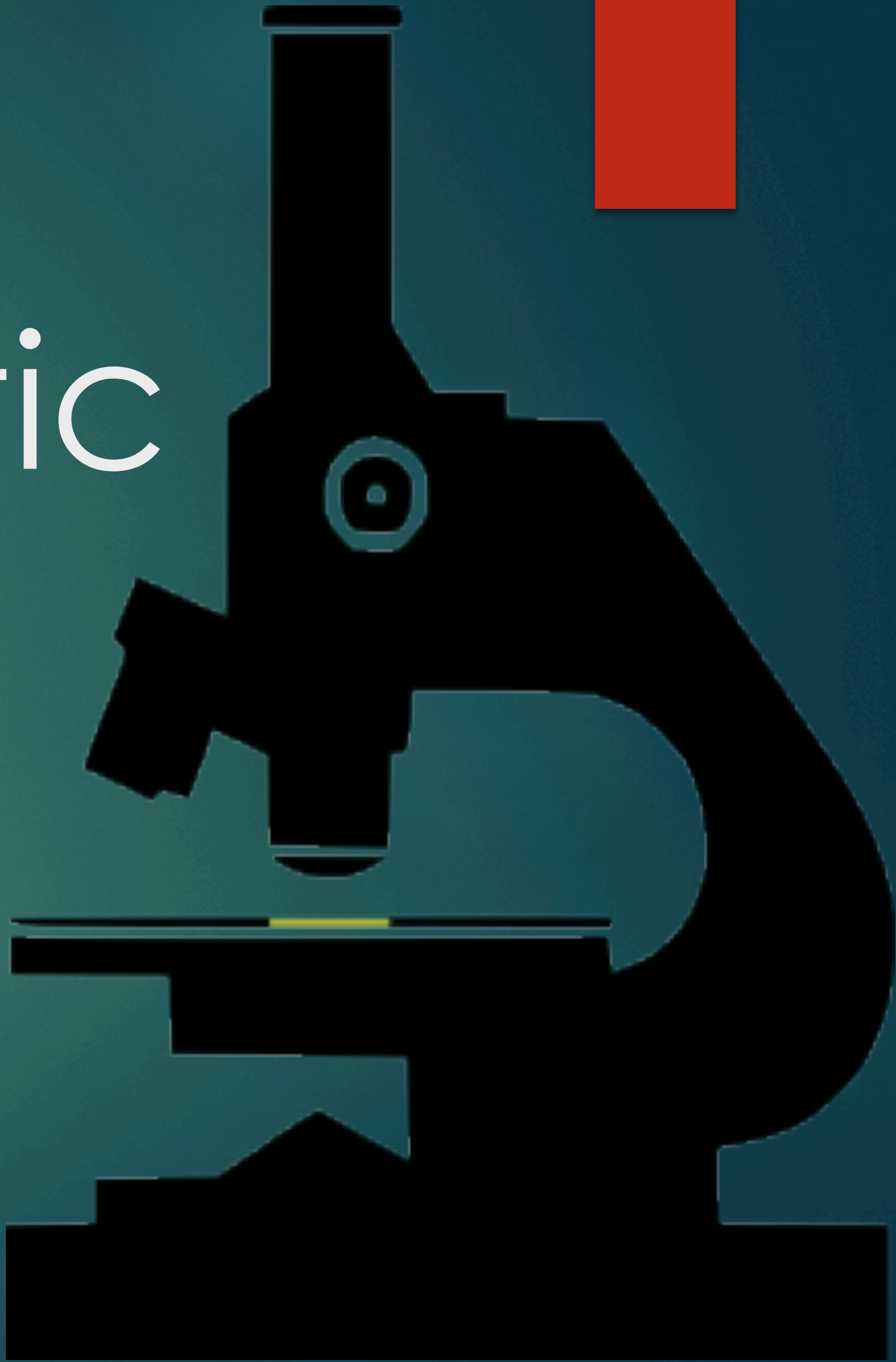
Chapter 8 Mineral diagnostic and rock identification

SARAH LAMBART



Recap Chapter 7

- **why reflected light and reflected light microscopes**
  - Opaques represent a large group of crystals
  - some other instruments (electronic microprobe, SEM, SIMS) may only have reflected light

- **optical properties in reflected light**
  - **Color**
  - **Reflectance** (and bireflectance)
  - Pleochroism, anisotropy and internal reflection,
  - Polishing hardness
  - Exsolution lamellae and cleavage

GRAIN MOUNT vs. THIN SECTION

- **Only after the examination of the hand sample!!!!!**

- **Grain mount:**
  - Quicker to prepare
  - Accurate determination of n (oil), δ and related optical variable
  - Determination of the chemical composition

- **Thin section:**
  - Texture and mineral intergrowth
  - Mineral association
  - Qualitative determination of n (Becke line)

GRAIN MOUNT

- **Procedure with grain mount:**
- **1) Scan an observe as many of these properties:**

- Relative relief to immersion oil
- Nature of twinning
- Nature of cleavage and fracture
- Alteration
- Color, pleochroism

GRAIN MOUNT

- **Procedure with grain mount:**
- **2) If isotropic:** compare n with immersion oils (Becke line)
- **3) If anisotropic:**

- Scan the slide to find the grain with the lowest birefringence color (circular section)
  - (a) Uniaxial: 1) determine the optic sign from the cross-centered interference figure; 2) remove the Bertrand lens and the gypsum plate and note the birefringence color associated with ω and the relief n_{ω}
  - (b) Biaxial: 1) From interference figure: determine optic sign and 2V; 2) remove the Bertrand lens and the gypsum plate and note the birefringence color associated with β and the relief n_{β}

GRAIN MOUNT

- **Procedure with grain mount:**

- Scan the slide to find the grain with the highest birefringence color:
  - (a) If mineral elongated or one cleavage direction: measure extinction angle and determine elongation sign
  - (b) Record the birefringence color and the relief associated with ε or, α and γ

- **4) go to identification tables (Appendix B in your Nesse textbook)**

THIN SECTION

- **Use the same procedure than with a grain mount**
- **Use the mineral association and the textures to identify rocks**

(appendix C in the textbook)

IGNEOUS ROCKS

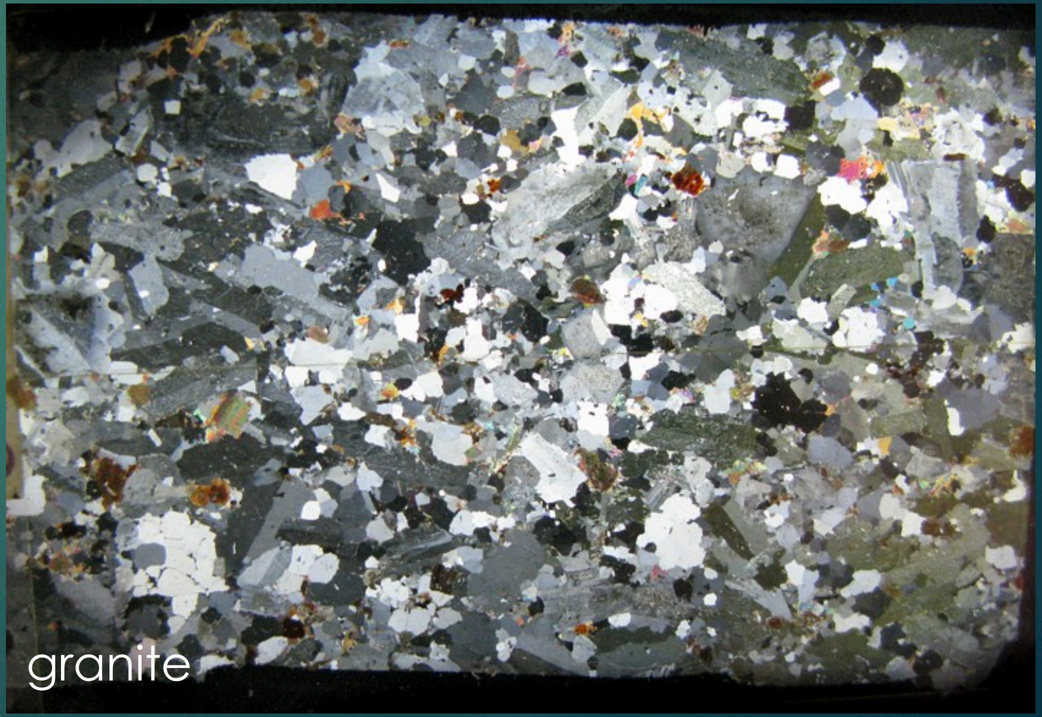
- **Texture in igneous rocks:**
  - **Crystallinity**

Hypocrystalline

Crystal + glass

Holocrystalline

100% crystal



IGNEOUS ROCKS

- **Texture in igneous rocks:**
  - **Grain size**

Aphanitic (too small for naked eye)

-> microcrystalline: crystal seen with microscope

-> cryptocrystalline: crystal seen with SEM

Phaneritic

-> fine <1mm

-> medium 1-5mm

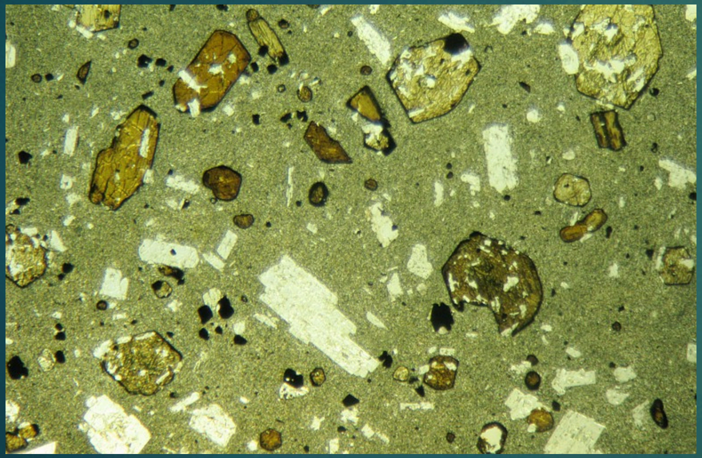
-> coarse: 5-30mm

-> pegmatitic: >30mm

IGNEOUS ROCKS

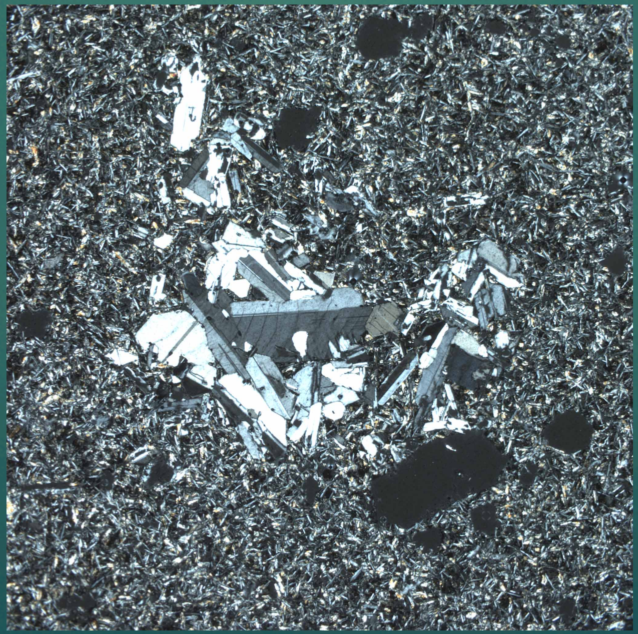
- **Texture in igneous rocks:**
  - **Shape: euhedral vs anhedral**
  - **Relation between minerals:** equigranular vs inequigranular
  - **Inequigranular textures:**

Porphyritic



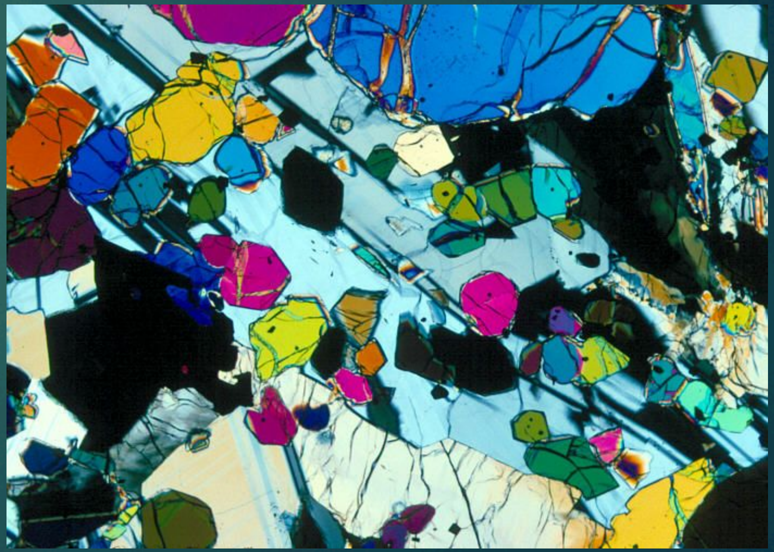
mugearite

Micropyritic



basalt

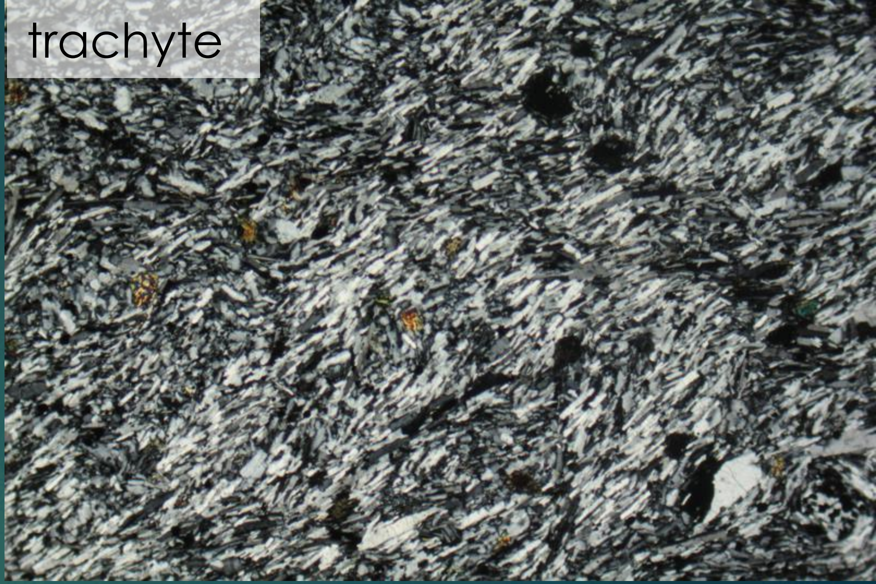
Poikilitic

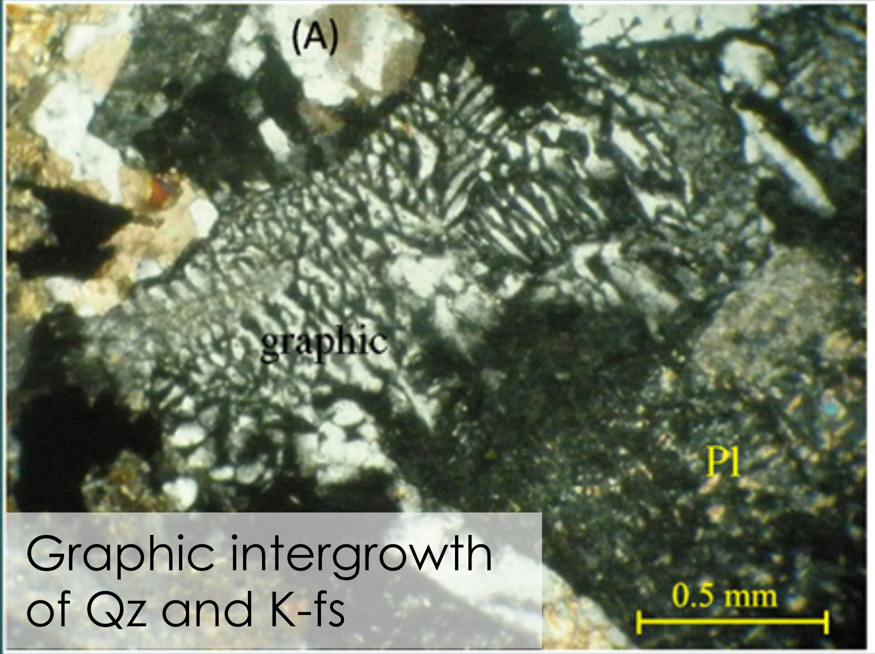


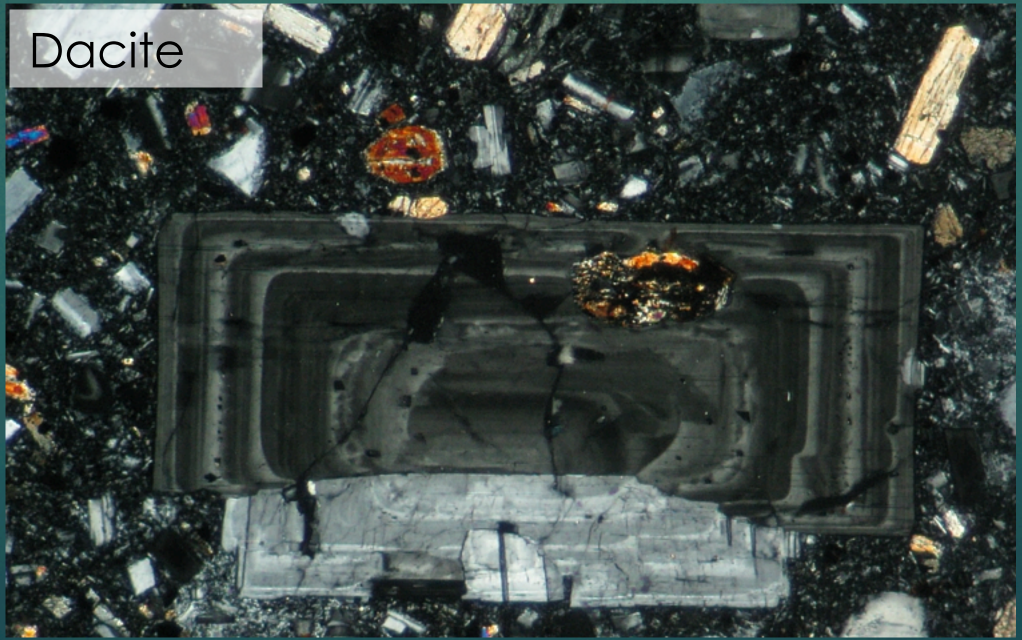
Lunar basalt

IGNEOUS ROCKS

- **Texture in igneous rocks:**
  - **Directive textures:** evidence of flow
  - **Intergrowth/exsolution textures**
  - **Zoning**
  - **Twinning**







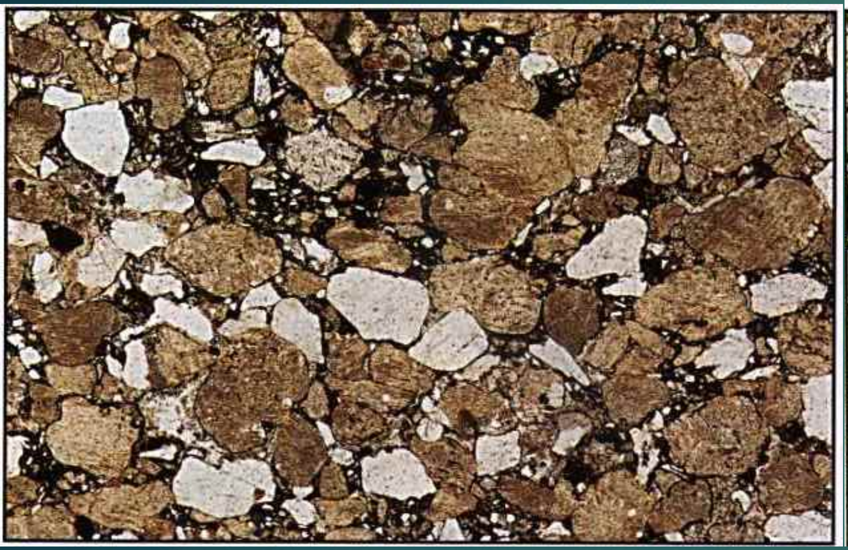
IGNEOUS ROCKS

- **Mineral in igneous rocks:**

Rock type	**Felsic** (granite, granodiorite, rhyolite, rhyodacite)	**Granitic pegmatite**	**Intermediate** (diorite, tonalite, andesite, dacite)	**Mafic, ultramafic** (basalt, gabbro, norite, peridotite, pyroxenites)	**Si-deficient** (syenite, phonolite)
Essential mnls	Quartz, Plagioclase, K-feldspar	Quartz Plagioclase K-felspar Muscovite Biotite	Plagioclase Hornblende	Plagioclase Cpx Opx olivine	K-feldspar Plagioclase Nepheline Sodalite Leucite
Additional likely minerals	Muscovite, Biotite, horneblende	Beryl Lepidolite Spodumene Tourmaline	Quartz Biotite Muscovite Opx cpx	Biotite hornblende	Biotite Muscovite Na-amphibole Na-pyroxenes

SEDIMENTARY ROCKS

- **Texture:**
  igneous and metamorphic: crystalline ≠ sedimentary: mnl or rock fragment= **clastic texture**



Arkosic Sandstone

Glauconitic Sandstone

Calcareous Sandstone

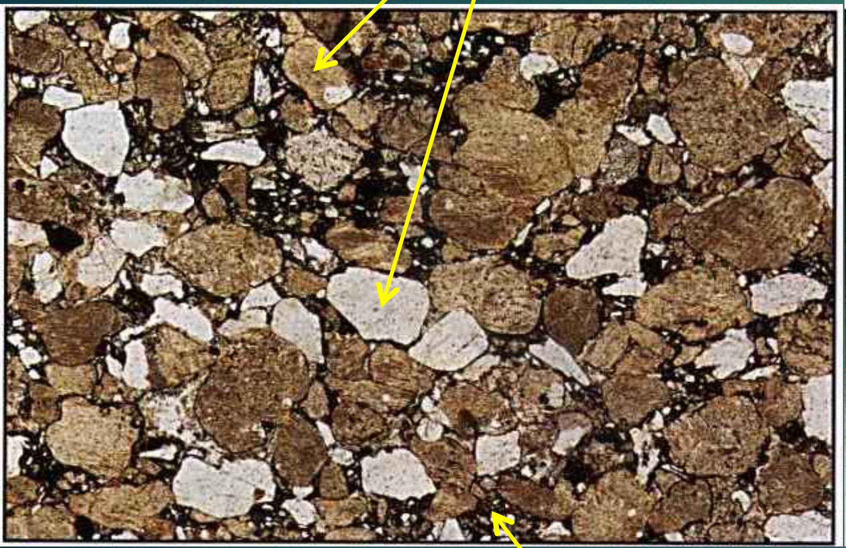
http://www.cas.usf.edu/~jryan/rocks.html

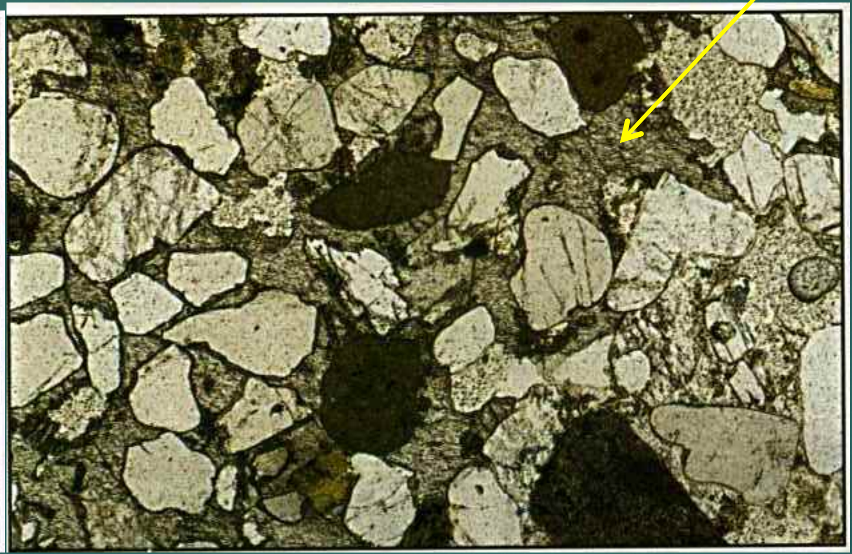
SEDIMENTARY ROCKS

- **Nomenclature:**

Framework grains

Cement: precipitated minerals in pore space (ex.: calcite)

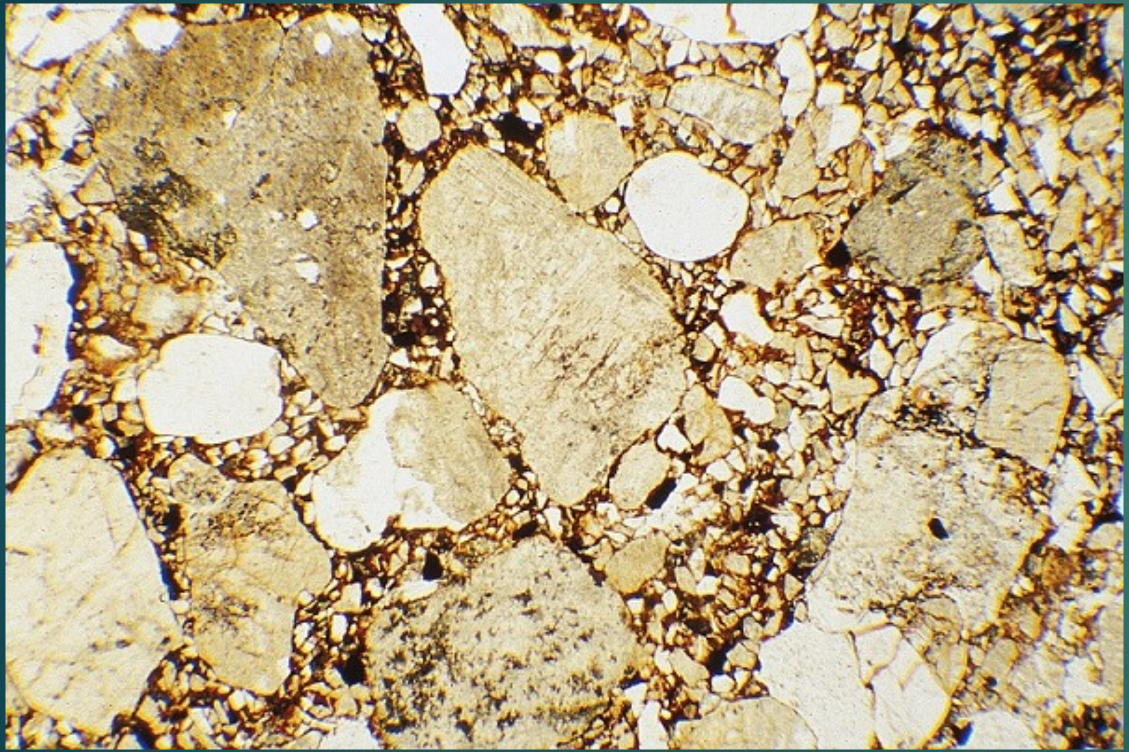


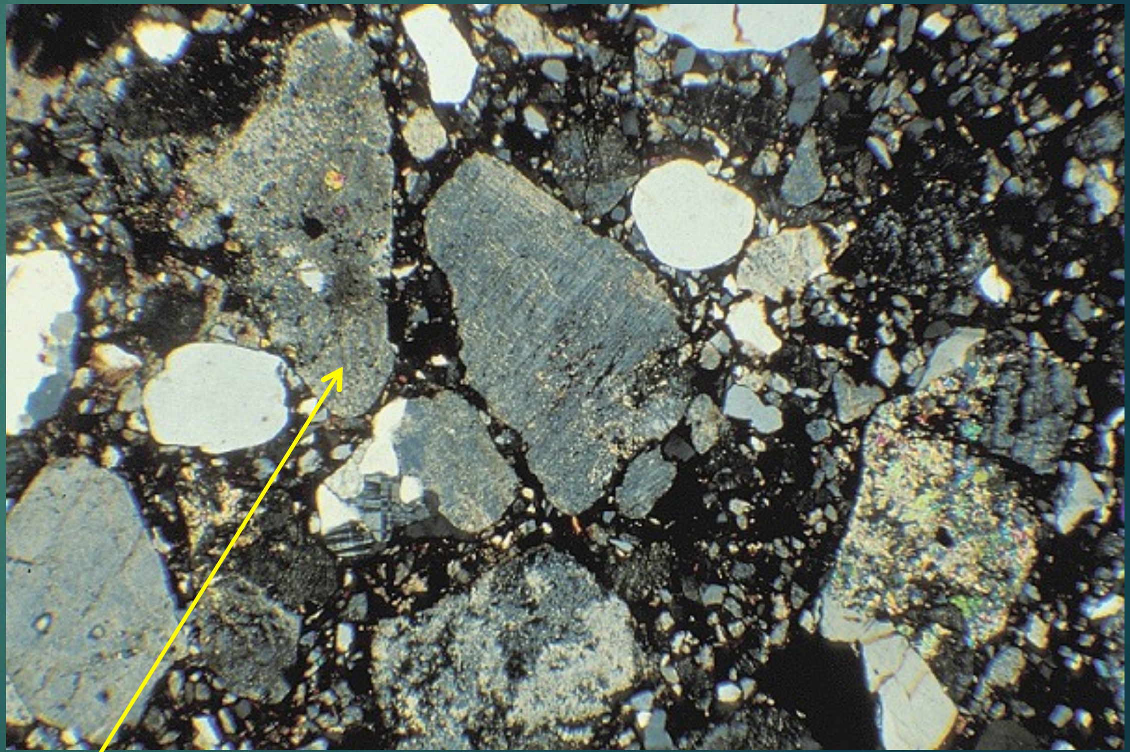


matrix

SEDIMENTARY ROCKS

- **Nomenclature:**
- **Lithic:** fragments of a preexisting rock, e.g., volcanic, chert, shale, quartzite



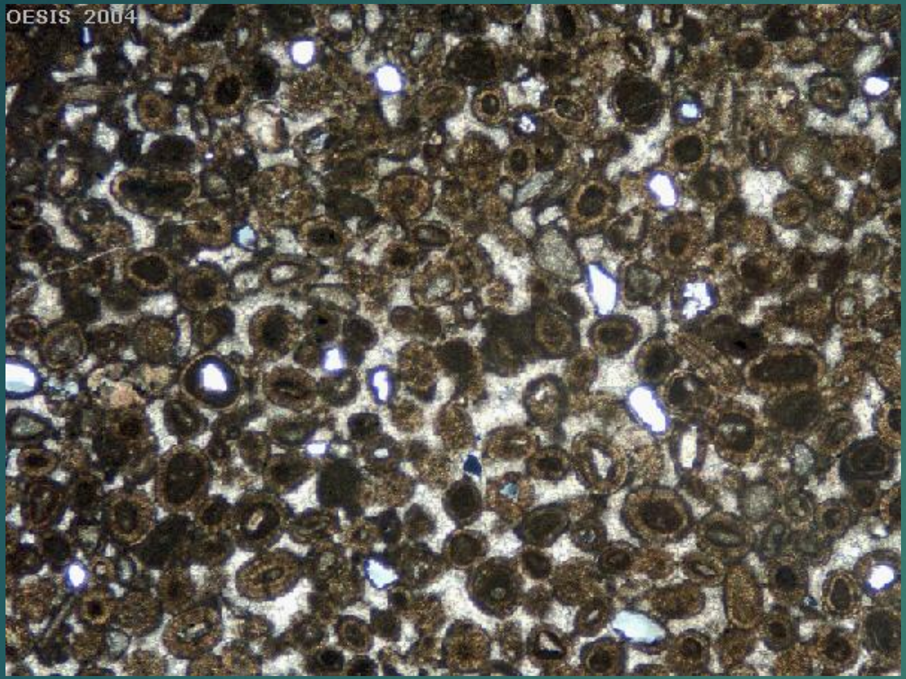


Clast of gneiss

http://www.earth.ox.ac.uk/

SEDIMENTARY ROCKS

- **Only in sedimentary rocks:**



Oolite: rounded pellets of calcium carbonate formed in warm shallow water where carbonate sediment is moved about by currents.

Fossils: Ex.: in limestone

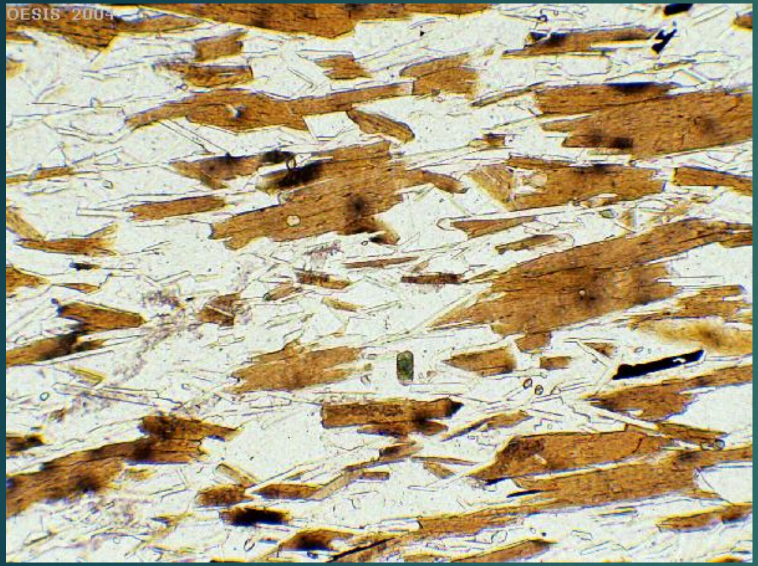
SEDIMENTARY ROCKS

- **Mineral in sedimentary rocks:**

Rock type	Clastic	Carbonate	Evaporite
Essential mnls	Quartz K-feldspar Plagioclase Clay Chalcedony Calcite Muscovite Biotite Glauconite Magnetite, Ilmenite, Hematite Zoelites + more heavy minerals	Calcite Dolomite Clay Glauconite Clastic material Fossils	Anhydrite Calcite Chalcedony Dolomite Gypsum Halite Sulfur Sylvite Clastic material

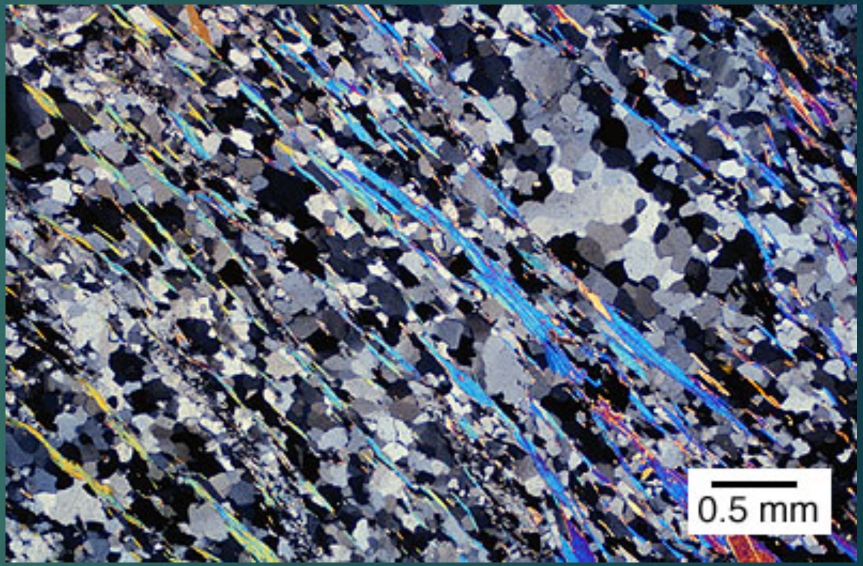
METAMORPHIC ROCKS

- **Texture:**
- **Planar fabric: foliation**



Micaschist

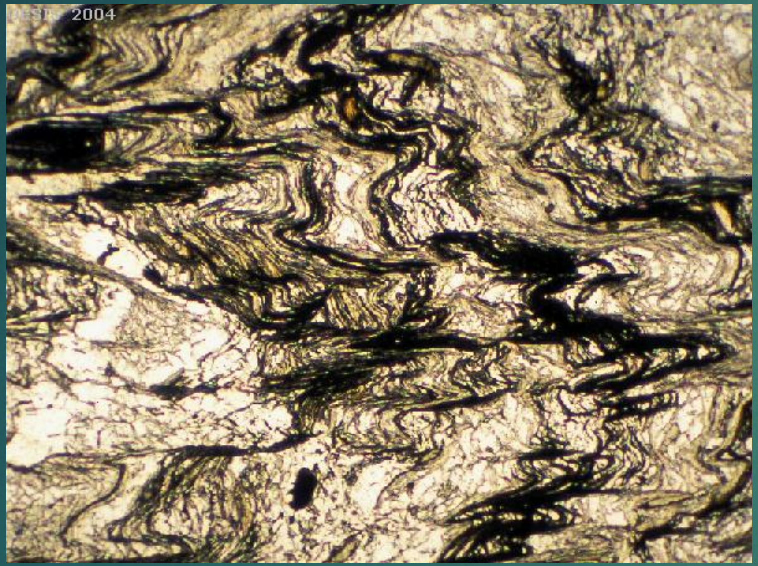
Amphibolite

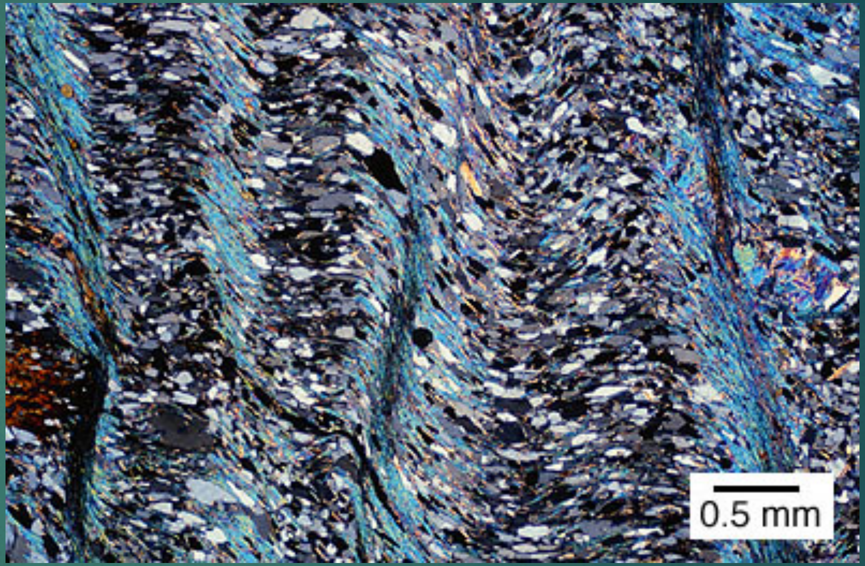


Quartz-micaschist

METAMORPHIC ROCKS

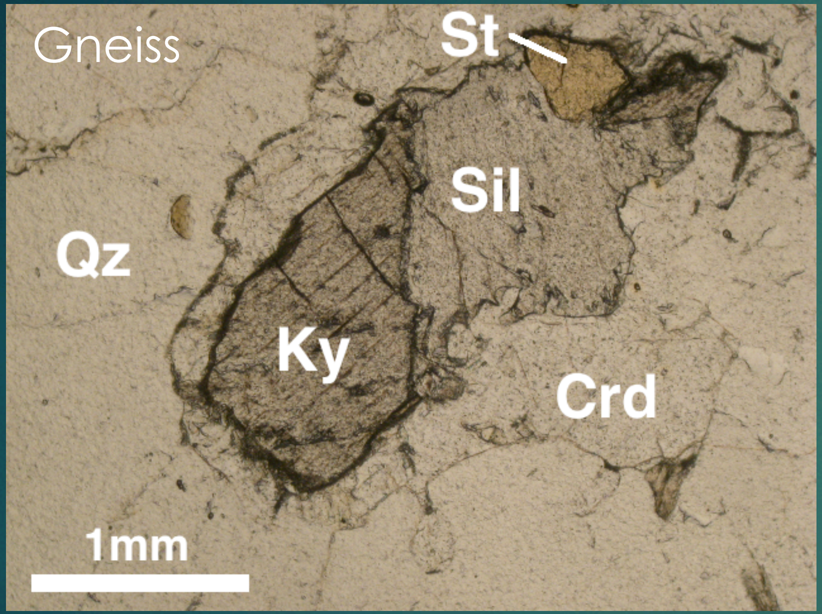
- **Texture:**
- **Fold, crenulation**



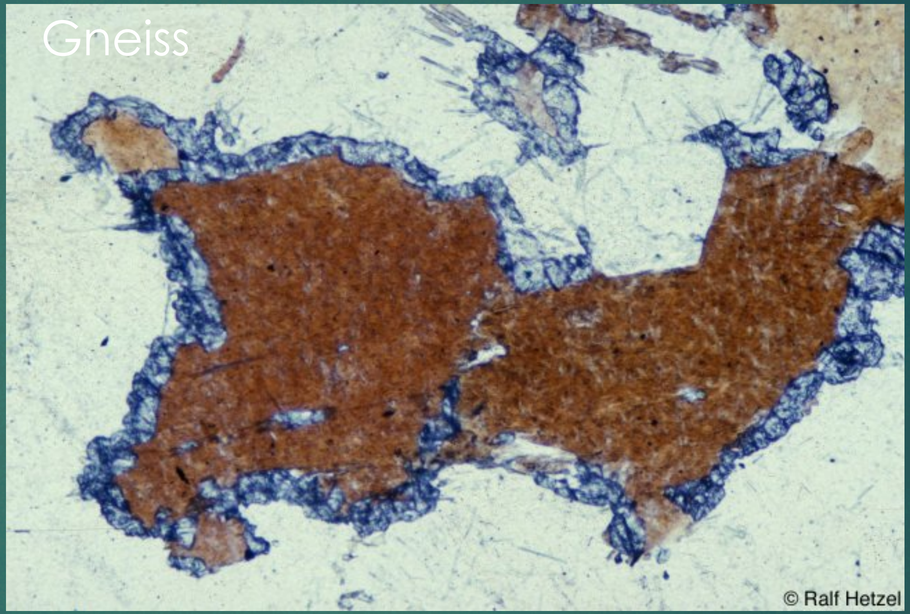


METAMORPHIC ROCKS

- **Texture:**
- **Reactions**



HP: Kyanite to HT: sillimanite to LT +Qz and staraulite: cordierite
Metamorphism retrograde
Credits: Charly Stamper

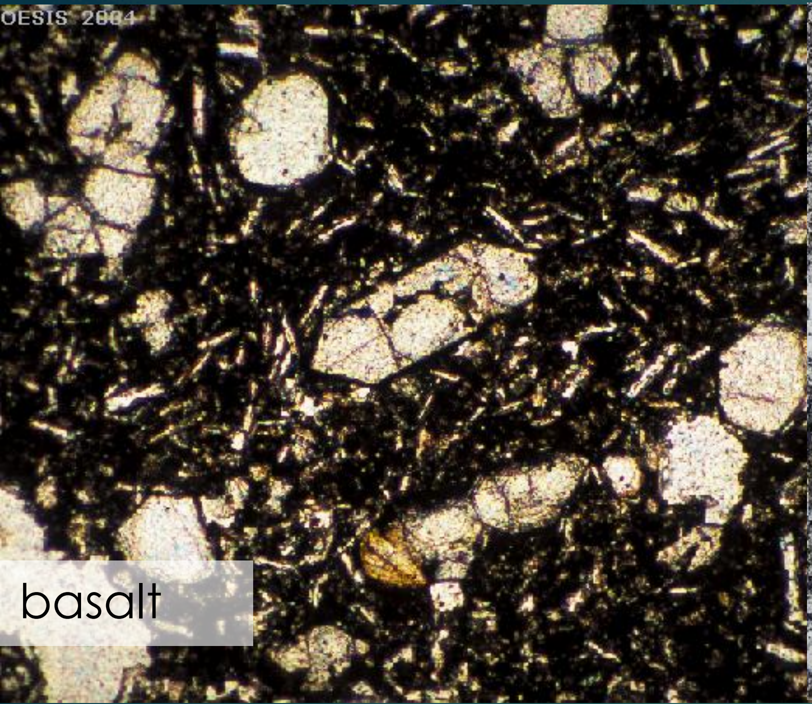


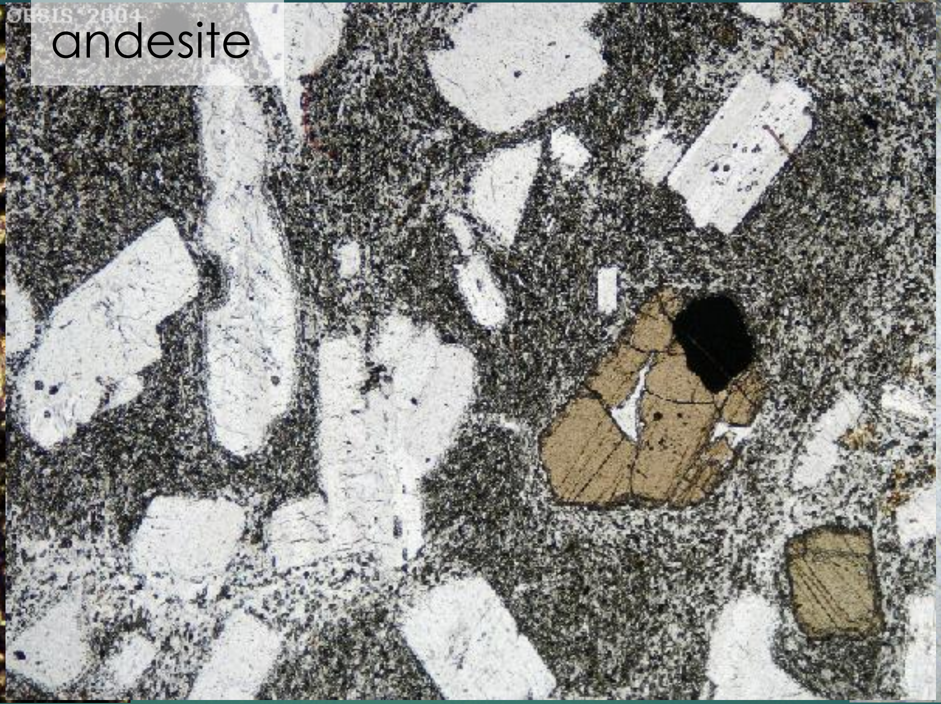
LP: Biotite to HP: garnet (rim)
Metamorphism prograde
Credits: Hetzel et al., 1998.

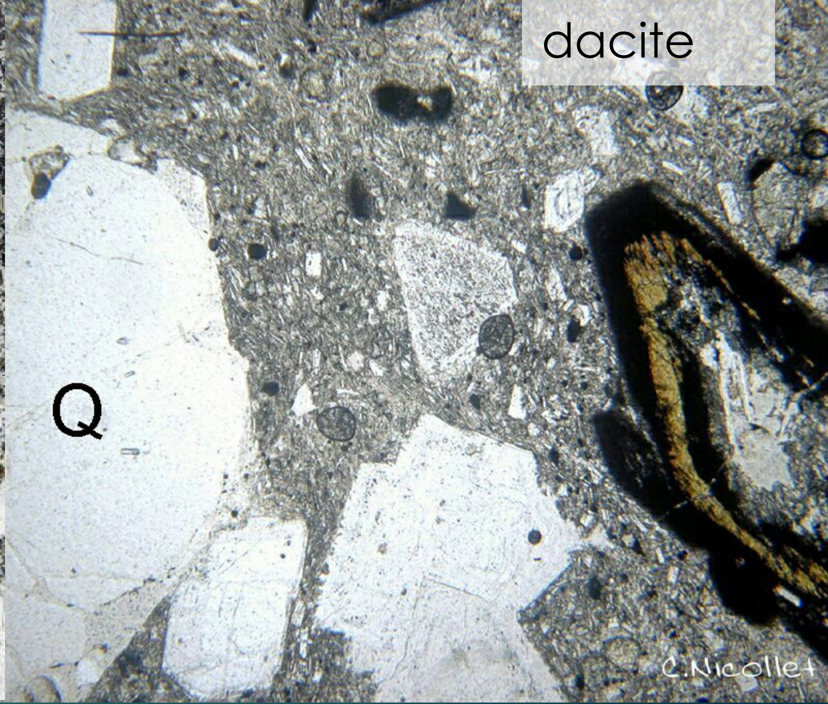
METAMORPHIC ROCKS

- **Mineral in metamorphic rocks:**

Rock type	Pelitic(metam. shales: slate, phyllite, mica schist)	Mafic (metam. igneous rocks)	Carbonate and cal-silicate (Metam. Limestone, dolostone)	HP-LT (Metagraywacke, blueschist, zeolite)	Granitic gneiss (metam. Arkosic sediments, granite, rhyolite)
Essential mnls	Quartz, Plagioclase, Muscovite, Chlorite, Biotite, Garnet, Cordierite, Staurolite, Aluminium silicates, K-feldspar	Plagioclase, Ca-amphibole, cpx, omphacite, biotite, quartz, titanite, calcite, garnet, cordierite	Calcite Dolomite Epidote Garnet Cpx Ca-amphibole Biotite Olivine Quartz aragonite	Quartz Plagioclase (Na) Jadeite Omphacite Na-Amphibole Epidote Lawsonite Micas Calcite Garnet zeolites	Quartz K-feldspar Plagioclase Biotite Cordierite Hornblende Opx


OESIS 2004
basalt

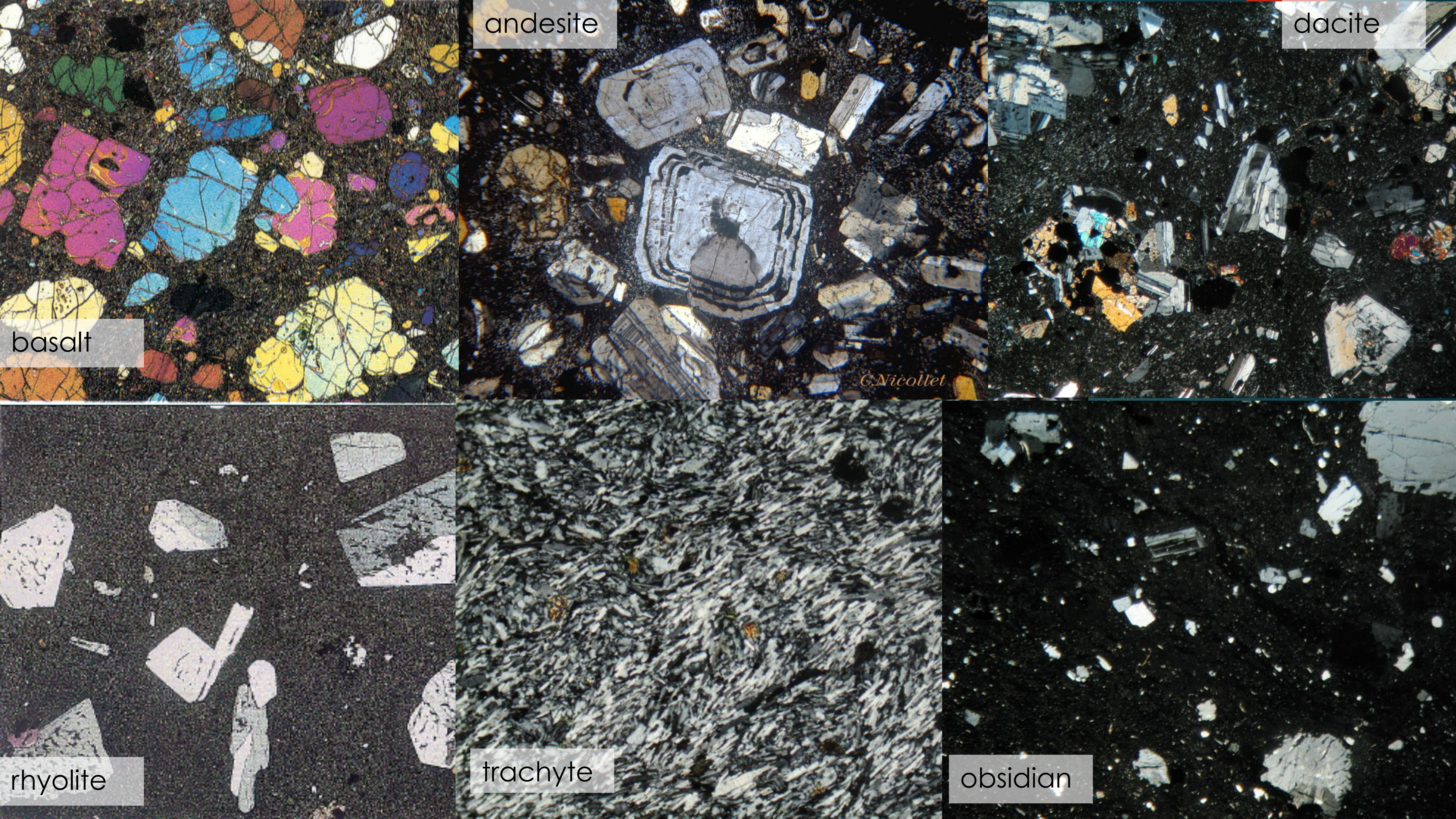

OESIS 2004
andesite

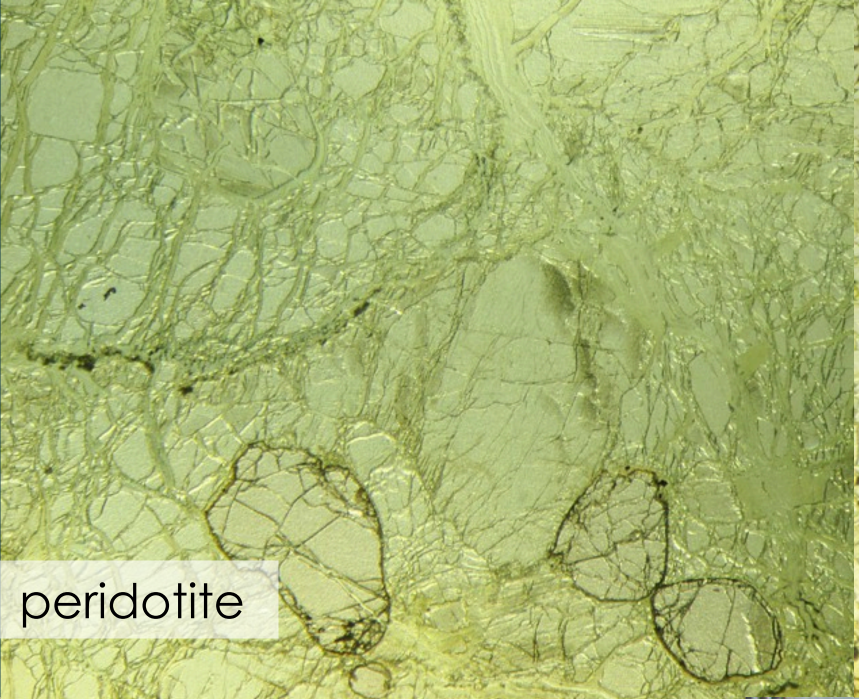

dacite
Q
C.Nicollet


rhyolite

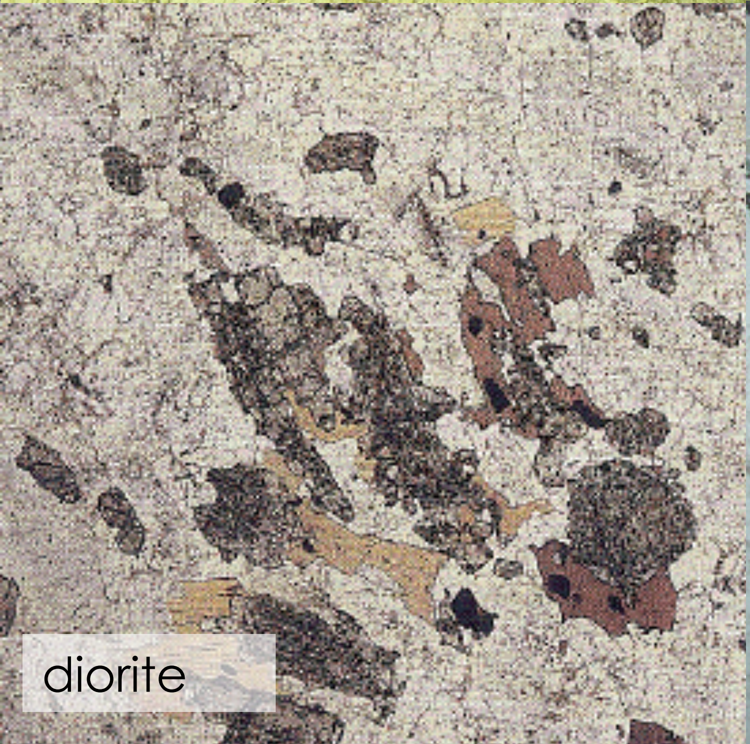

rhyolite


obsidian


basalt
andesite
C.Nicollet
dacite
rhyolite
trachyte
obsidian


peridotite

Olivine-gabbro

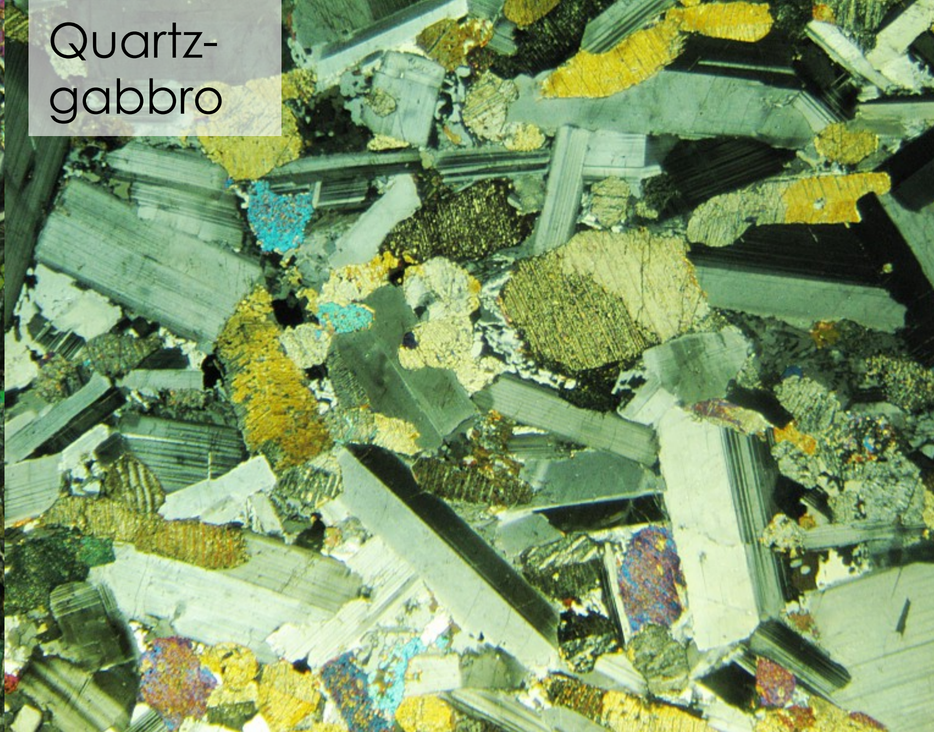
gabbro
L 1 8

diorite

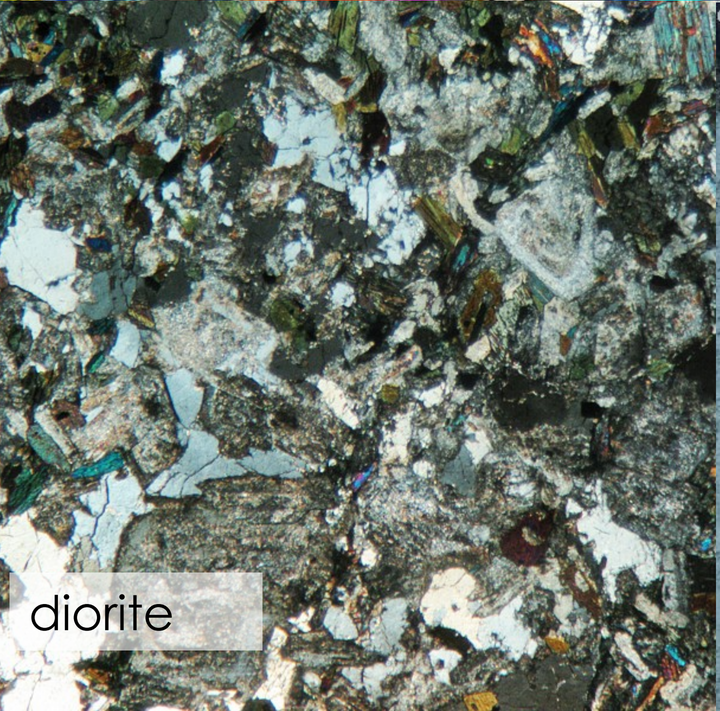
granodio
rite

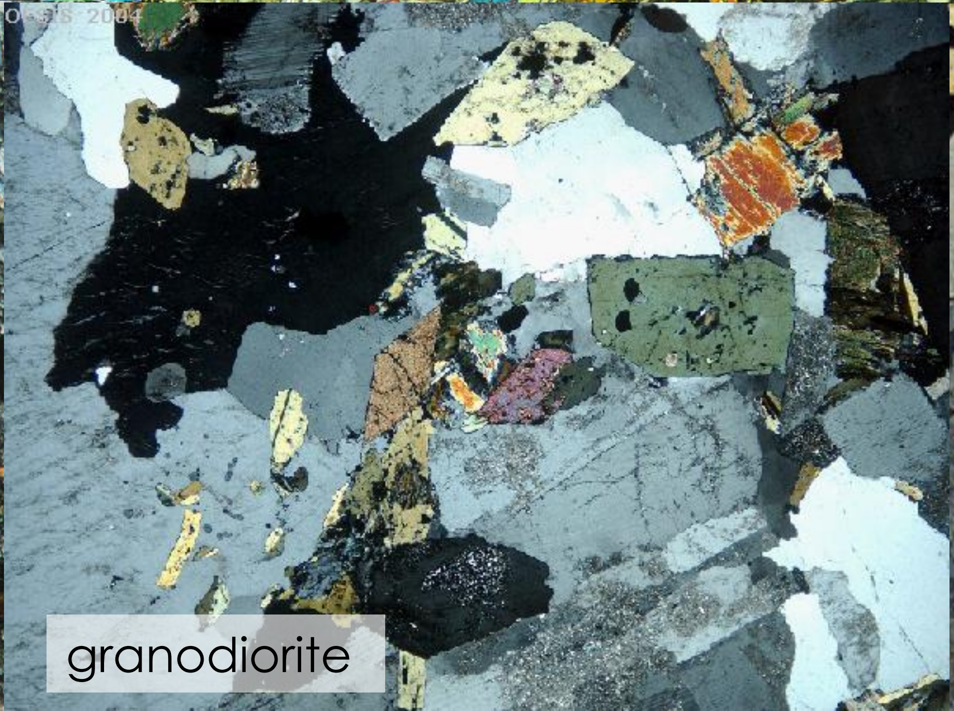
granite

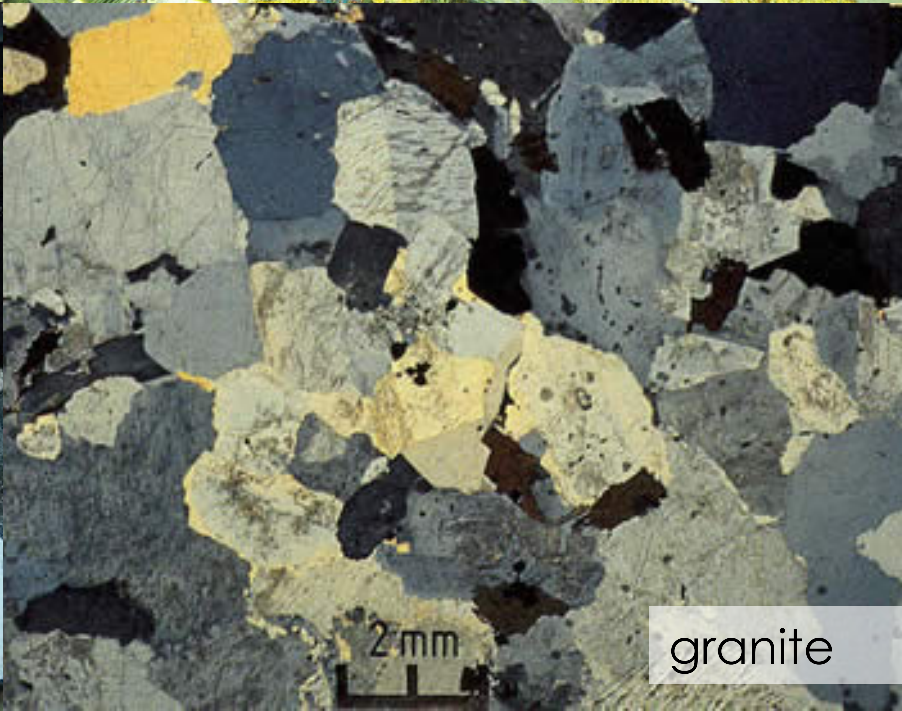

peridotite

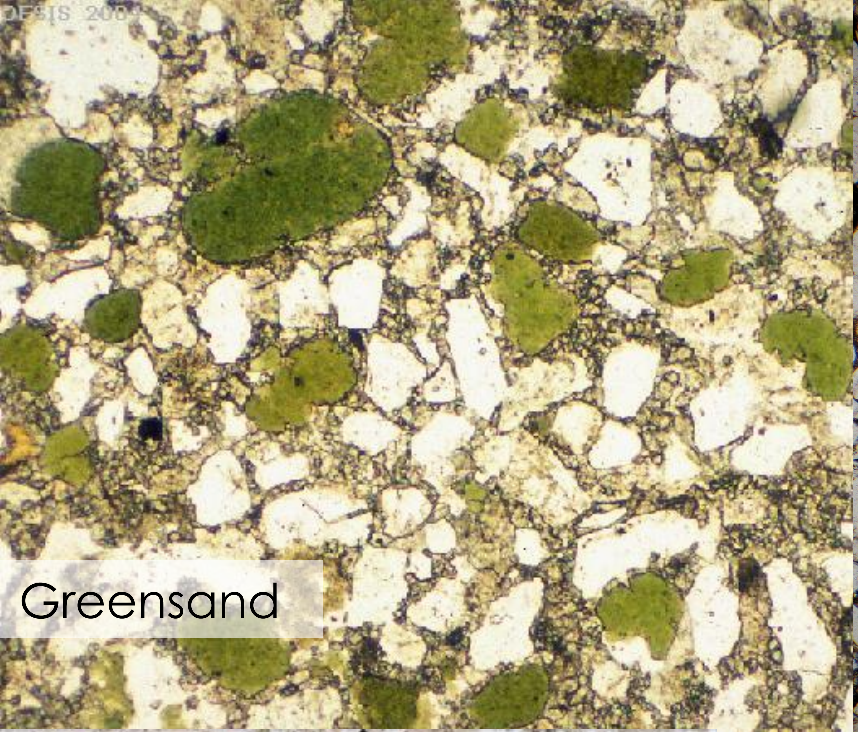

Olivine-
gabbro

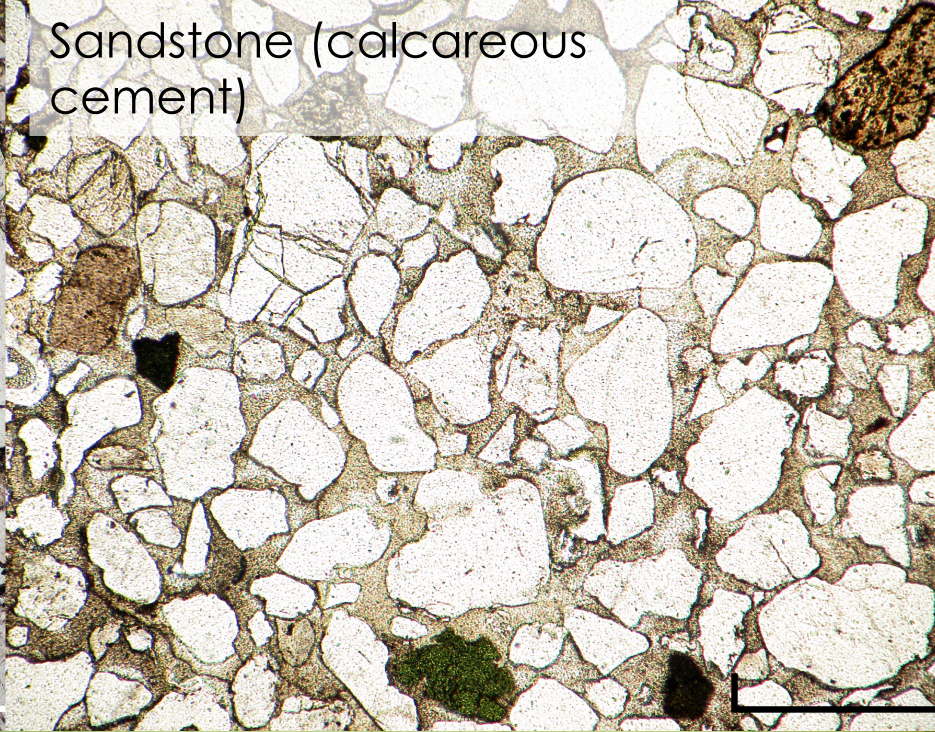

Quartz-
gabbro

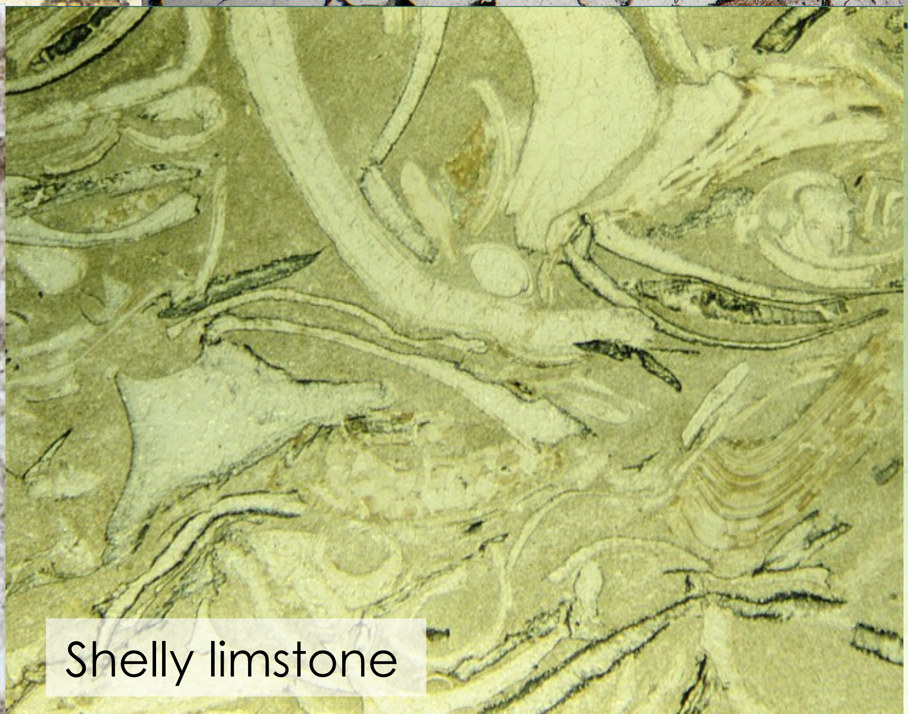
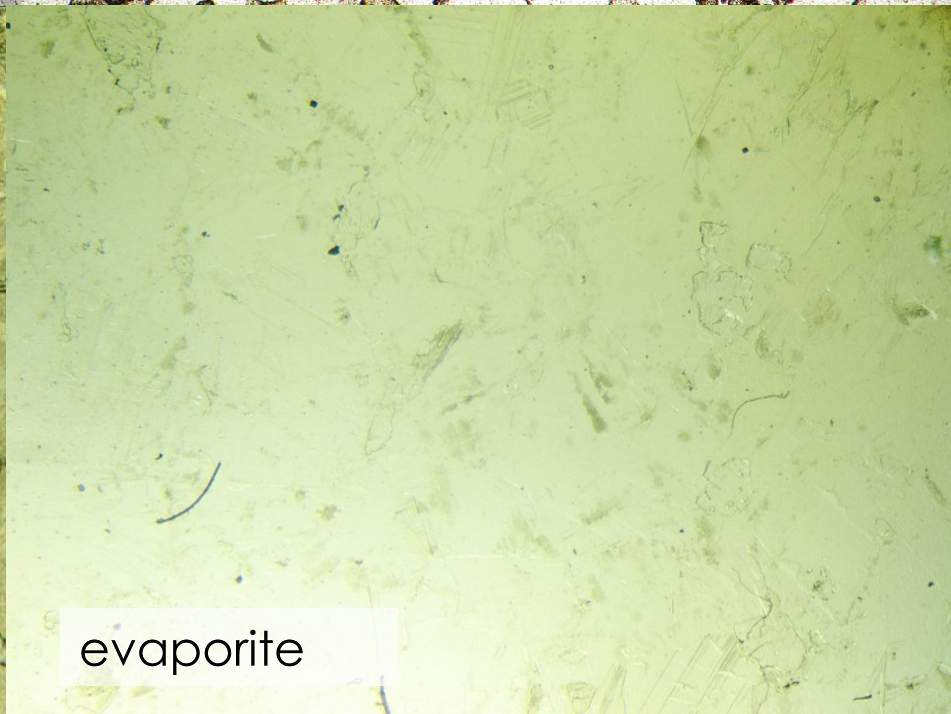

diorite

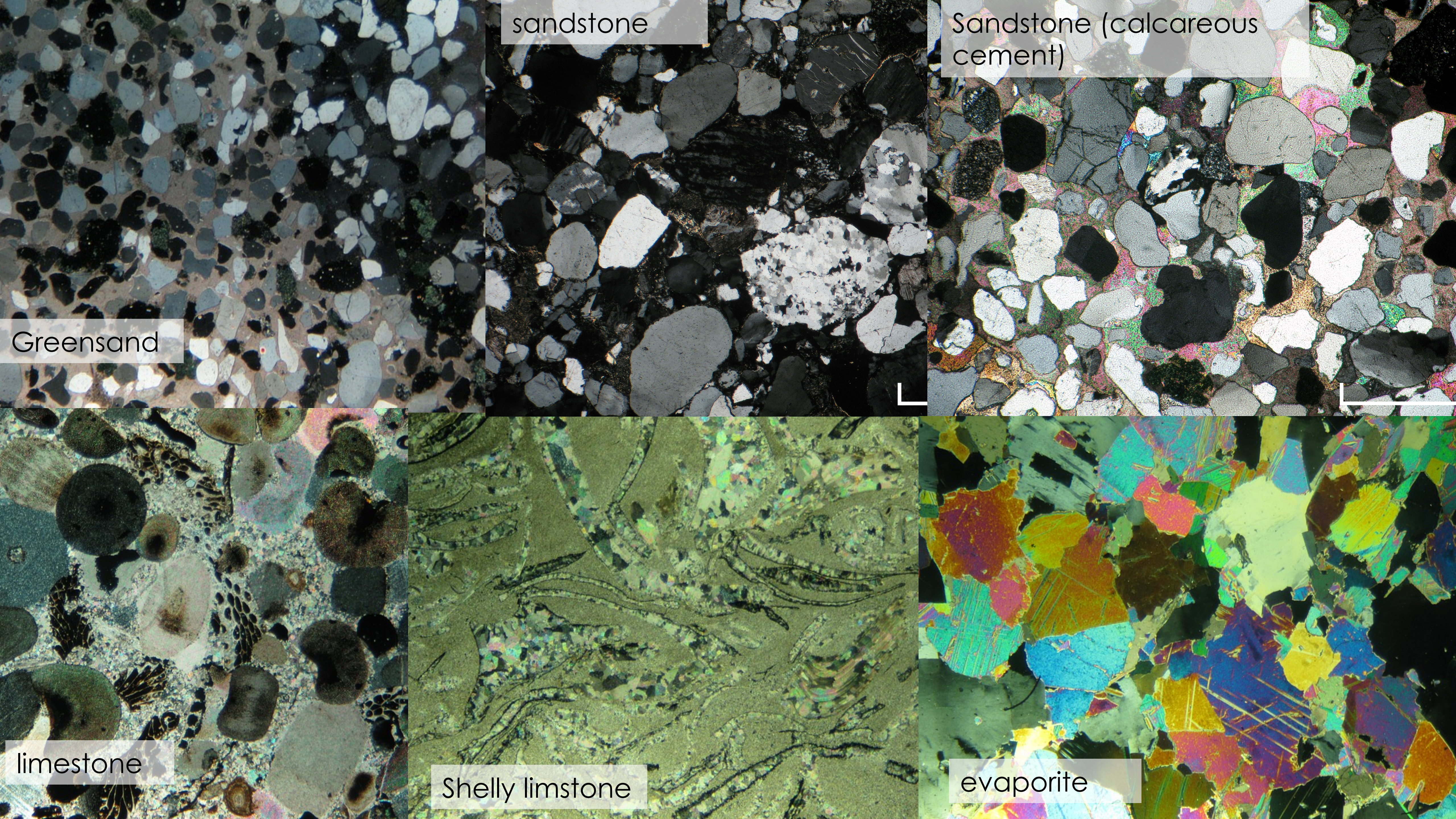

granodiorite

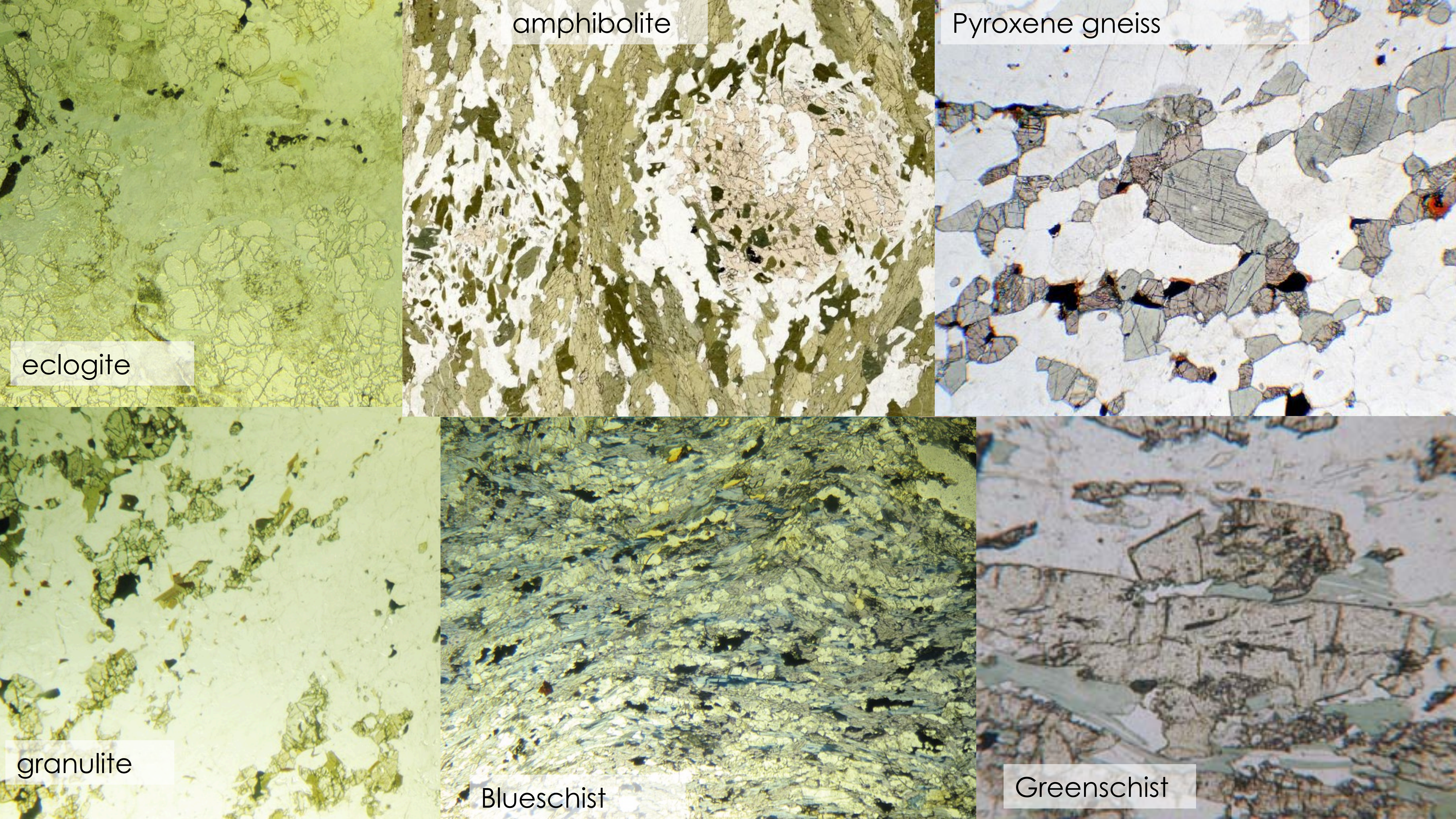

2 mm
granite

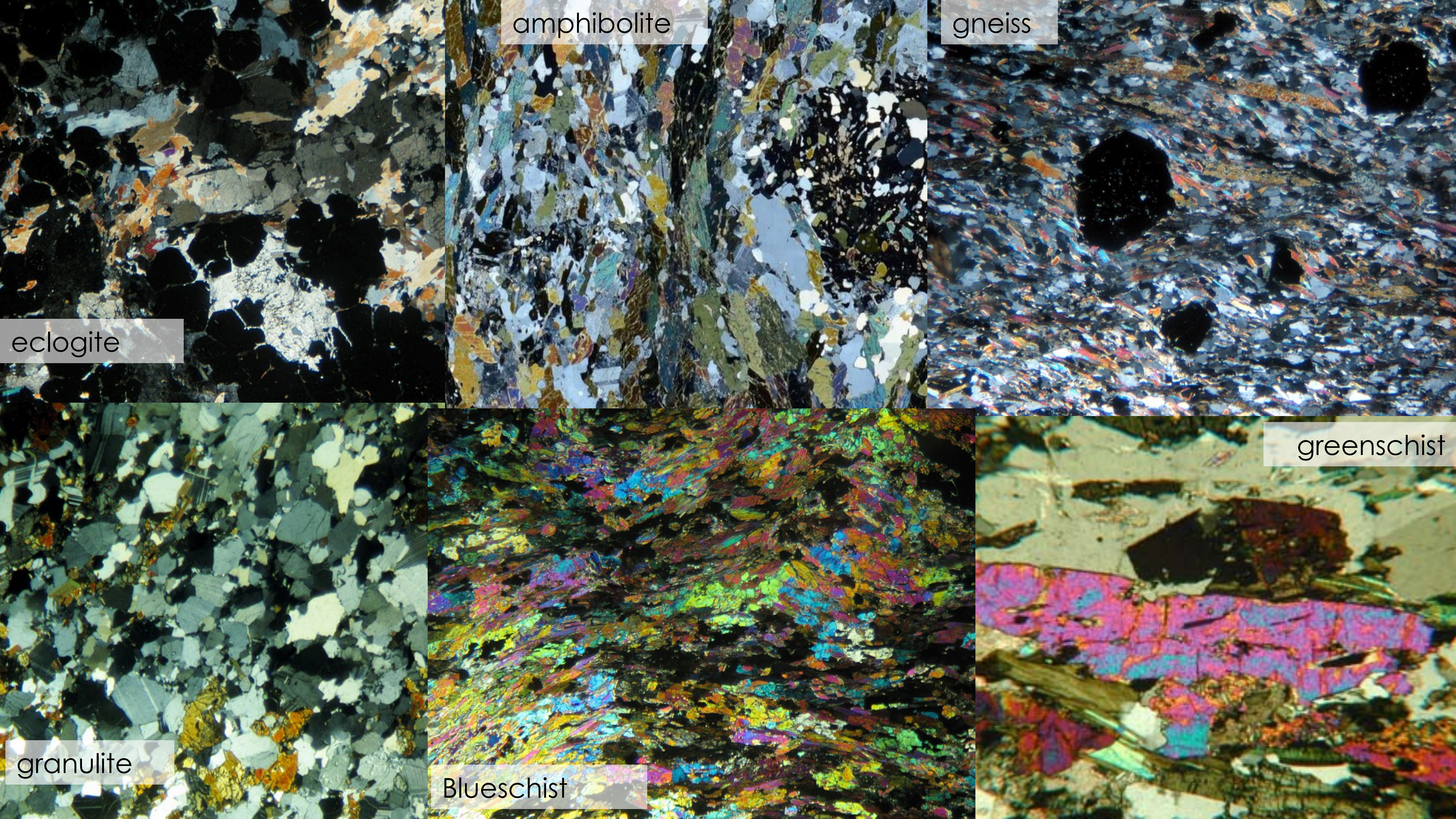

Greensand

sandstone

Sandstone (calcareous
cement)

limestone

Shelly limstone

evaporite


Greensand
sandstone
Sandstone (calcareous cement)
limestone
Shelly limstone
evaporite


eclogite
amphibolite
Pyroxene gneiss
granulite
Blueschist
Greenschist


eclogite
amphibolite
gneiss
granulite
Blueschist
greenschist

NEXT WEEK

- **Lectures: Review and questions**
- **Lab: Final exam**