slow ⟶ Pegmatitic
- Rapid rate ⟶ Glassy – Vesicular

3. Mode of occurrence (origin)

i. Volcanic or extrusive rocks

- Magmas that erupt onto the earth's surface cool and solidify slowly. Rapid cooling results in an aphanitic igneous texture

- If gas bubbles are escaping from the lava as it solidifies, it will end up with "frozen bubble holes, the resulting texture is said to be frothy or vesicular (pumice and scoria).

ii. Plutonic or intrusive rocks

When magma cools slowly underground and solidifies there, it usually grows crystals big enough to be seen easily with the naked eye (phaneritic or pegmatitic texture).

Hypabyssal or sub-volcanic rocks are intrusive igneous rocks that are emplaced at medium to shallow depths within the crust and have intermediate grain size and often porphyritic texture between that of volcanic rocks and plutonic rocks. Ex Diabase or Dolerite.

4. color

- The color of igneous rocks depends on the proportion of felsic minerals to mafic minerals

- rocks that contain lots of felsic minerals (feldspar and quartz) are light colored (ex:- white, pink, white gray), and rocks that contain lots of mafic minerals (pyroxenes, olivines, and amphiboles) are dark colored (ex:- dark, dark-gray), and those have a mixture of felsic and subordinate of mafic minerals are medium colored (ex:- greenish-gray)

5. Mineral composition of igneous rocks

i. Felsic (Acidic) igneous rocks comprise quartz, alkali feldspar, plagioclase, and mica
ii. intermediate igneous rocks comprise quartz, Ca-plagioclase, biotite, hornblende, and sometimes pyroxene
iii. Mafic (basic) igneous rocks comprise Ca-plagioclase, olivines, pyroxene, hornblende, biotite, and iron-oxides
iv. ultramafic (ultrabasic) igneous rocks comprise of olivines and pyroxenes

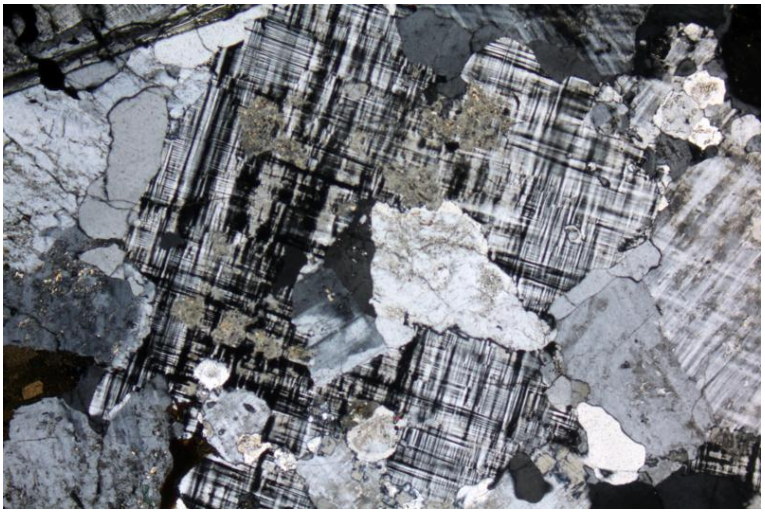
6. Chemical classification of igneous rocks

- Igneous rocks are classified based on silica percentage (SiO_2%) into: -
  i. Felsic (Acidic) igneous rocks are those containing a high silica content (SiO2 > 63%) and are rich in light minerals (quartz, feldspars). Ex: - granites
  ii. intermediate igneous rocks are those containing between 52–63% SiO2 and have a mixture of light mineral and dark minerals (biotite, hornblende). Ex: - diorites
  iii. Mafic (basic) igneous rocks are those that have low silica 45–52% and are rich in mafic minerals (olivine, pyroxene, amphiboles). ex gabbro
  iv. ultramafic (ultrabasic) igneous rocks are those that have less than 45% silica and are dominated by mafic minerals (olivine and pyroxene) ex: - peridotite

Week (4-5)

Plutonic acidic igneous rocks (Granites)

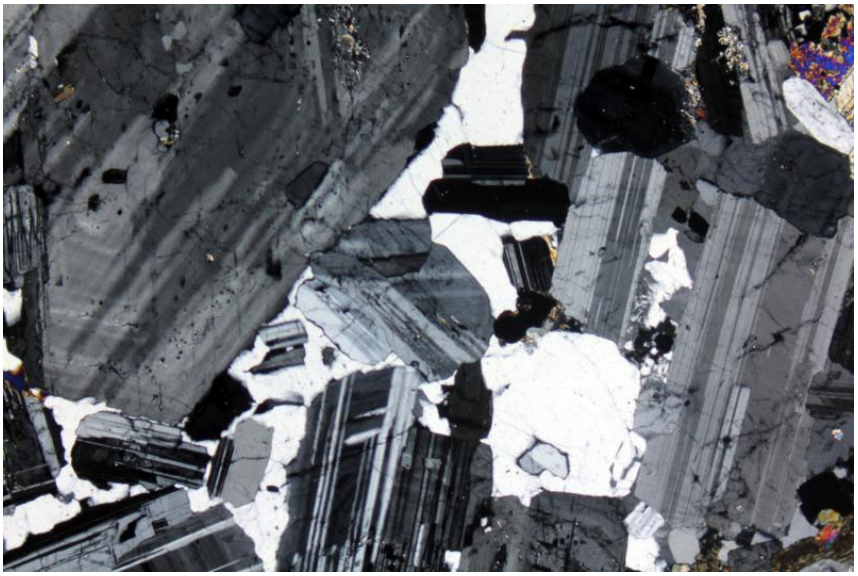
1- Alkali-feldspar granite



Quartz and microcline in alkali-feldspar granite. XPL image, 2x (Field of view = 7mm)

- **Texture:- Hpidomorphic texture**
- **Mode of occurrence:- Plutonic**
- **Mineral composition:- quartz, alkali-feldspars >90% (orthoclase, microcline), plagioclase, mica, and iron oxides**
- **Chemical composition:- Acidic**
- **Rock family:- Granites**
- **Rock name:- Alkali-feldspar granite**

2- Tonalite



Plagioclase, quartz, and biotite in a tonalite. XPL image, 2x (Field of view = 7mm)

- **Texture:- Hpidomorphic texture**
- **Mode of occurrence:- Plutonic**
- **Mineral composition:- quartz, plagioclase >90%, alkali-feldspars, mica, hornblende, sphene, and iron oxides**
- **Chemical composition:- Acidic**
- **Rock family:- Granites**
- **Rock name:- Tonalite**

3- Granodiorite

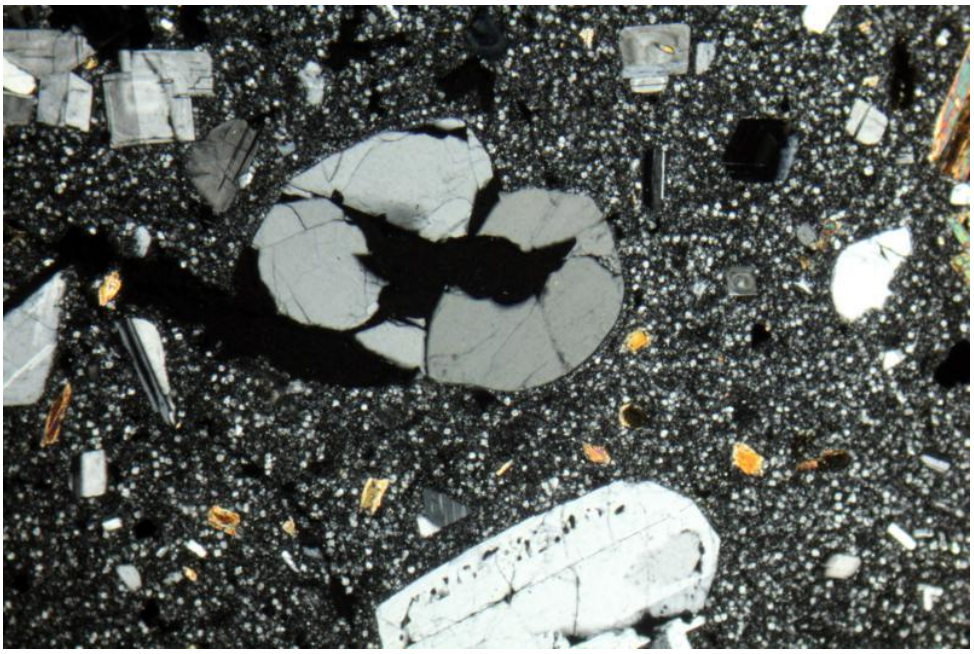
Plagioclase, quartz, alkali-feldspars, and biotite in a granodiorite. XPL image, 2x (Field of view = 7mm)

- **Texture:- Hpidomorphic texture**
- **Mode of occurrence:- Plutonic**
- **Mineral composition:- quartz, plagioclase >65%, alkali-feldspars, mica, hornblende, and iron oxides**
- **Chemical composition:- Acidic**
- **Rock family:- Granites**
- **Rock name:- Granodiorite**

Week (6)

Volcanic acidic igneous rocks (Dacites and Rhyolites)

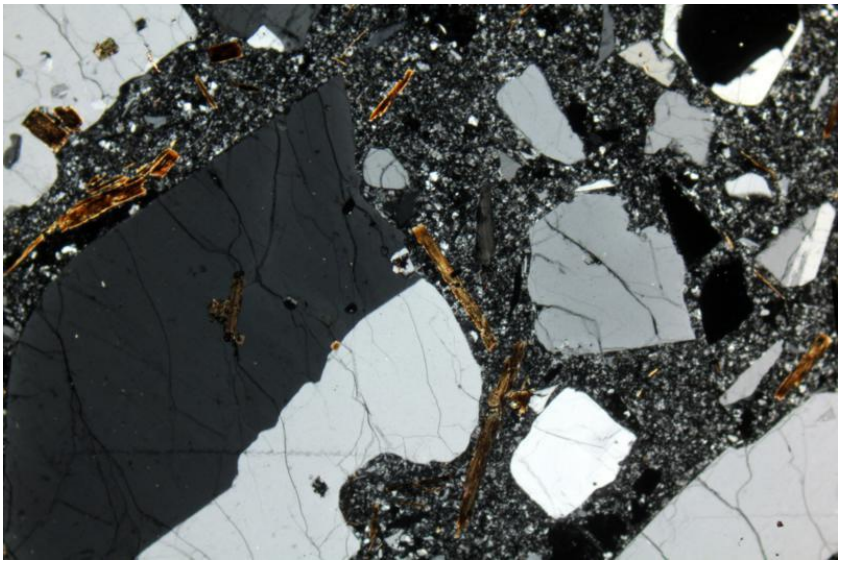
1- Dacite



Plagioclase, and quartz (rounded) in a Dacite with felsic groundmass from Bulgaria. XPL image, 2x (Field of view = 7mm))

- **Texture:- porphyritic texture**
- **Mode of occurrence:- volcanic**
- **Mineral composition:- quartz, plagioclase, mica, hornblende, and iron oxides**
- **Chemical composition:- Acidic**
- **Rock family:- Dacites**
- **Rock name:- Dacite**

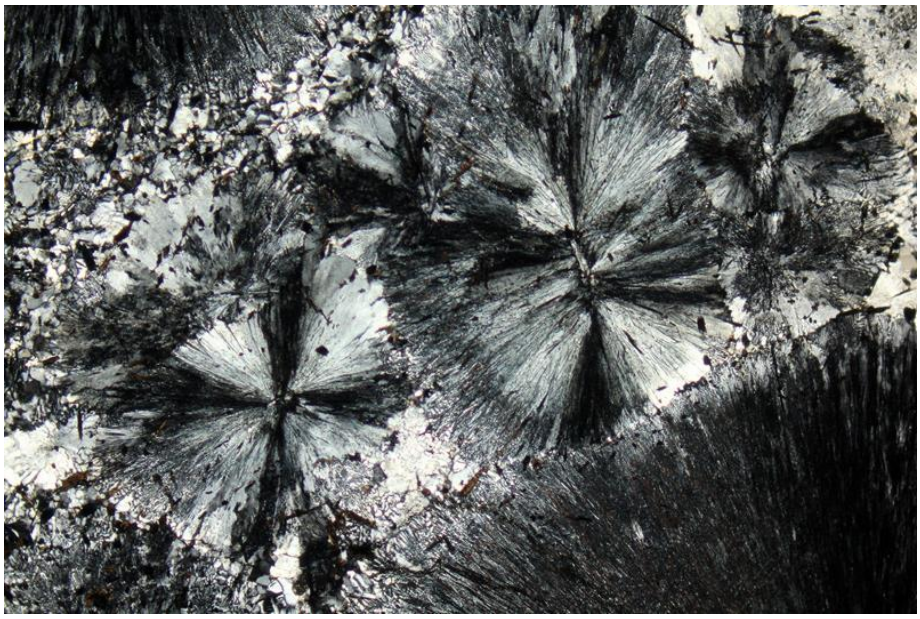
2- Porphyritic Rhyolite



Quartz and Sanidine crystal in a Rhyolite with felsic groundmass. XPL image, 2x (Field of view = 7mm)

- **Texture:- porphyritic texture**
- **Mode of occurrence:- volcanic**
- **Mineral composition:- quartz, sanidine, plagioclase, mica, and iron oxides**
- **Chemical composition:- Acidic**
- **Rock family:- Rhyolites**
- **Rock name:- Rhyolite**

3- Spherulitic Rhyolite



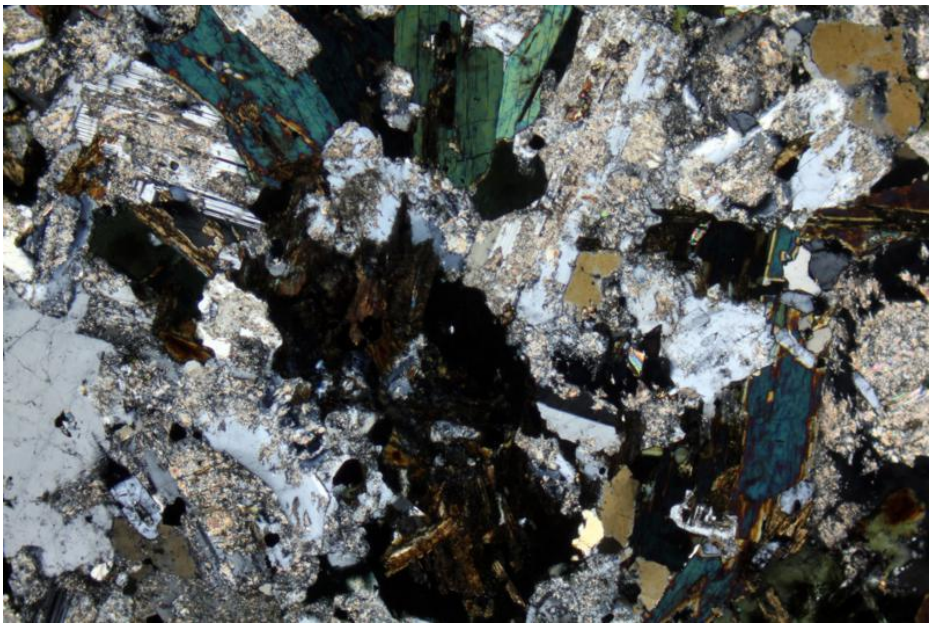
Spherulites are composed of Feldspar and quartz crystals. XPL image, 2x (Field of view = 7mm)

- **Texture:- Spherulitic texture**
- **Mode of occurrence:- volcanic**
- **Mineral composition:- quartz, alkali-feldspars, and iron oxides**
- **Chemical composition:- Acidic**
- **Rock family:- Rhyolites**
- **Rock name:- Spherulitic rhyolite**

Week (7-8)

Intermediate igneous rocks (diorites and andesites family)

1- Diorite



Hornblende and plagioclase altered by sericite in a diorite. XPL image, 2x (Field of view = 7mm)

- **Texture:- Hpidomorphic texture**
- **Mode of occurrence:- Plutonic**
- **Mineral composition:- plagioclase, hornblende, biotite, quartz, sericite, and iron oxides**
- **Chemical composition:- intermediate**
- **Rock family:- Diorites**
- **Rock name:- Diorite**

2- Andesite

Hornblende and plagioclase crystals in a Andesite. XPL image, 2x (Field of view = 7mm)

- **Texture:- porphyritic texture**
- **Mode of occurrence:- Volcanic**
- **Mineral composition:- plagioclase, hornblende, biotite, quartz, and iron oxides**
- **Chemical composition:- intermediate**
- **Rock family:- Andesites**
- **Rock name:- Andesite**

Week (9)

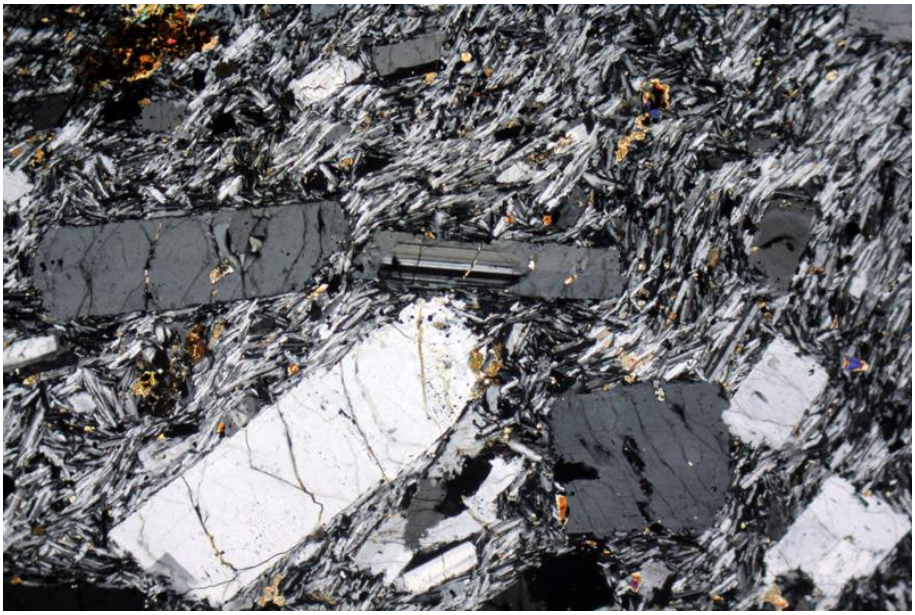
Intermediate igneous rocks (Syenites and Trachytes family)

1- Syenite

Orthoclase perthite in syenite. XPL image. 10x (Field of view = 2mm)

- **Texture:- Hpidomorphic, Granophyric, and perthitic textures**
- **Mode of occurrence:- Plutonic**
- **Mineral composition:- orthoclase perthite, biotite, quartz, and iron oxides**
- **Chemical composition:- intermediate**
- **Rock family:- Syenites**
- **Rock name:- Syenite**

2- Trachyte



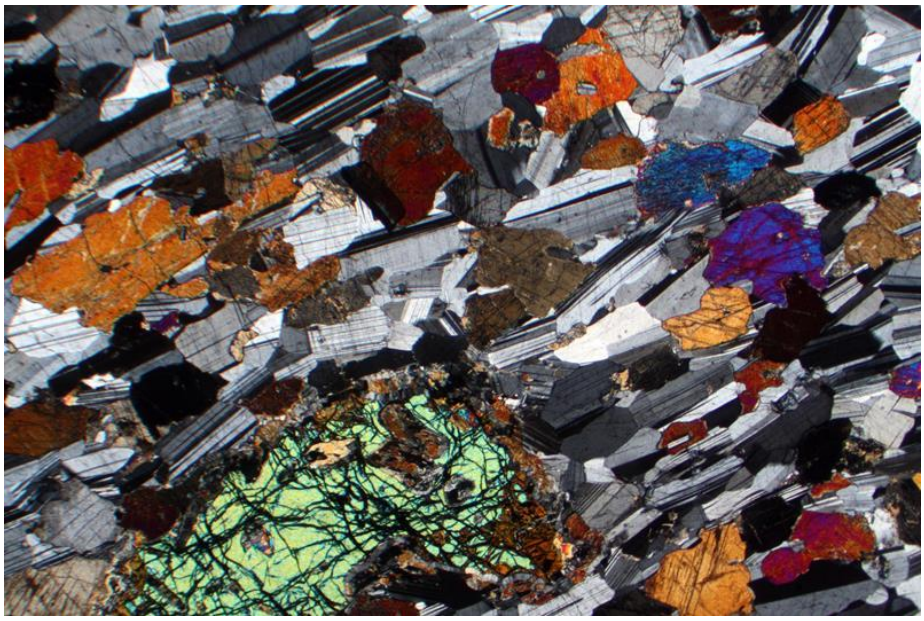
Sanidine and plagioclase in trachyte. XPL image, 10x (Field of view = 2mm)

- **Texture:- Trachytic or flow texture**
- **Mode of occurrence:- volcanic**
- **Mineral composition:- sanidine, biotite, quartz, and iron oxides**
- **Chemical composition:- intermediate**
- **Rock family:- Trachytes**
- **Rock name:- Trachyte**

Week (10)

Mafic igneous rocks (Gabbros and Basalts family)

1- Gabbro



clinopyroxene, plagioclase, and olivine crystals in Gabbro. XPL image, 1x (Field of view = 9mm)

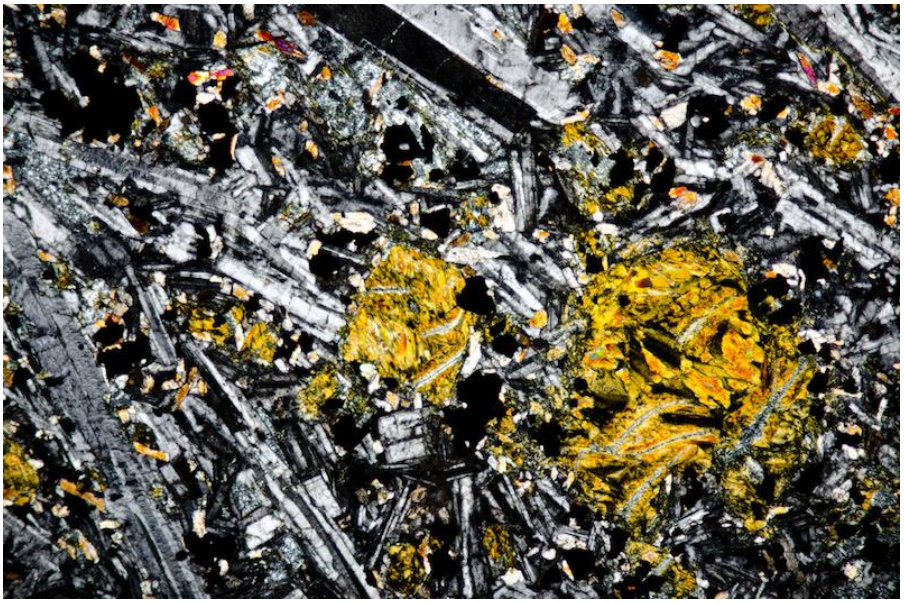
- **Texture:- Hpidomorphic, corona, ophitic and subophitic textures**
- **Mode of occurrence:- Plutonic**
- **Mineral composition:- plagioclase, pyroxene, olivine, and hornblende**
- **Chemical composition:- Mafic**
- **Rock family:- Gabbros**
- **Rock name:- Gabbro**

2- Basalts

Plagioclase laths, pyroxene, and olivine crystals within a fine-grained groundmass. XPL image, 2x (Field of view = 7mm)

- **Texture:- intergranular, intersertal, ophitic, and subophitic textures**
- **Mode of occurrence:- Volcanic**
- **Mineral composition:- plagioclase, pyroxene, and olivine**
- **Chemical composition:- Mafic**
- **Rock family:- Basalts**
- **Rock name:- Basalt**

3- Diabase



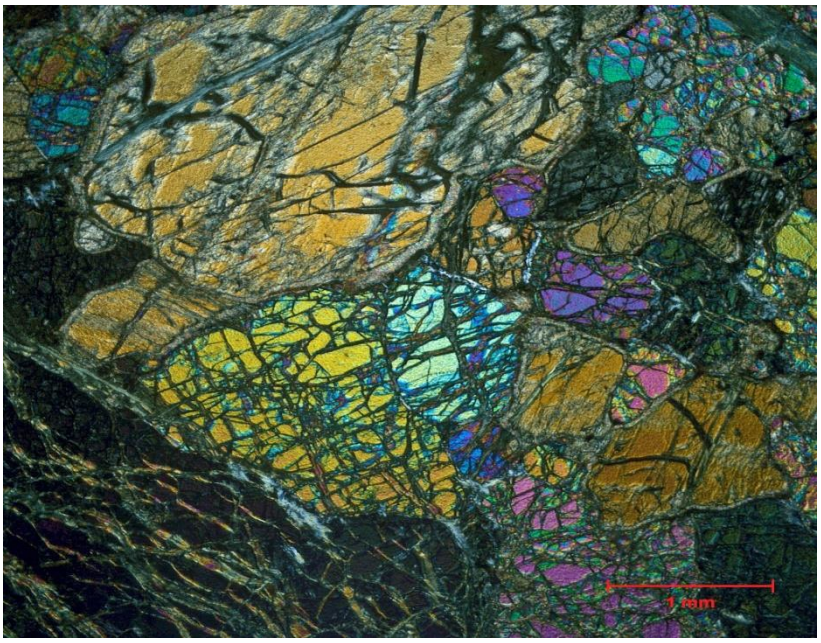
Plagioclase, pyroxene, and olivine crystals in diabase. XPL image, 2x (Field of view = 7mm)

- **Texture:- Diabasic, intersertal, ophitic, and subophitic textures**
- **Mode of occurrence:- Hypabyssal or subvolcanic**
- **Mineral composition:- plagioclase, pyroxene, and olivine**
- **Chemical composition:- Mafic**
- **Rock family:- Diabases**
- **Rock name:- Diabase**

Week (10)

Ultramafic igneous rocks (Peridotites family)

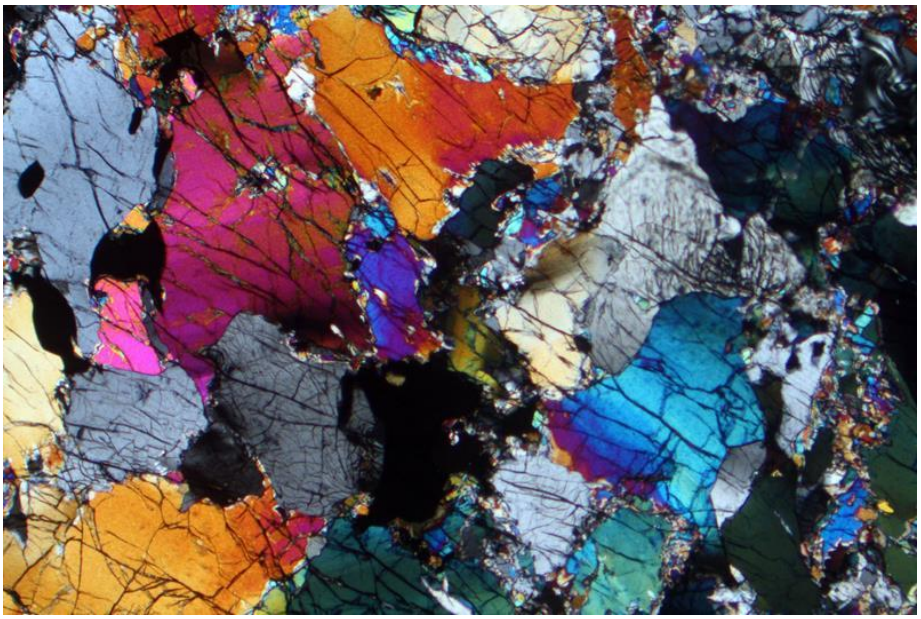
1- Dunite



Serpentinized Olivine in dunite. XPL image

- **Texture:-** **Mesh texture**
- **Mode of occurrence:-** **Plutonic**
- **Mineral composition:-** **mainly olivine (more than 90%)**
- **Chemical composition:-** **ultramafic**
- **Rock family:-** **Peridotites**
- **Rock name:-** **Dunite**

2- lherzolite



pyroxene, and Olivine crystals in lherzolite. XPL image, 2x (Field of view = 7mm)

- **Texture:- Hpidomorphic texture**
- **Mode of occurrence:- Plutonic**
- **Mineral composition:- clinopyroxene, orthopyroxene and minor olivine**
- **Chemical composition:- ultramafic**
- **Rock family:- Peridotites**
- **Rock name:- lherzolite**