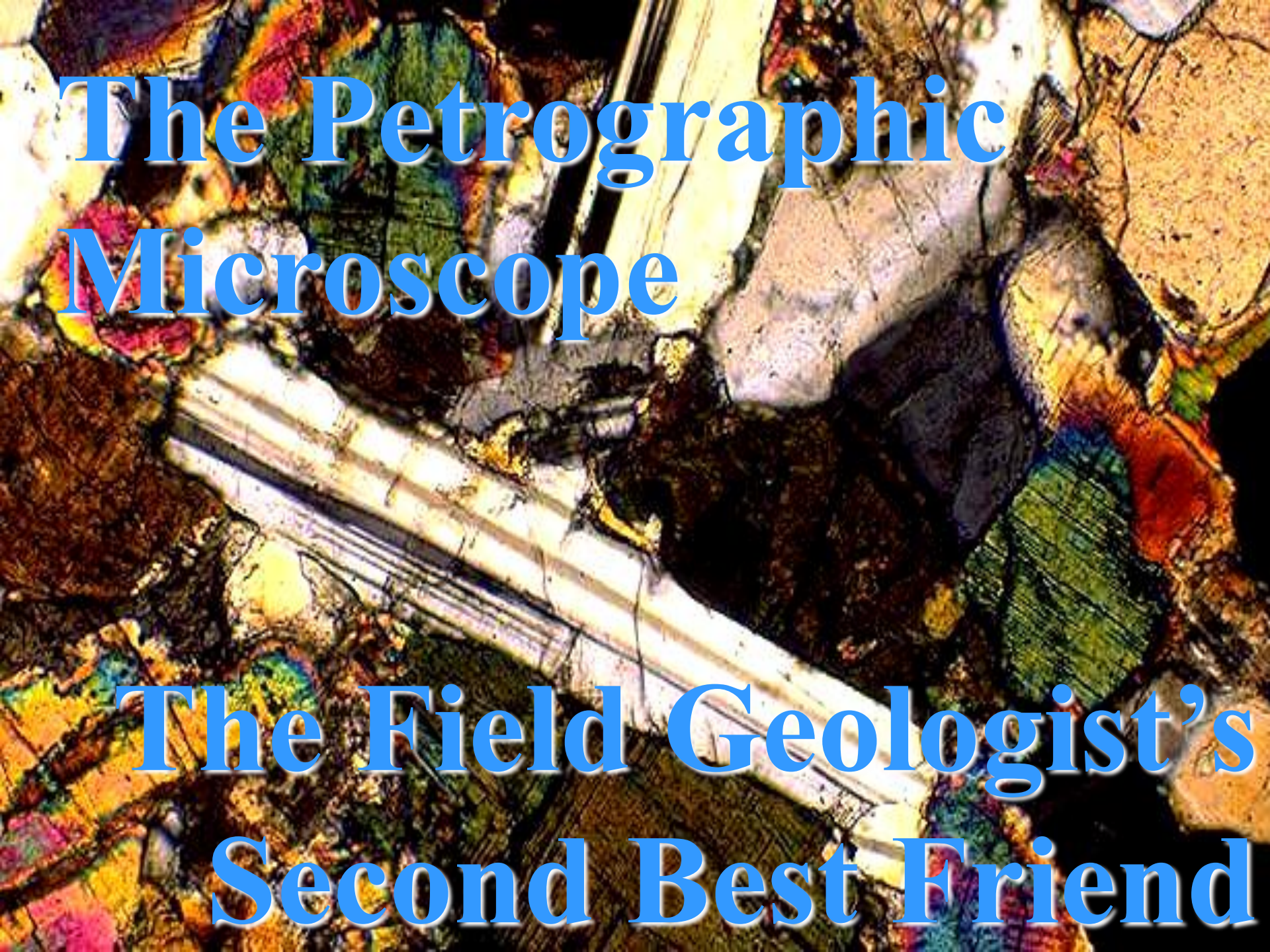
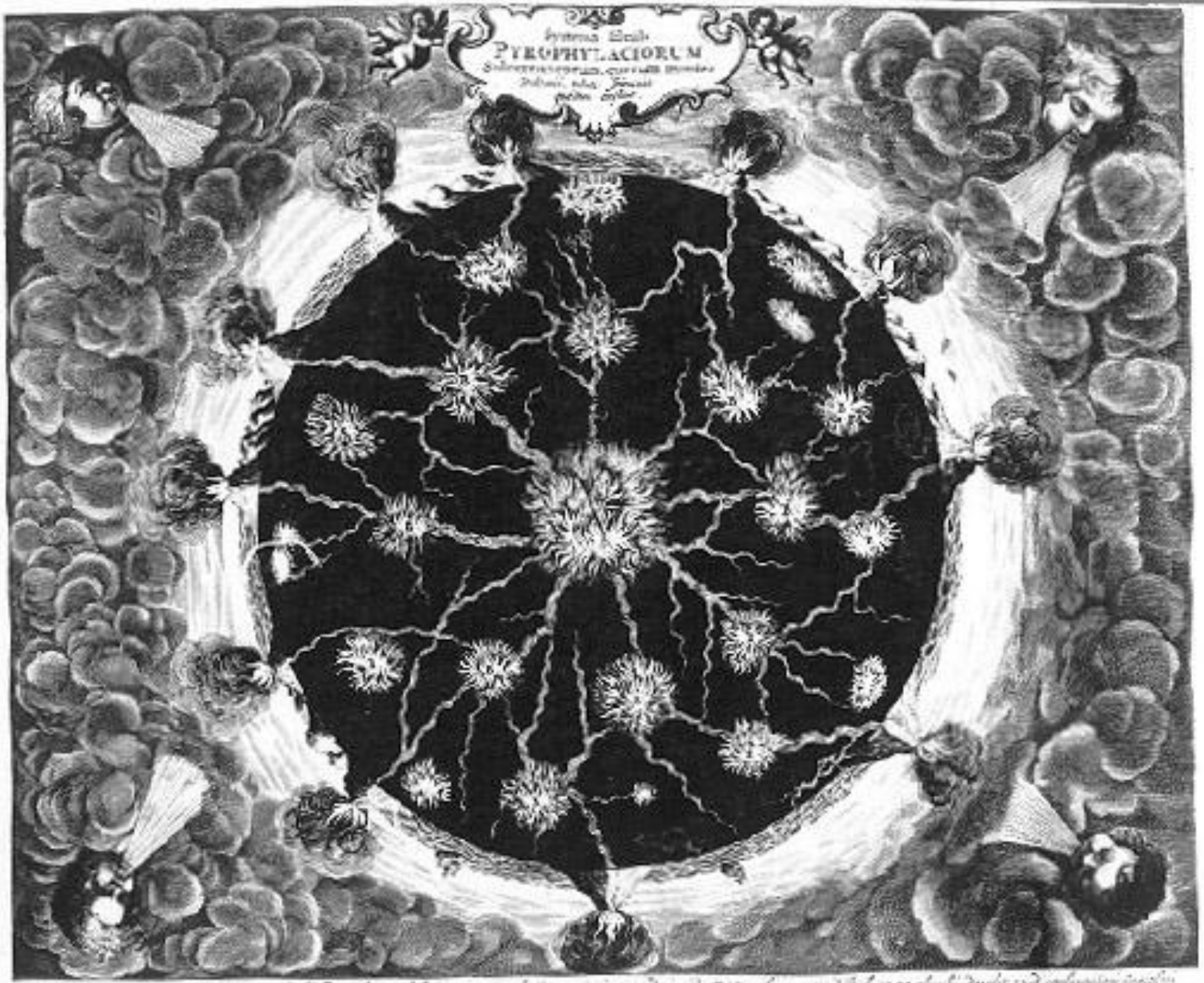
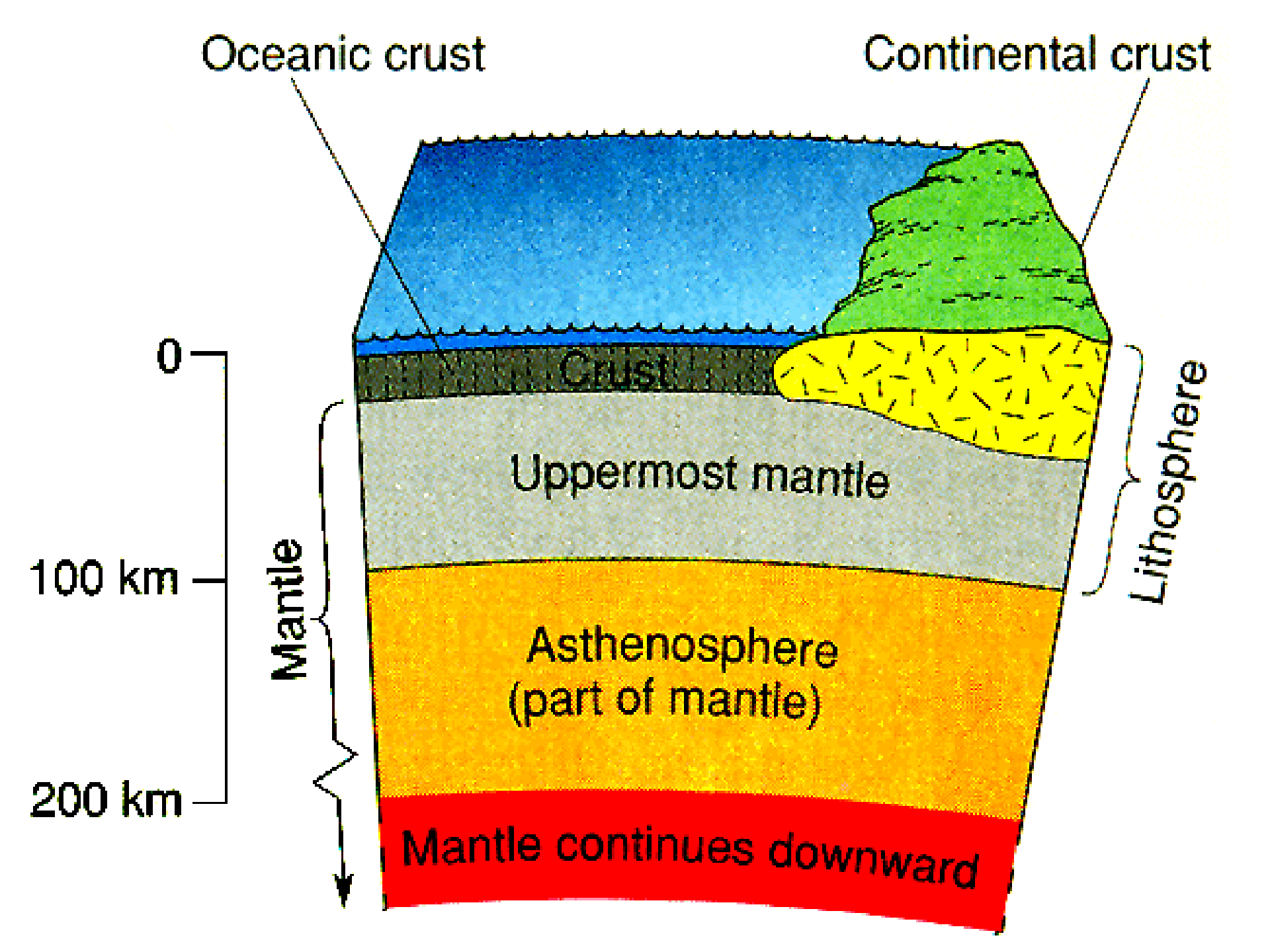

The Petrographic Microscope
The Field Geologist's Second Best Friend


Systema Orbis
PYROPHYLACIORUM

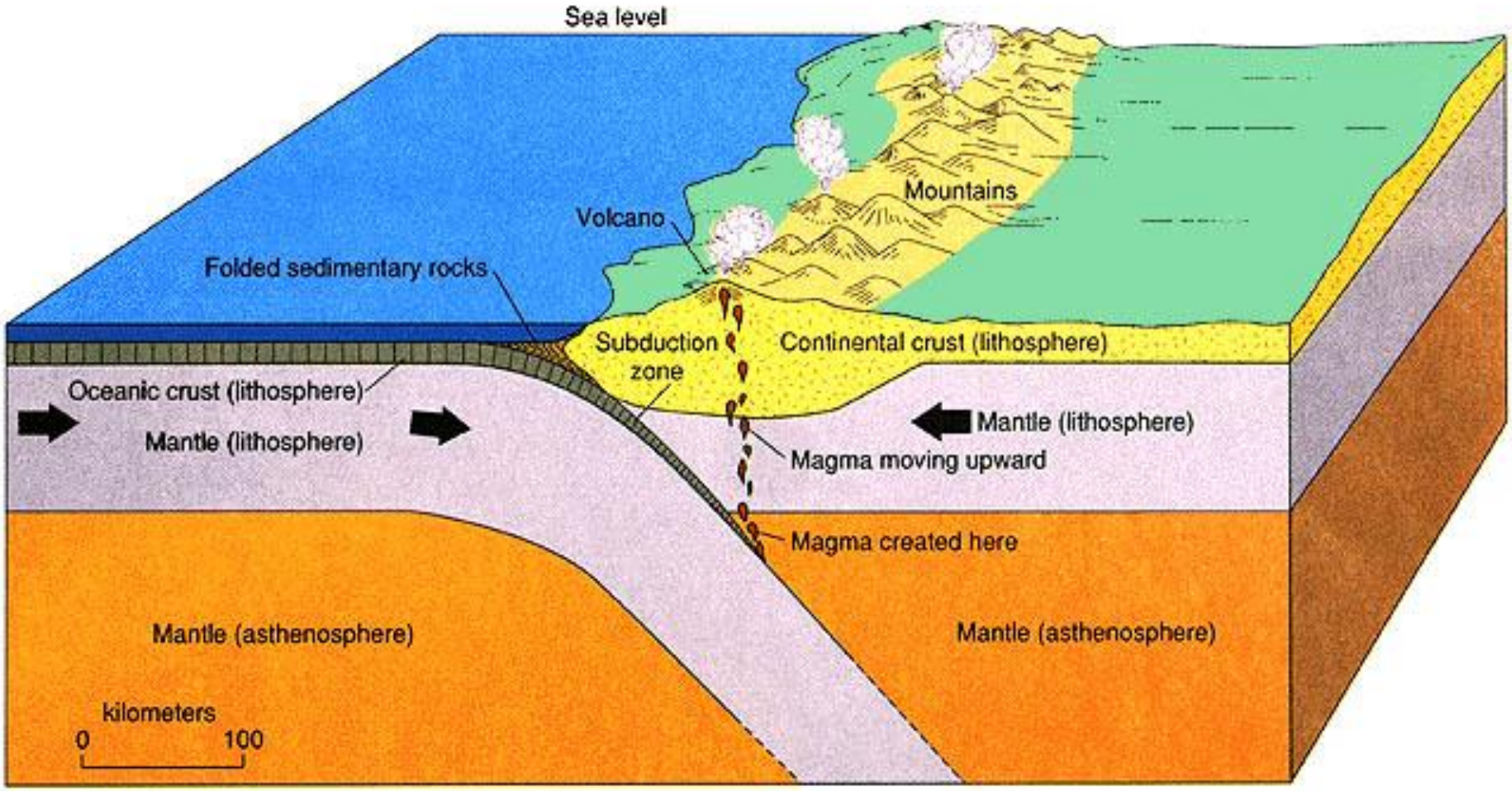

Oceanic crust
Continental crust
0
100 km
200 km
Crust
Uppermost mantle
Asthenosphere
(part of mantle)
Mantle continues downward
Mantle
Lithosphere

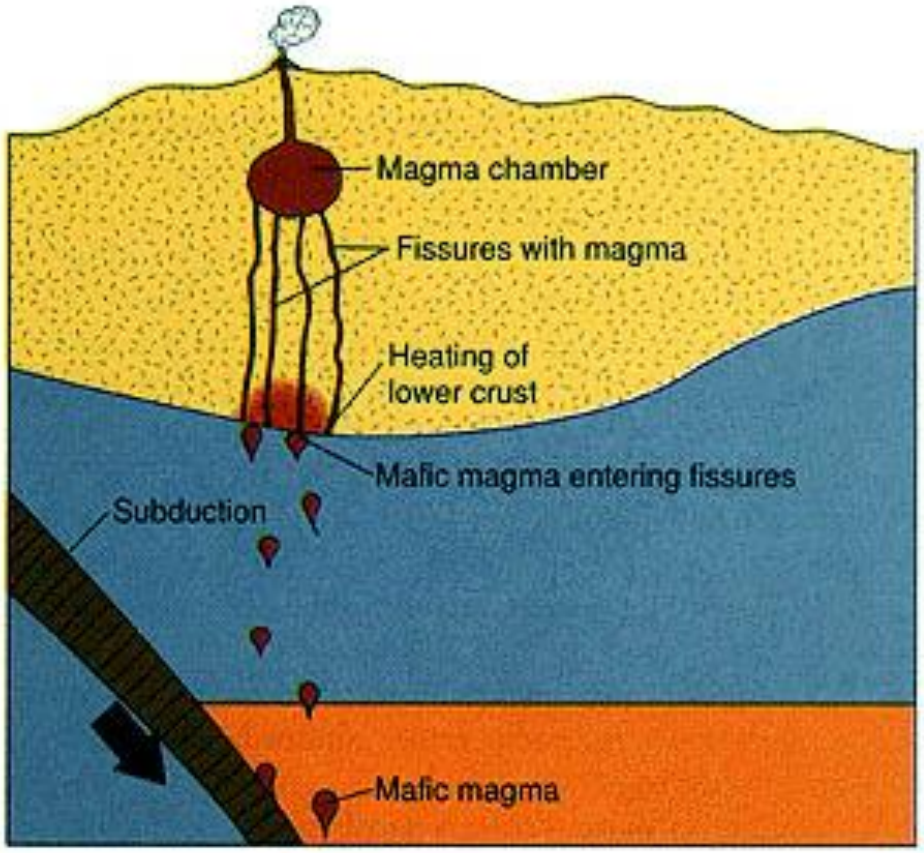
The Rock Cycle

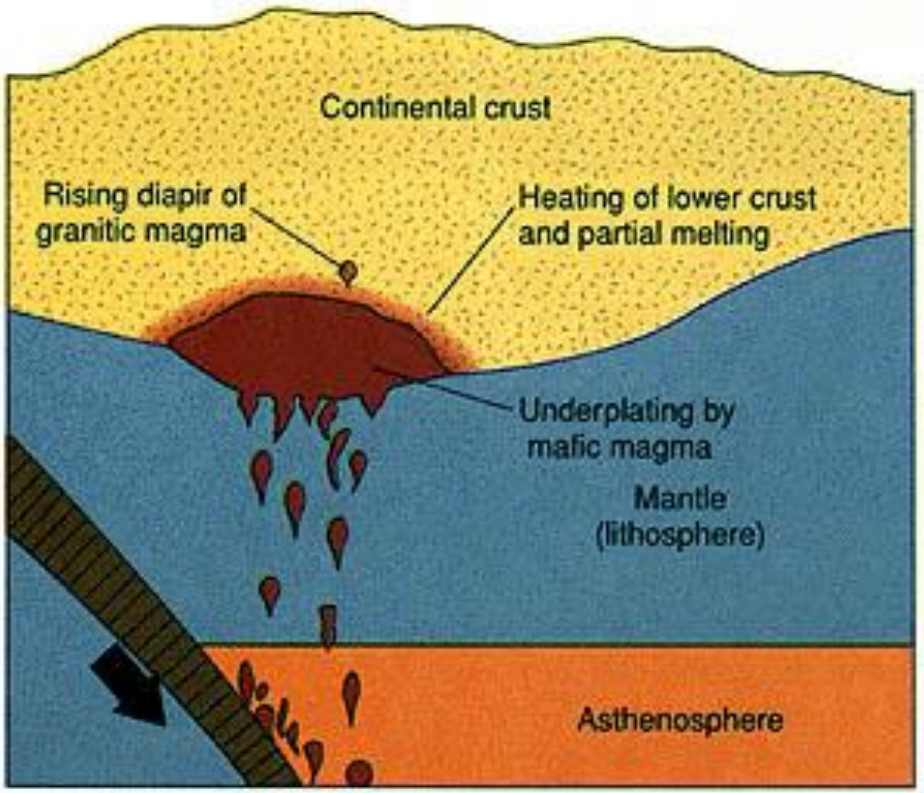
IGNEOUS ROCKS

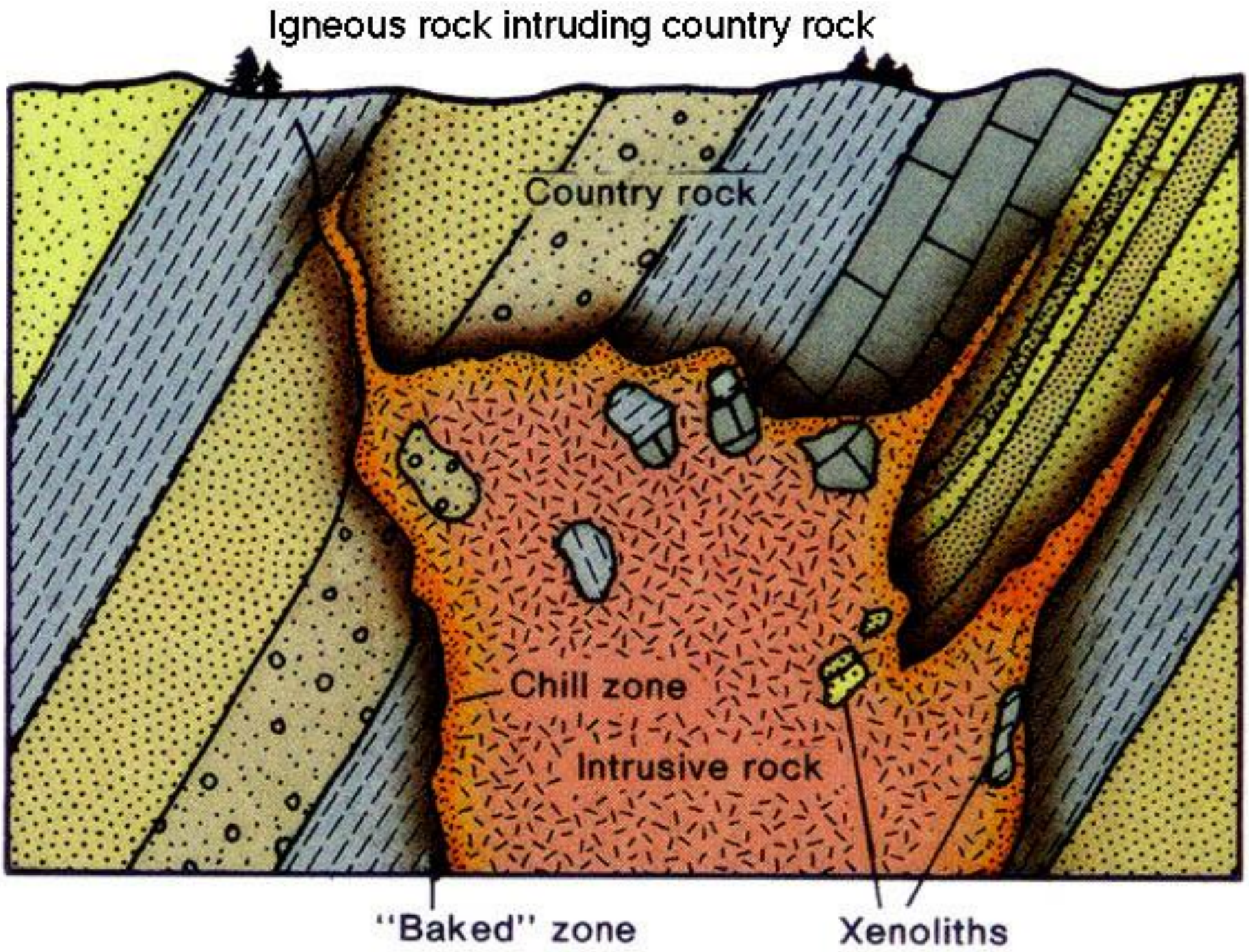
EXTRUSIVE (Volcanic)- Fine-grained

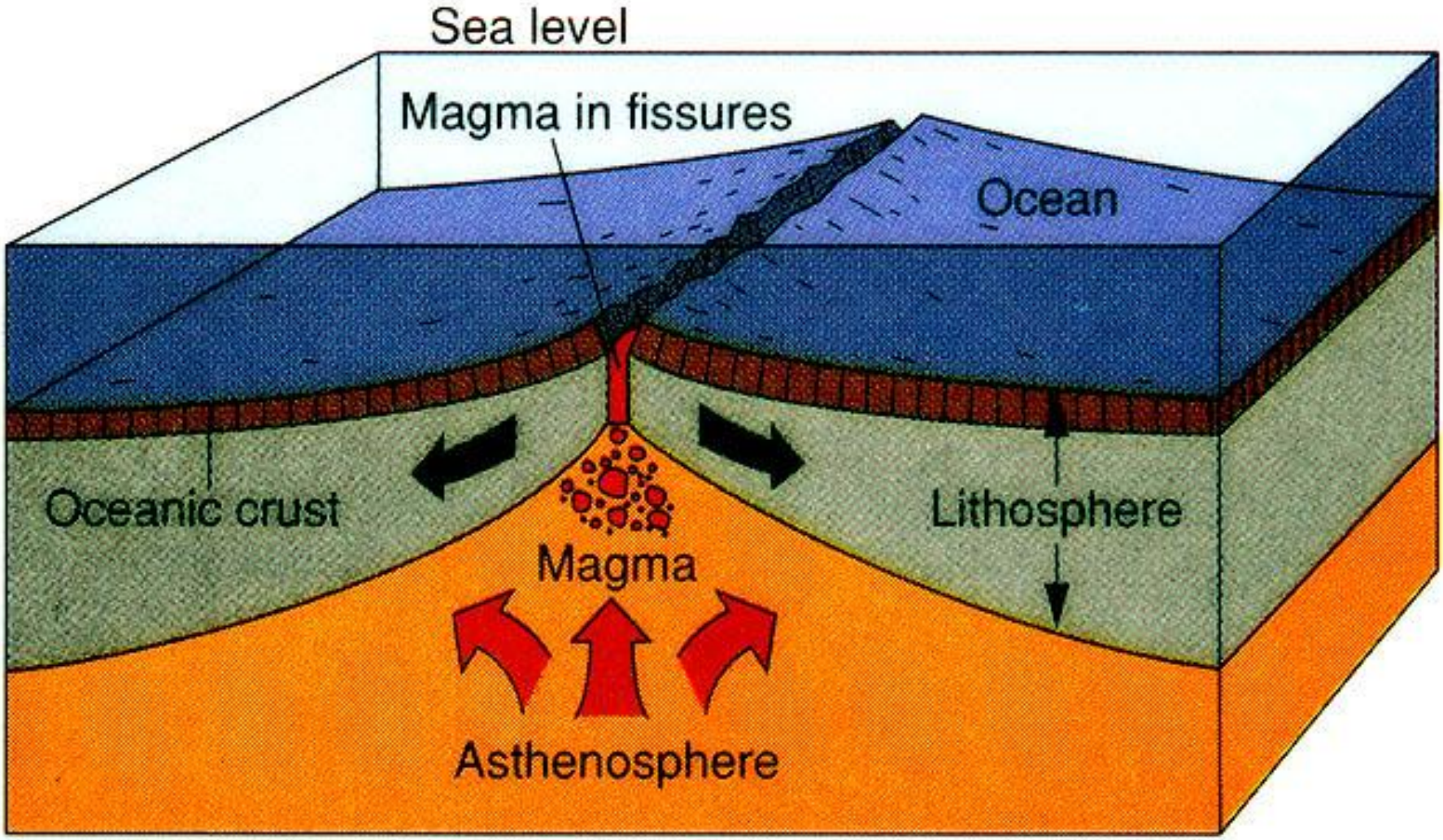
INTRUSIVE (Plutonic)- Coarse-grained


Sea level
Volcano
Mountains
Folded sedimentary rocks
Subduction zone
Continental crust (lithosphere)
Oceanic crust (lithosphere)
Mantle (lithosphere)
Mantle (lithosphere)
Magma moving upward
Magma created here
Mantle (asthenosphere)
Mantle (asthenosphere)
kilometers
0
100

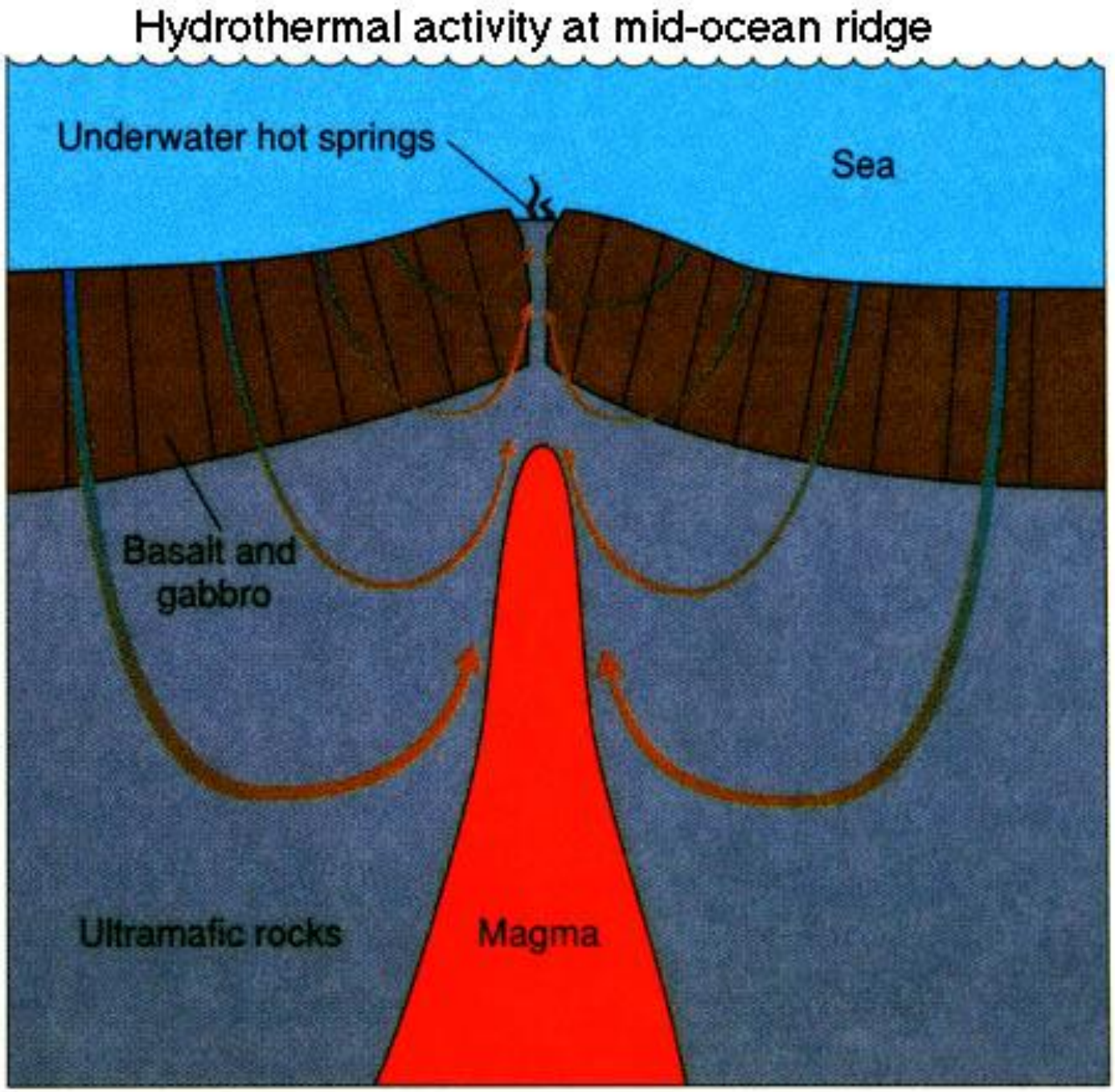

Magma chamber
Fissures with magma
Heating of lower crust
Mafic magma entering fissures
Subduction
Mafic magma


Continental crust
Rising diapir of granitic magma
Heating of lower crust and partial melting
Underplating by mafic magma
Mantle (lithosphere)
Asthenosphere


Igneous rock intruding country rock
Country rock
Chill zone
Intrusive rock
"Baked" zone
Xenoliths


Sea level
Magma in fissures
Ocean
Oceanic crust
Magma
Lithosphere
Asthenosphere

Mid-Atlantic Ridge


Hydrothermal activity at mid-ocean ridge
Underwater hot springs
Sea
Basalt and gabbro
Ultramafic rocks
Magma

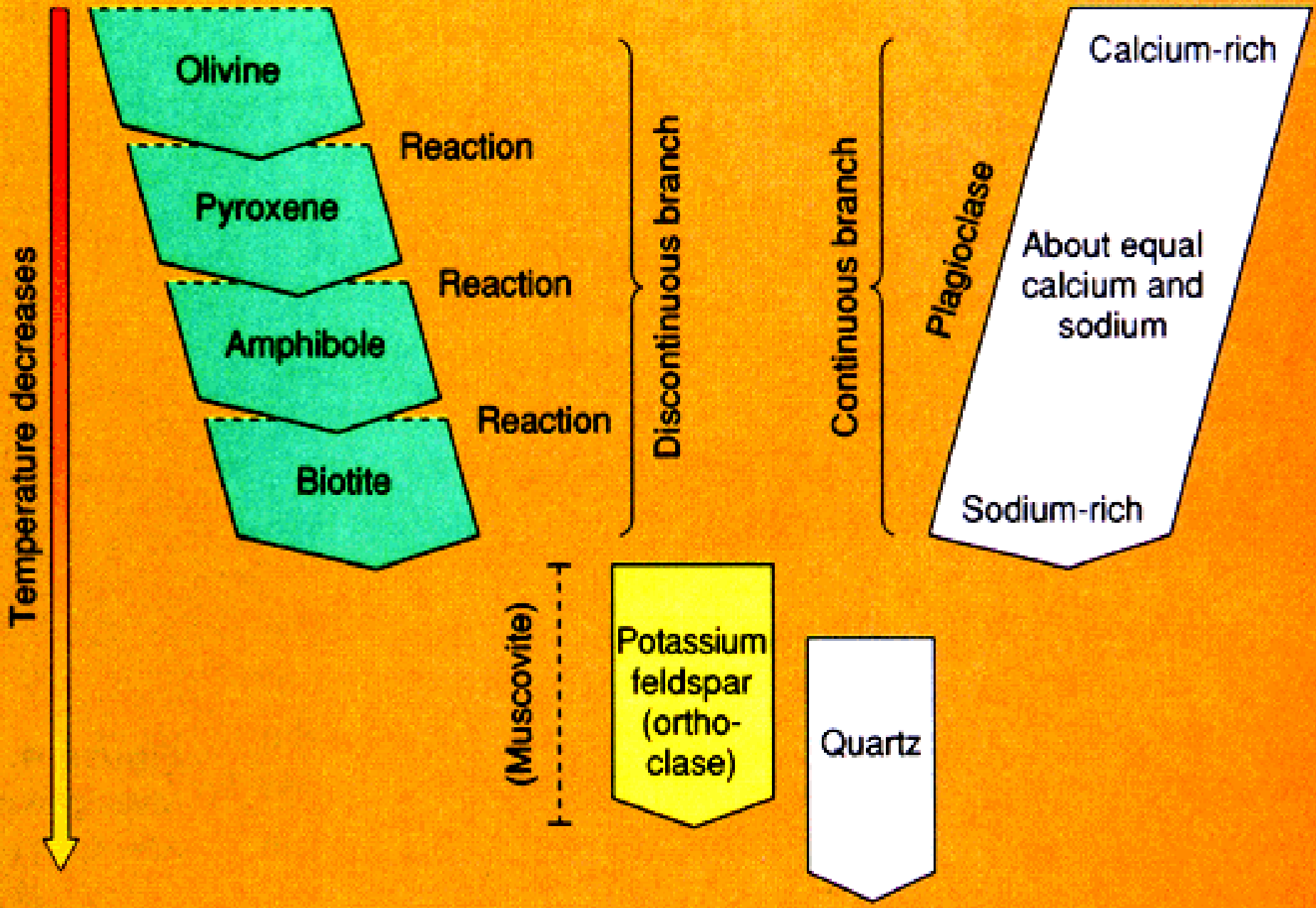
Black Smoker

Rocks are Impure Substances

Melting occurs at crystal boundaries

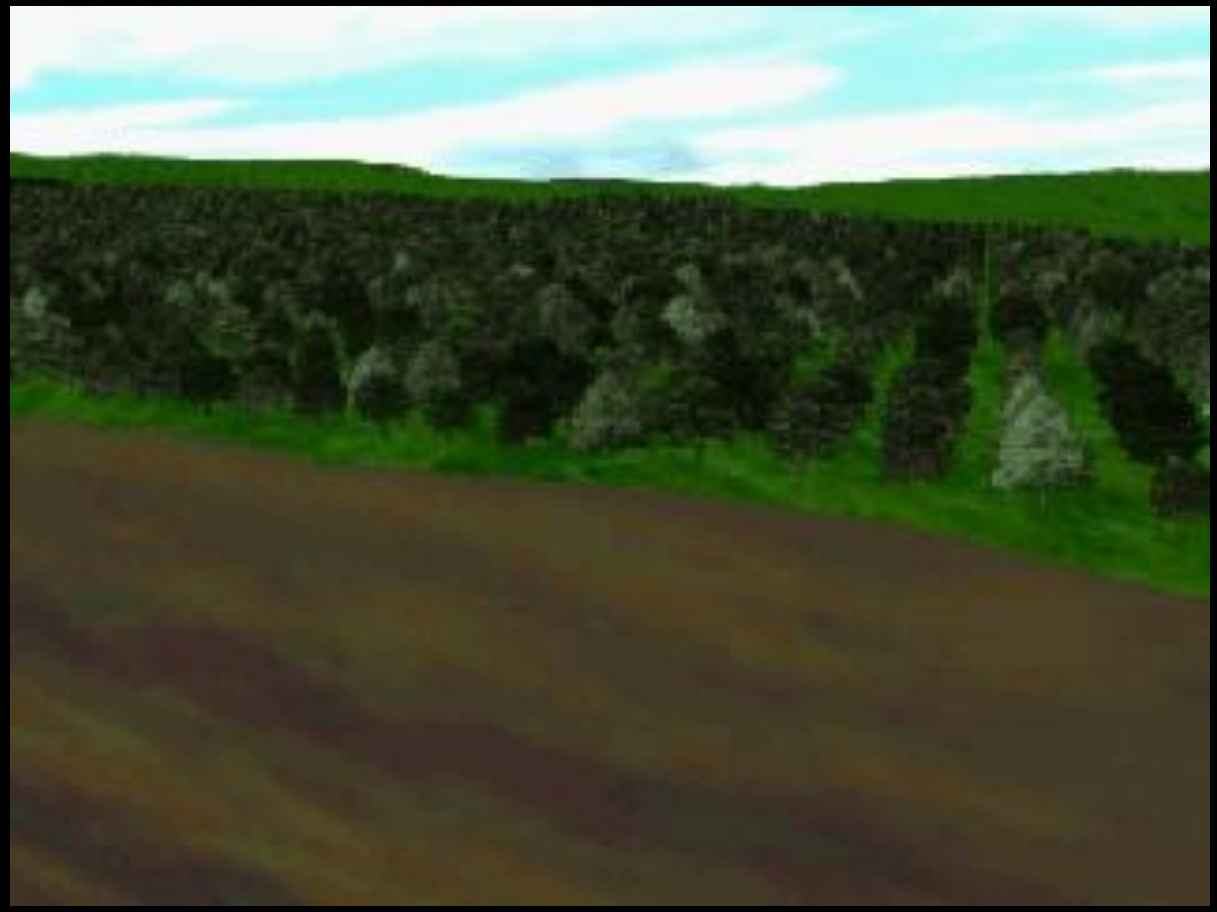
Low T phases melt first

High T phases melt last

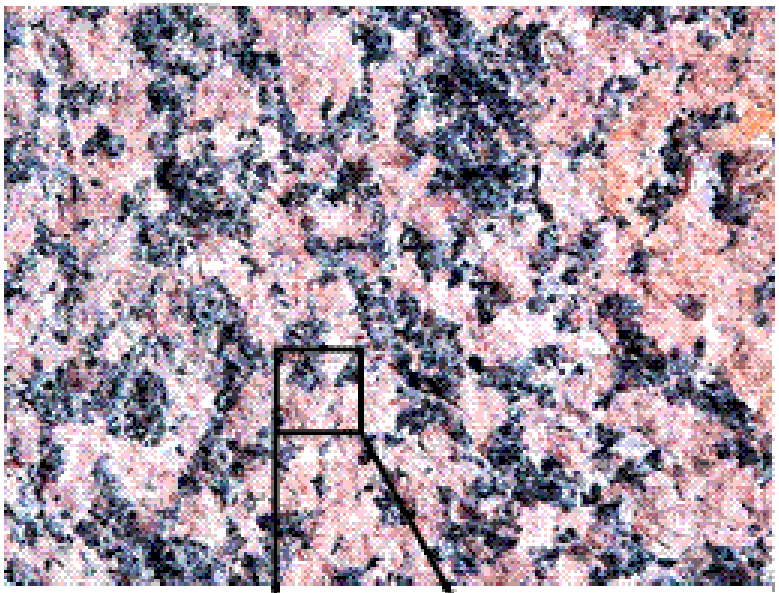

Temperature decreases
Olivine
Reaction
Pyroxene
Reaction
Amphibole
Reaction
Biotite
Discontinuous branch
Continuous branch
Plagioclase
Calcium-rich
About equal calcium and sodium
Sodium-rich
(Muscovite)
Potassium feldspar (ortho-clase)
Quartz

How magmas evolve

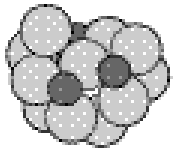
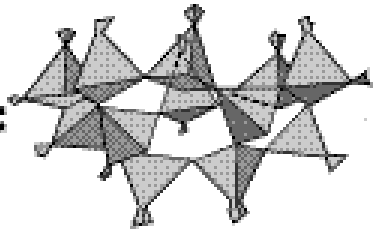
- Differentiation
  - Bowen's Reaction Series
    - Discontinuous Branch
    - Continuous Branch
  - Crystal Settling
    - Ore deposits due to crystal settling
- Partial melting
- Assimilation
- Mixing of magmas



Specimen of Granite



Specimen of Hammie

0.0000001 mm  = 

Silicon and oxygen atoms in crystalline structure

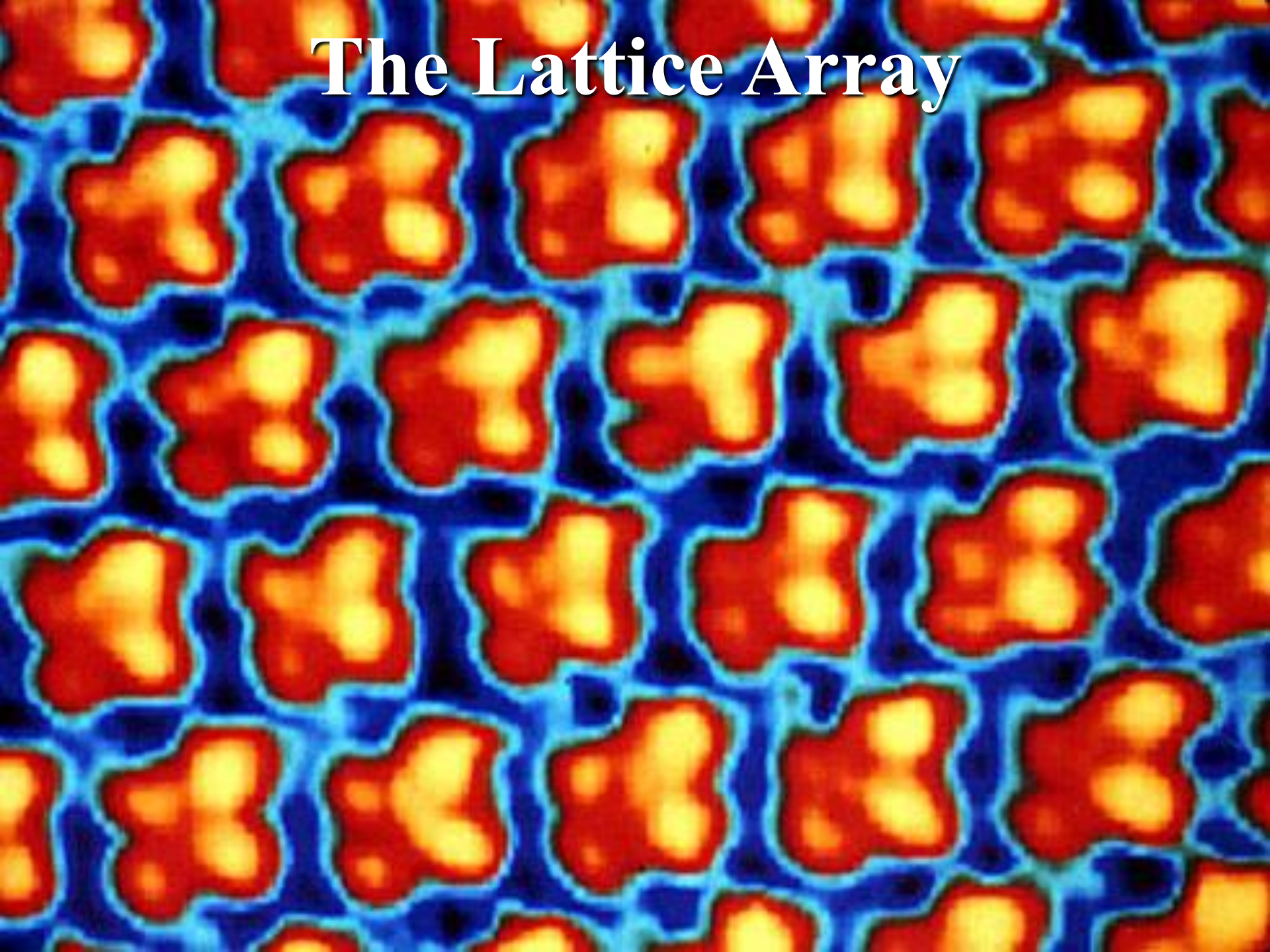
Diagrammatic representation of crystalline structure

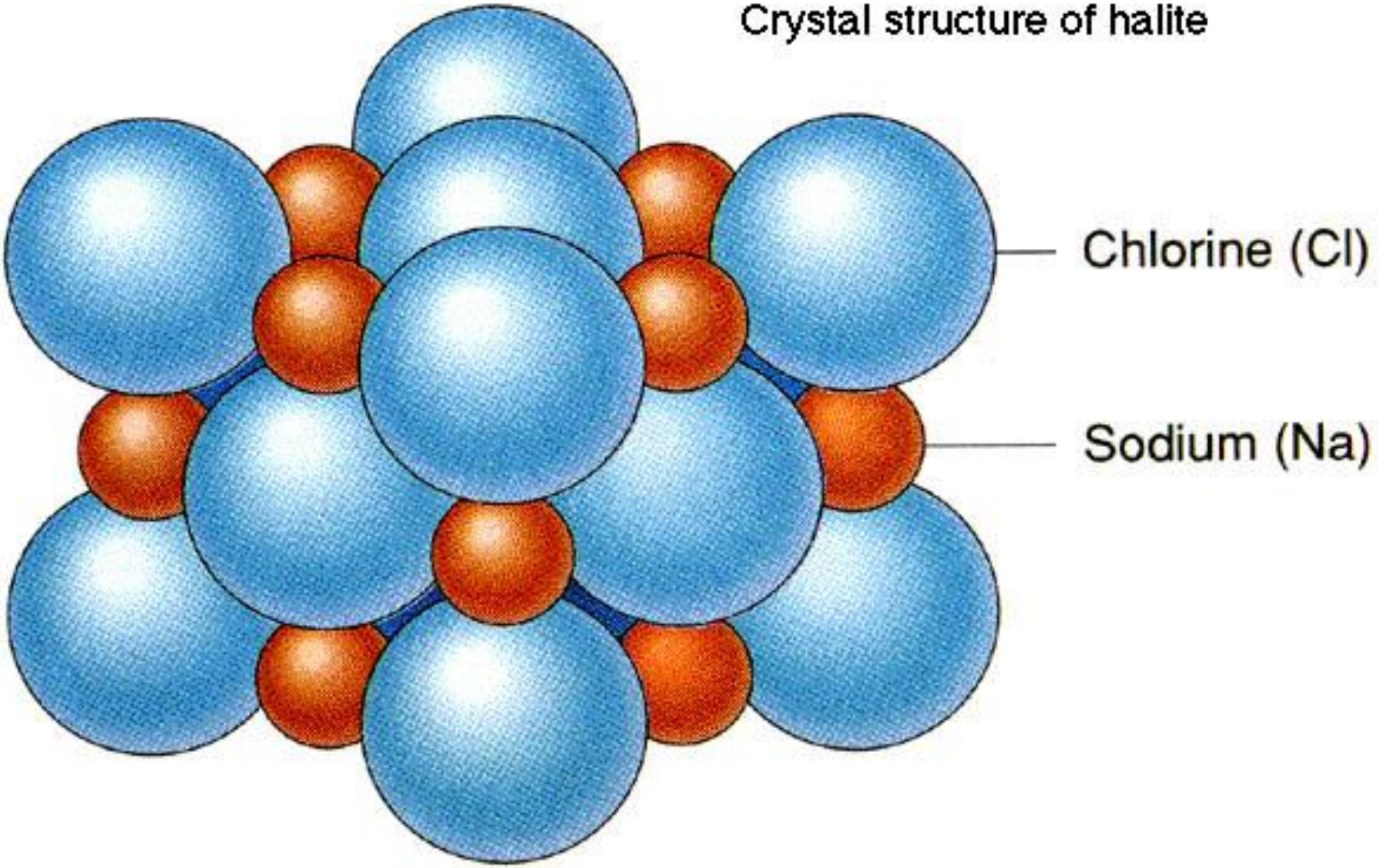
Granite – Rock of Ages

Interlocking Texture

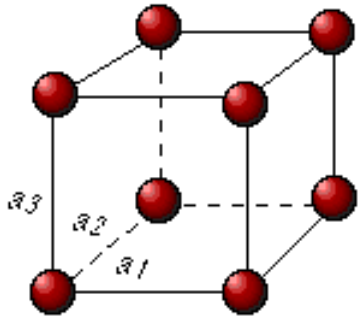
MINERALS

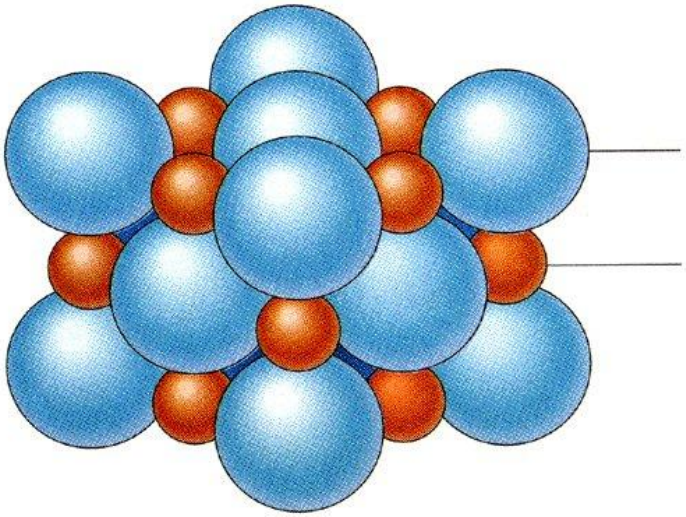
The Lattice Array



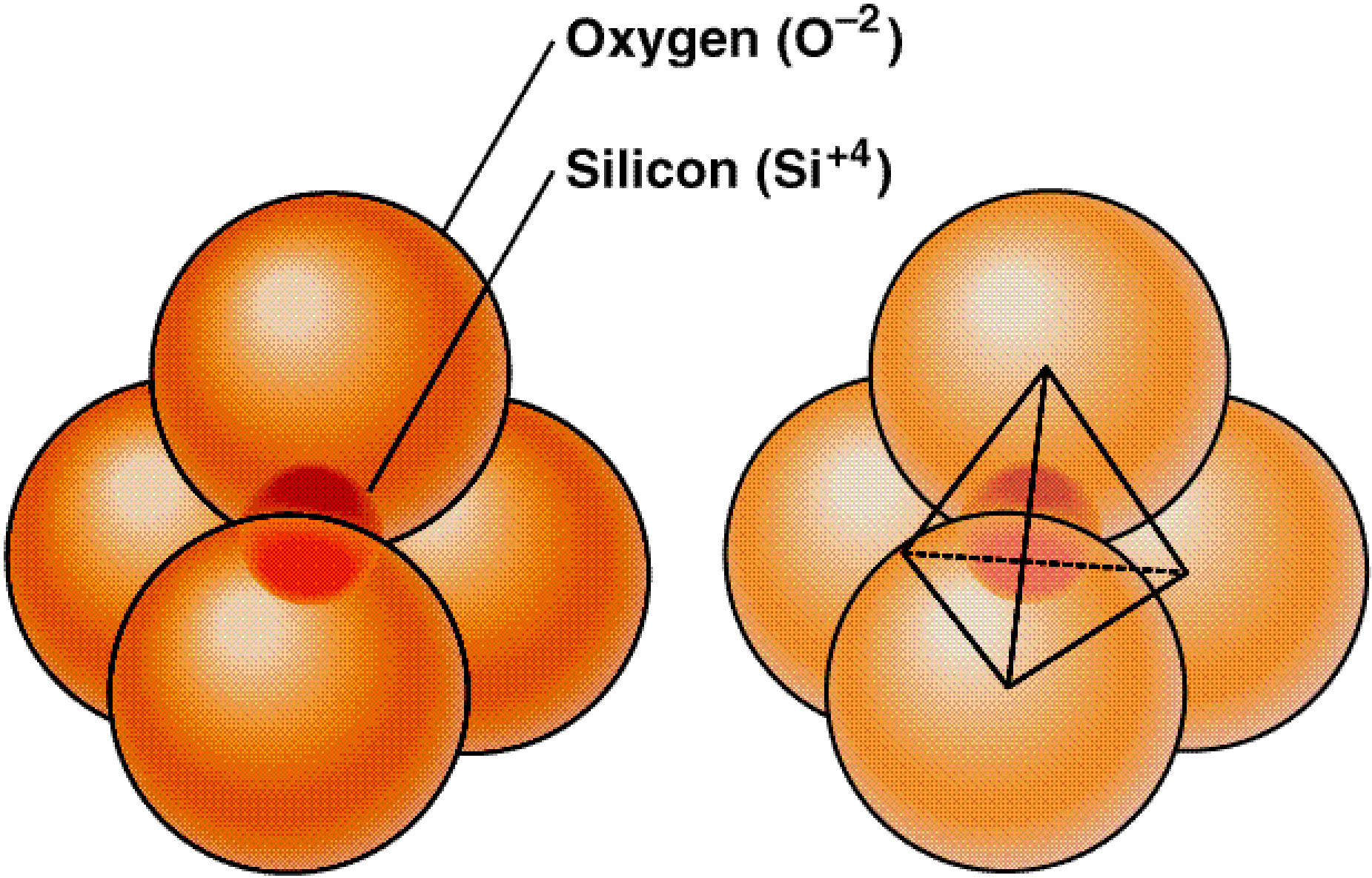

Crystal structure of halite
Chlorine (Cl)
Sodium (Na)

Cubic Cleavage Lattice Property





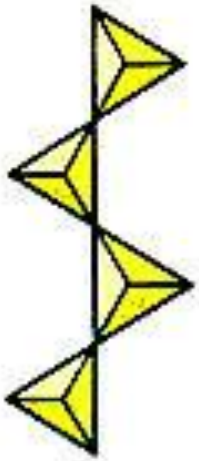
Silicon-Oxygen Tetrahedron



Silicate Architectural Groups

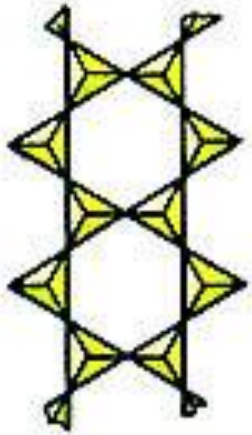
Isolated silicate structure

Olivine



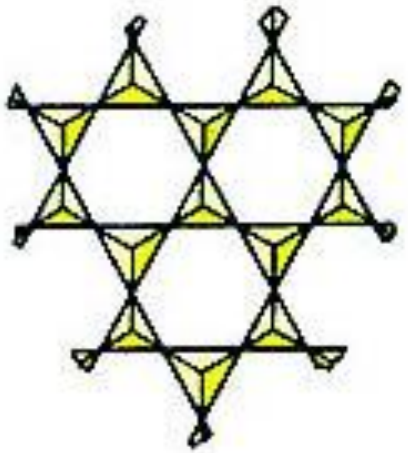
Single chain structure

Pyroxene group



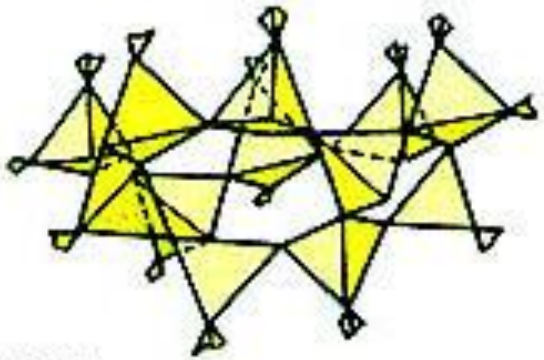
Double chain structure

Amphibole group



Sheet silicate structure

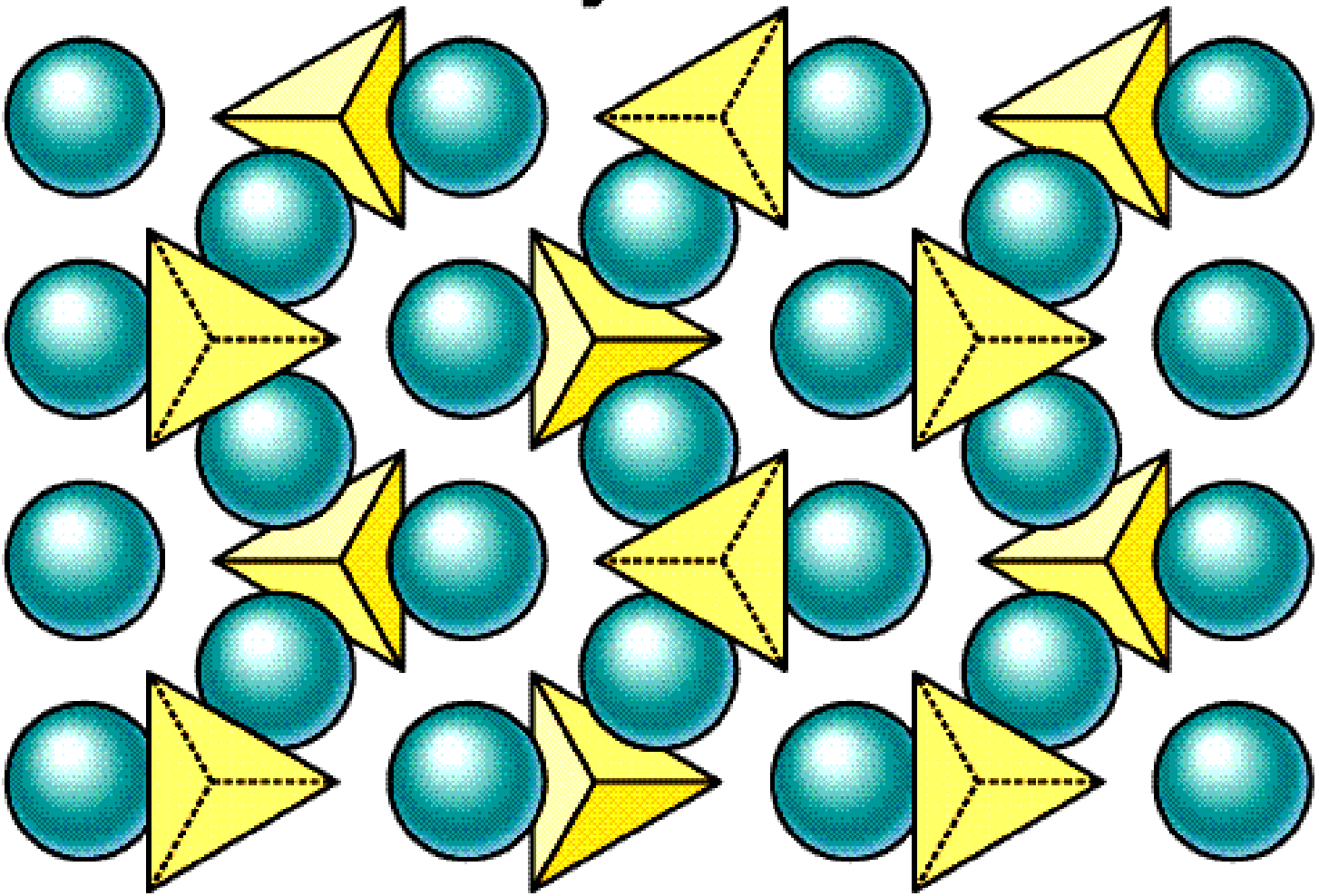
Mica group
Clay group



Framework silicate structure

Quartz
Feldspar group

Olivine Crystal Structure



Silicon-oxygen tetrahedron apex toward you

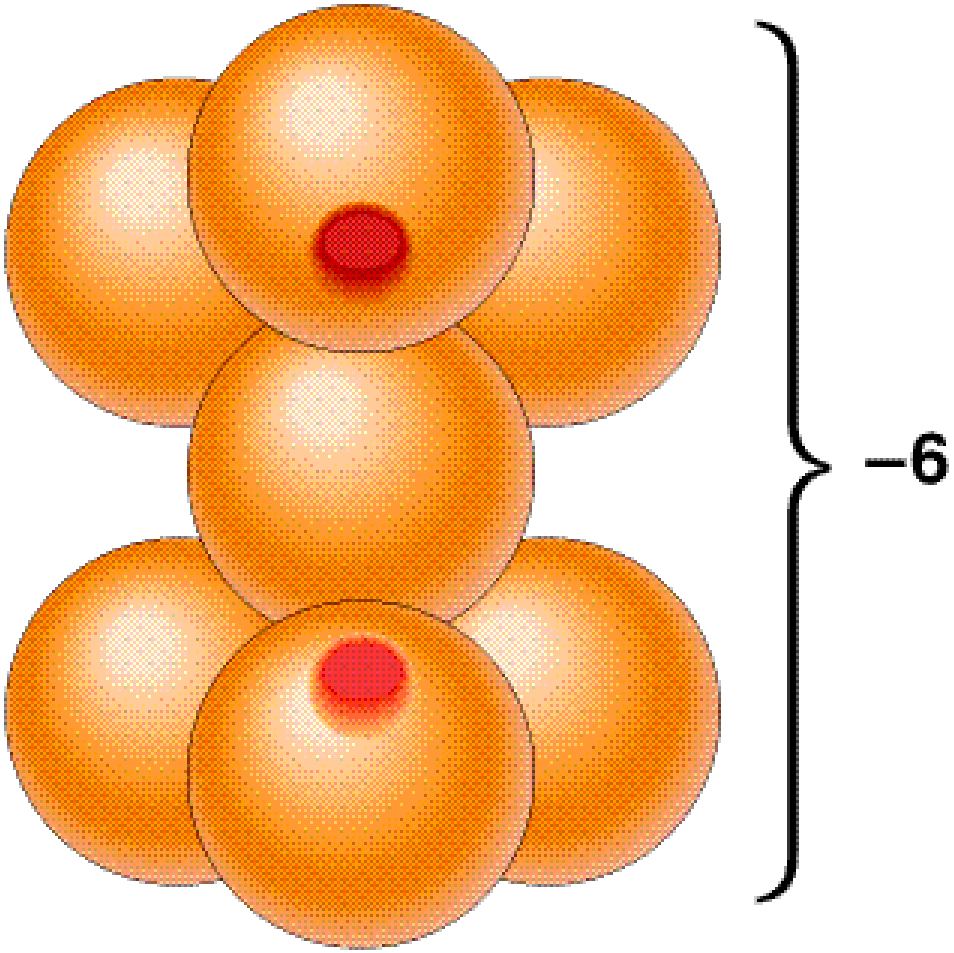
Silicon-oxygen tetrahedron apex away from you

Mg^{++} or Fe^{++}

Olivine

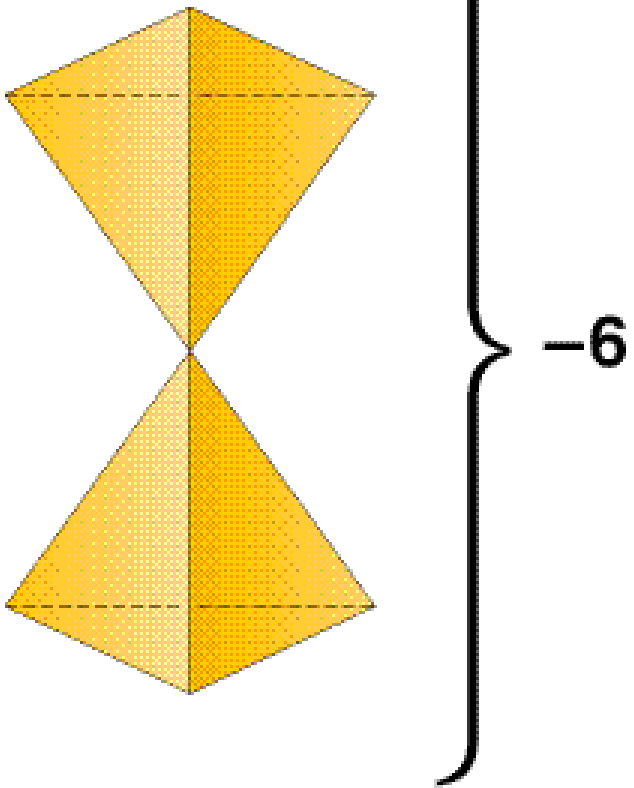
Two Tetrahedron Sharing an Oxygen Atom

$Si_2O_7^{-6}$



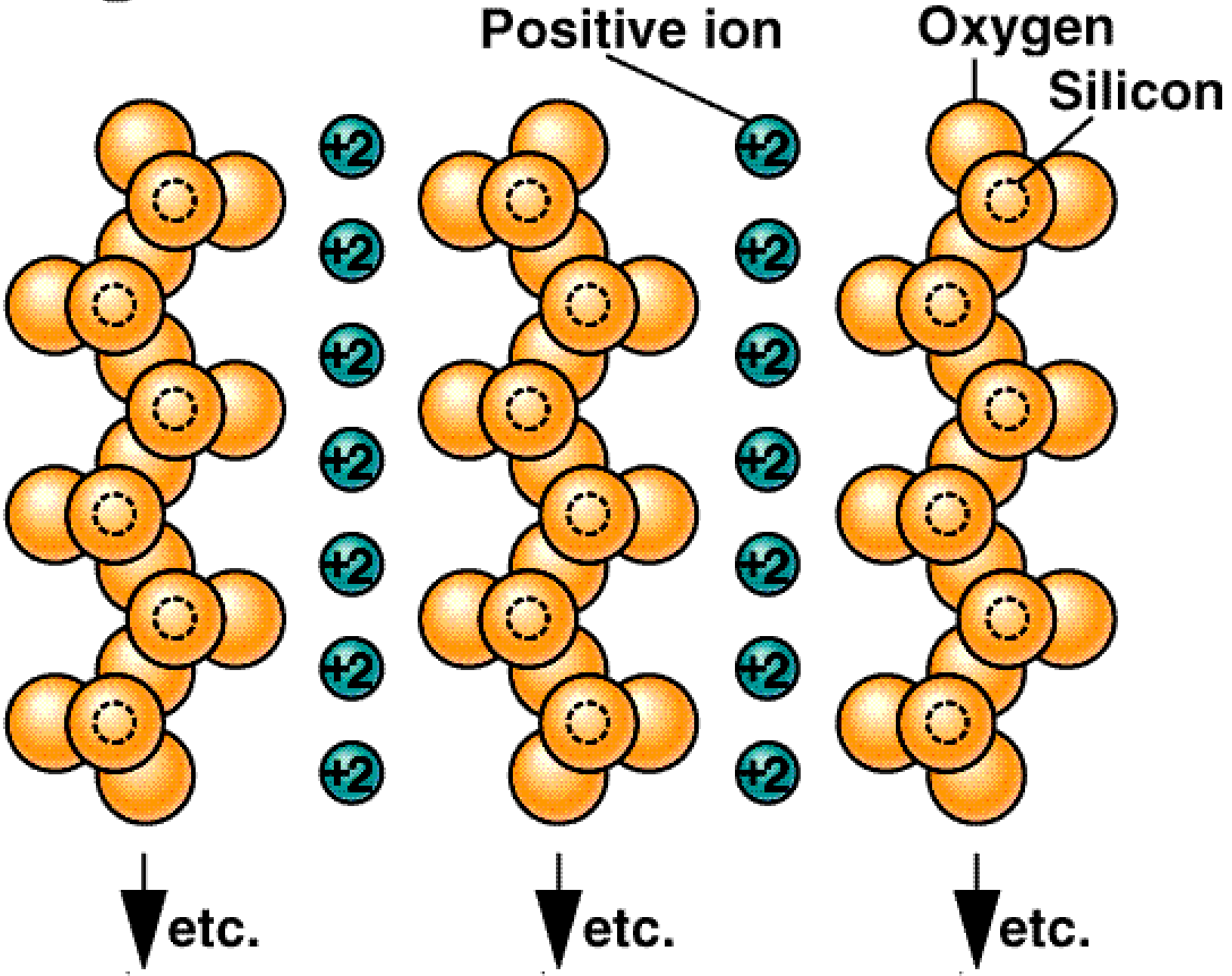
C

$Si_2O_7^{-6}$

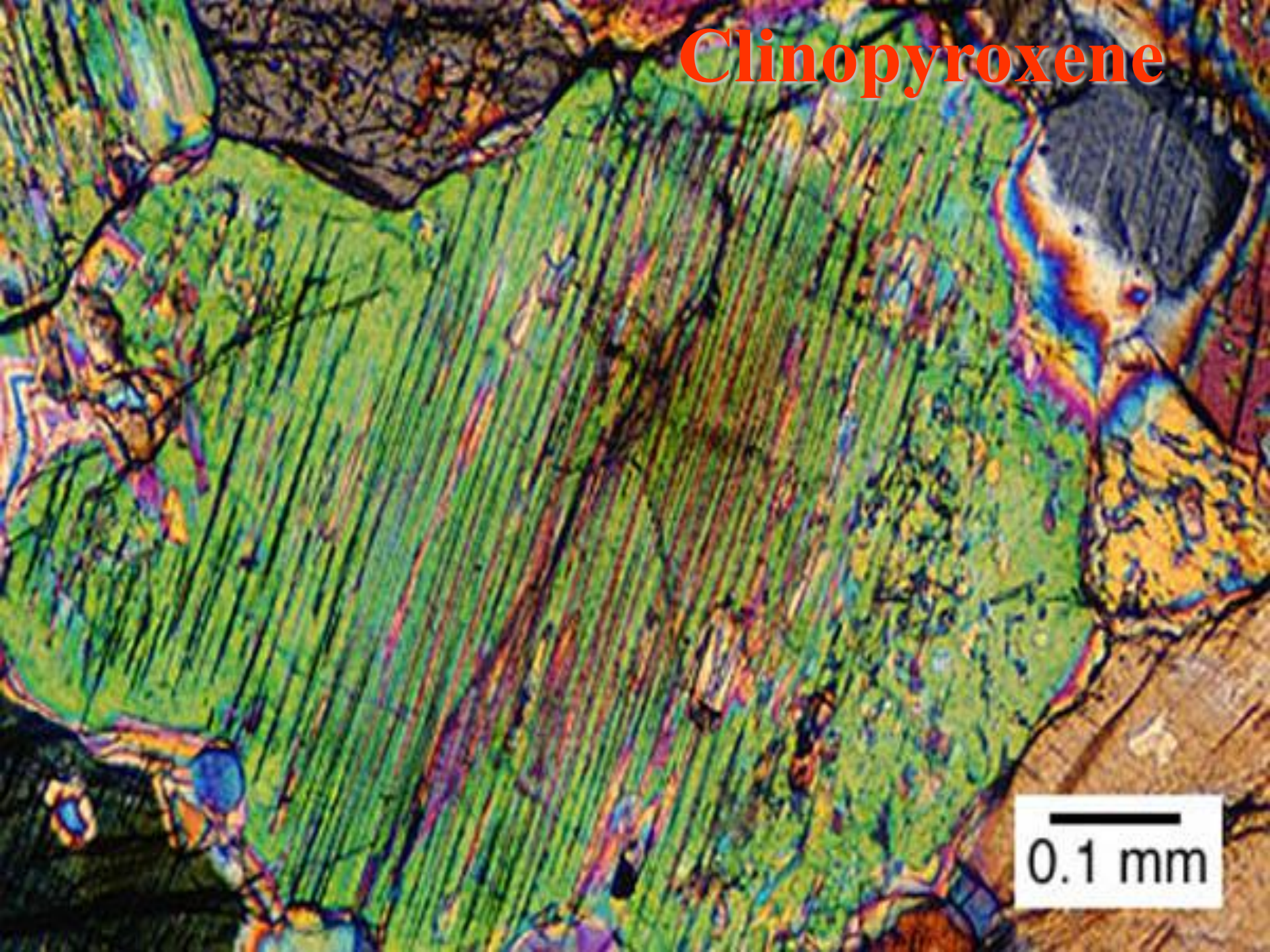


D

Single-Chain Silicate Mineral

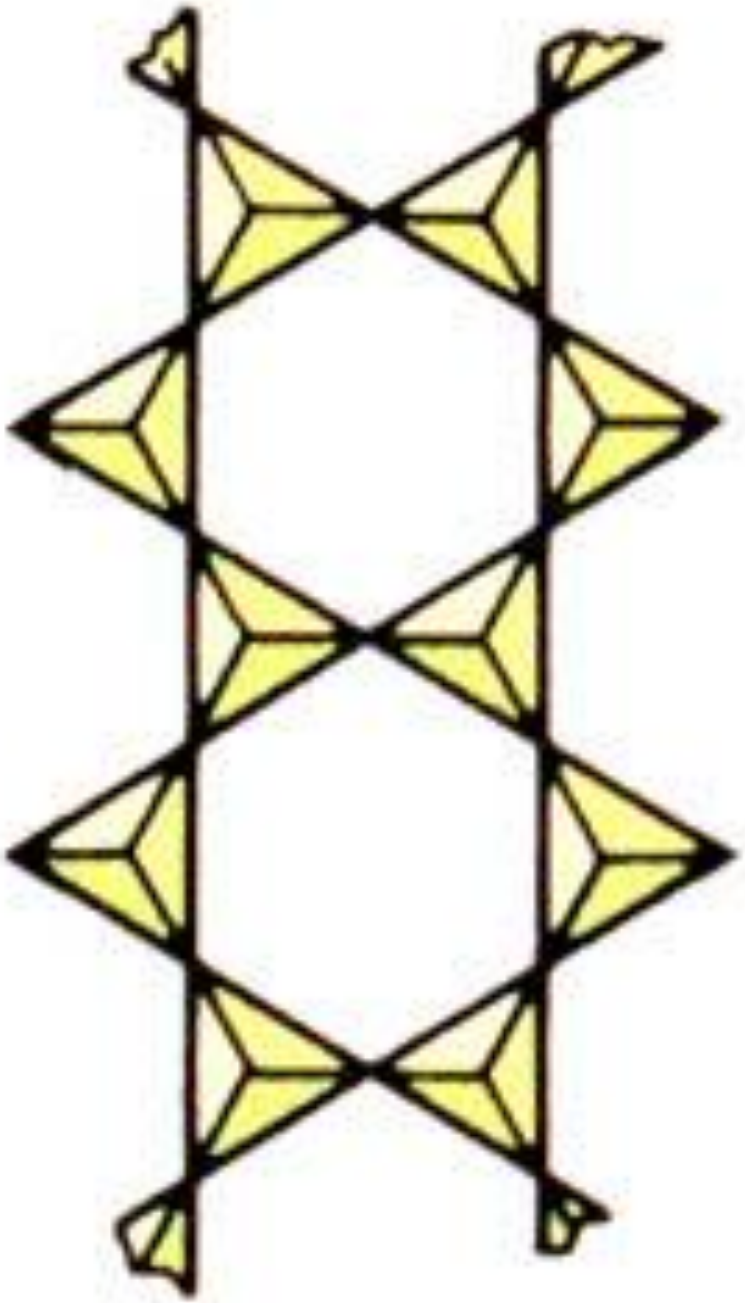


Pyroxene Group


Clinopyroxene
0.1 mm

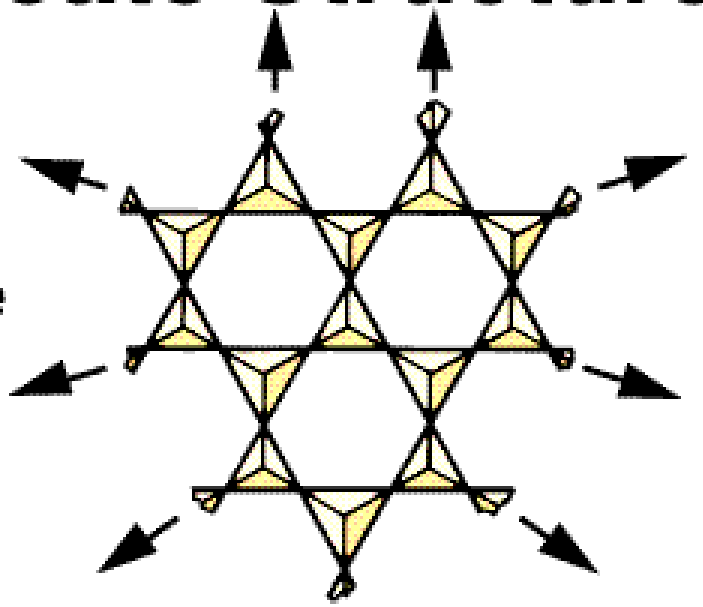
Amphibole group

Double chain structure



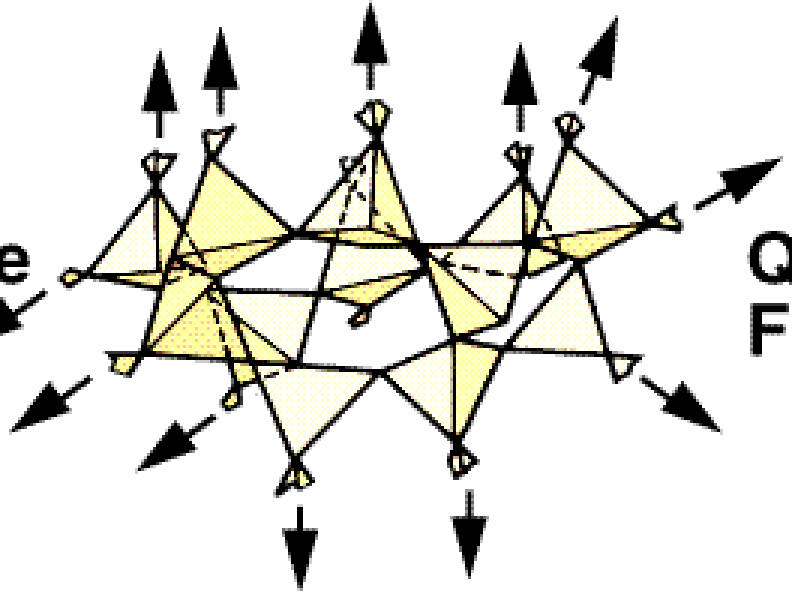
Amphibole Group

Silicate Structures



Sheet silicate structure

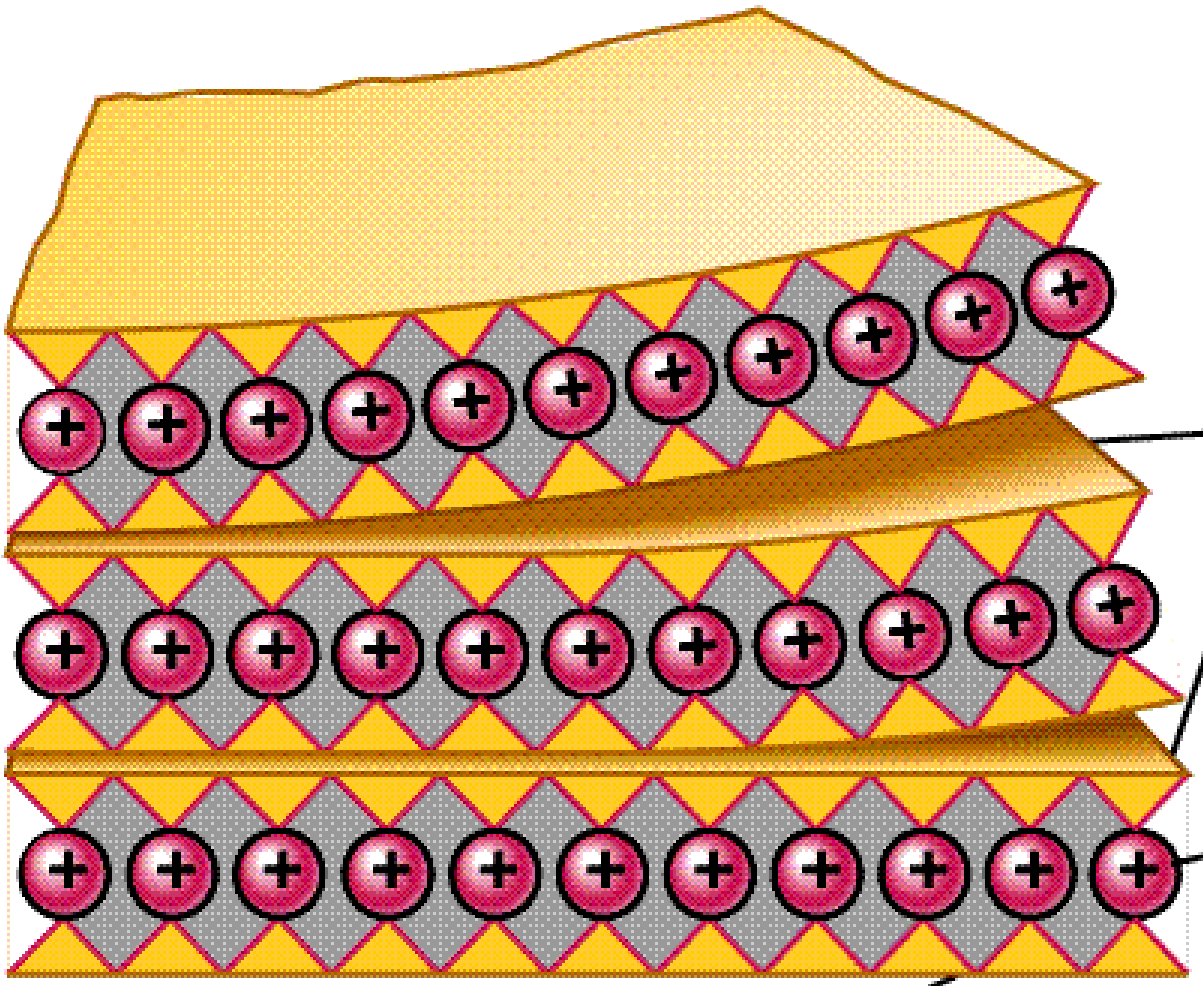
Mica group
Clay group



Framework silicate structure

Quartz
Feldspar group

Mica Crystal Structure



Because of weak bonds, mica splits easily between "sandwiches"

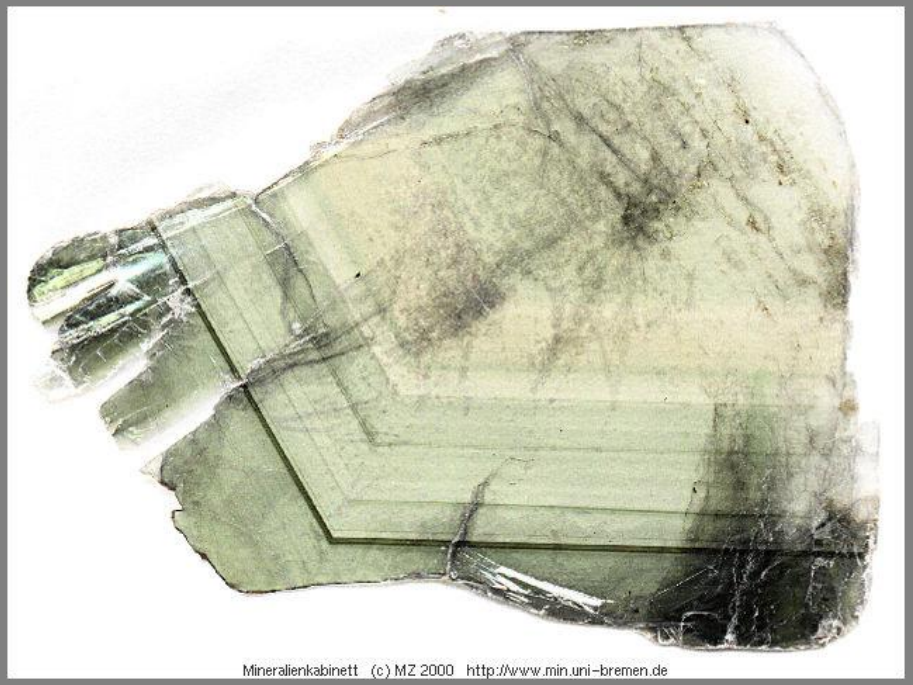
Positive ions, sandwiched between two sheet silicate layers

Sheet silicate layer

B

Mica Group

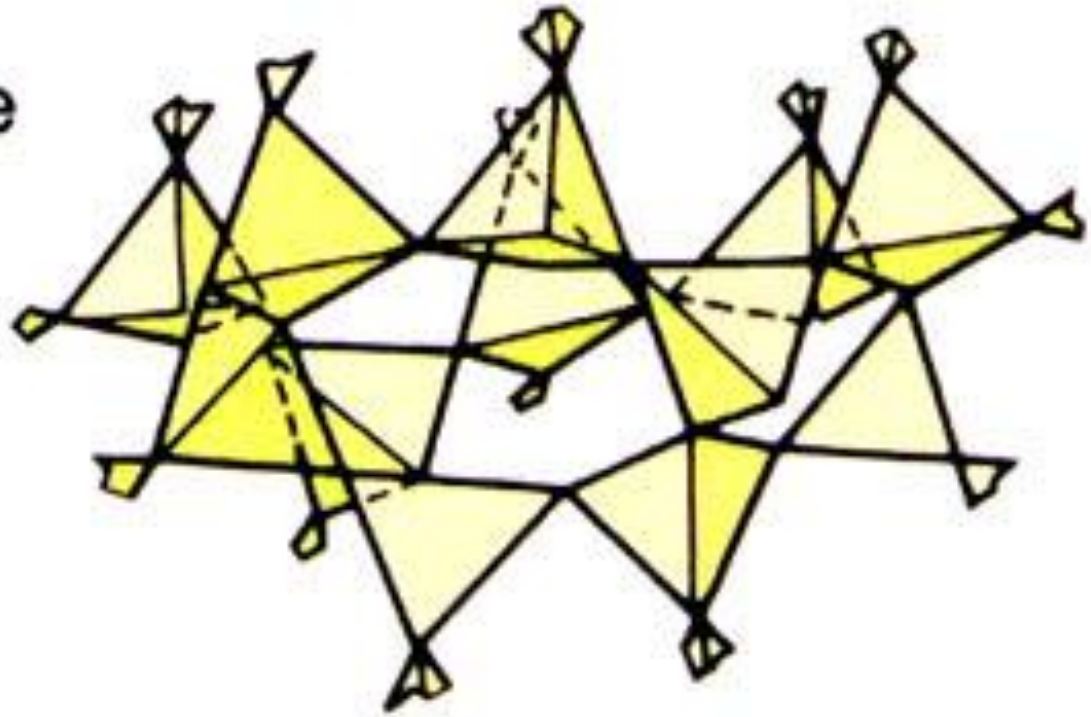

Mineralienkabinett (c) MZ 2000 http://www.min.uni-bremen.de


Mineralienkabinett (c) MZ 2000 http://www.min.uni-bremen.de

Framework silicate structure

Quartz

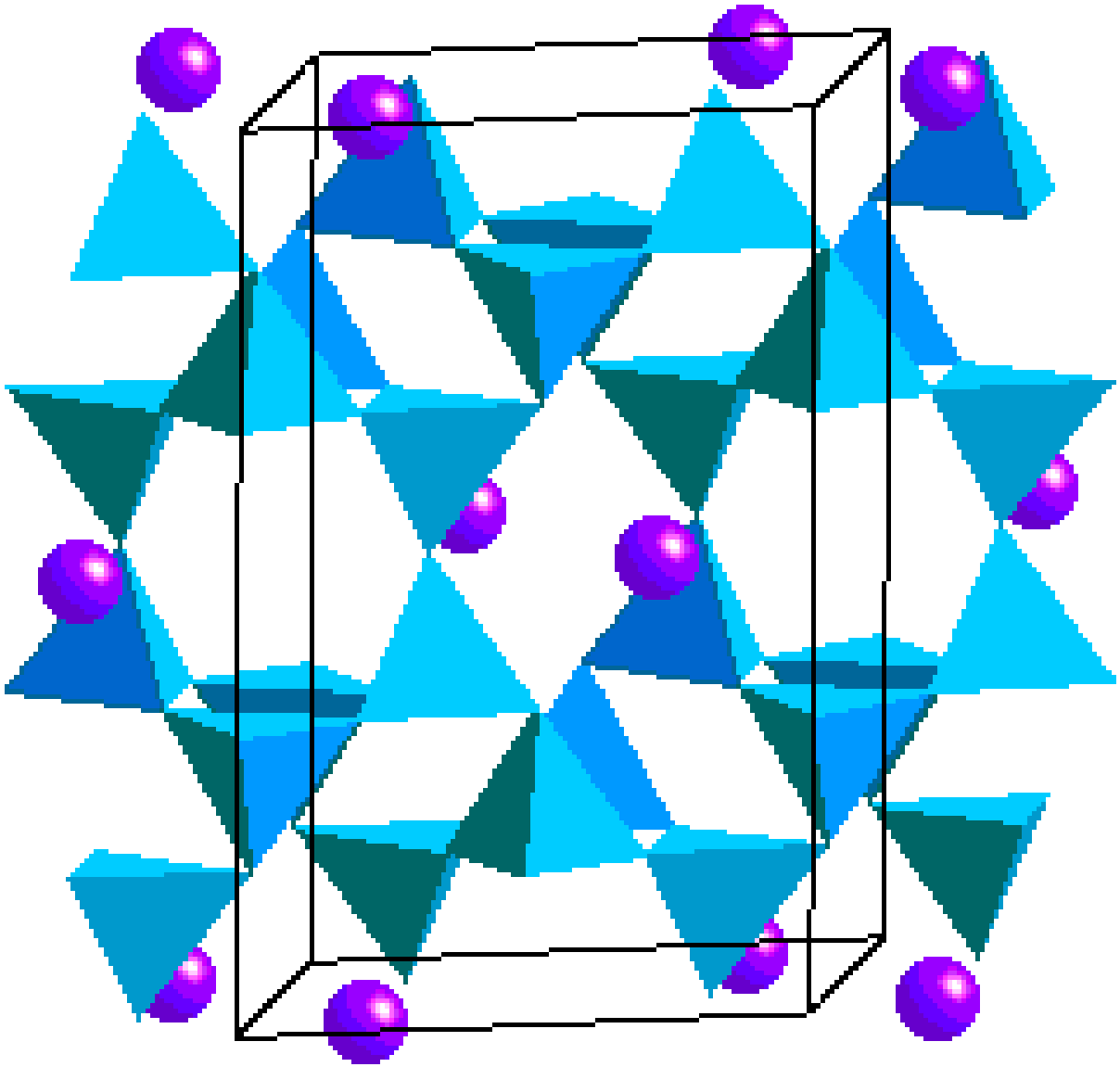
Feldspar group



Quartz Group

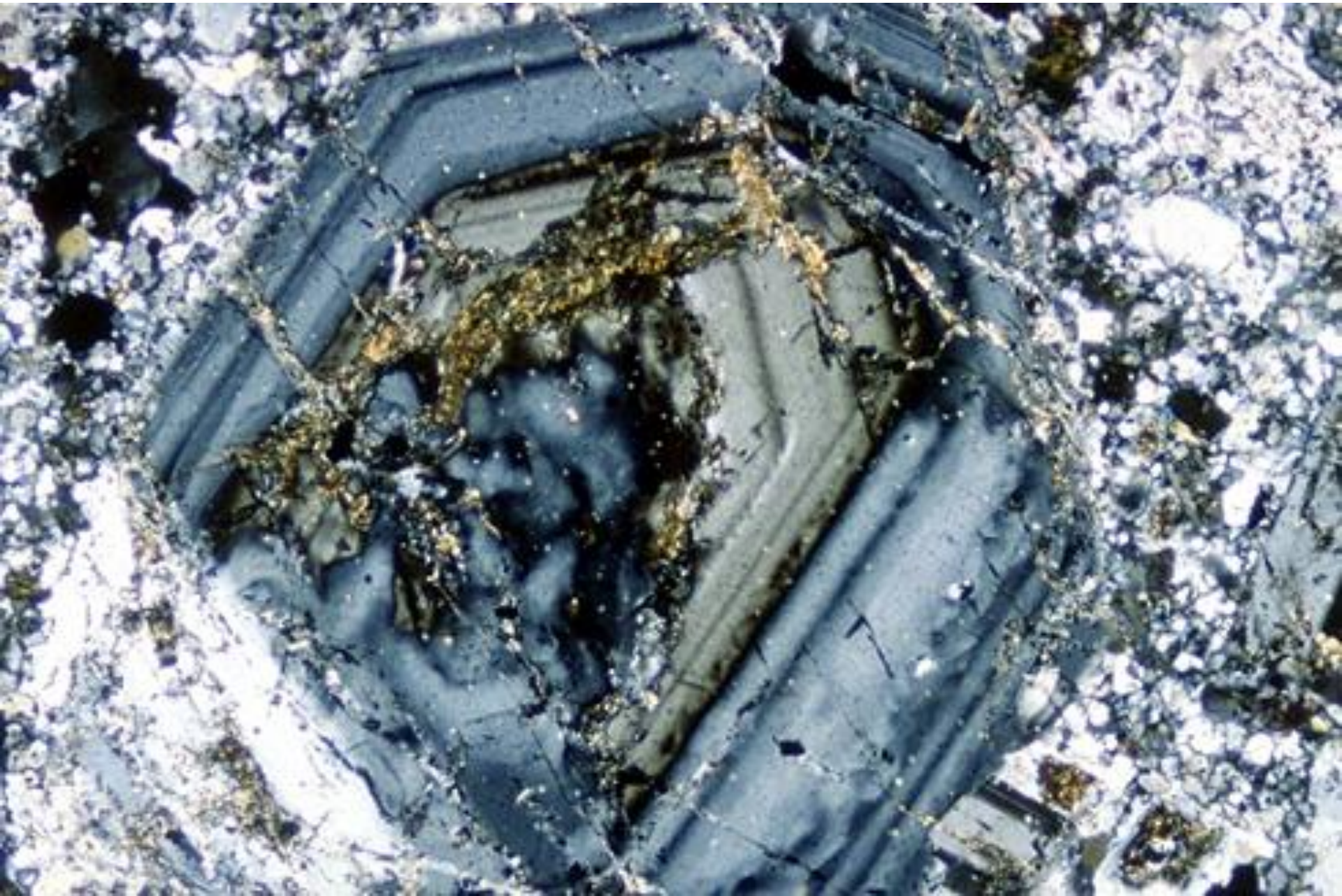
K-Feldspar Group

Sanidine (K-Feldpar)




Labradorite (Plagioclase)

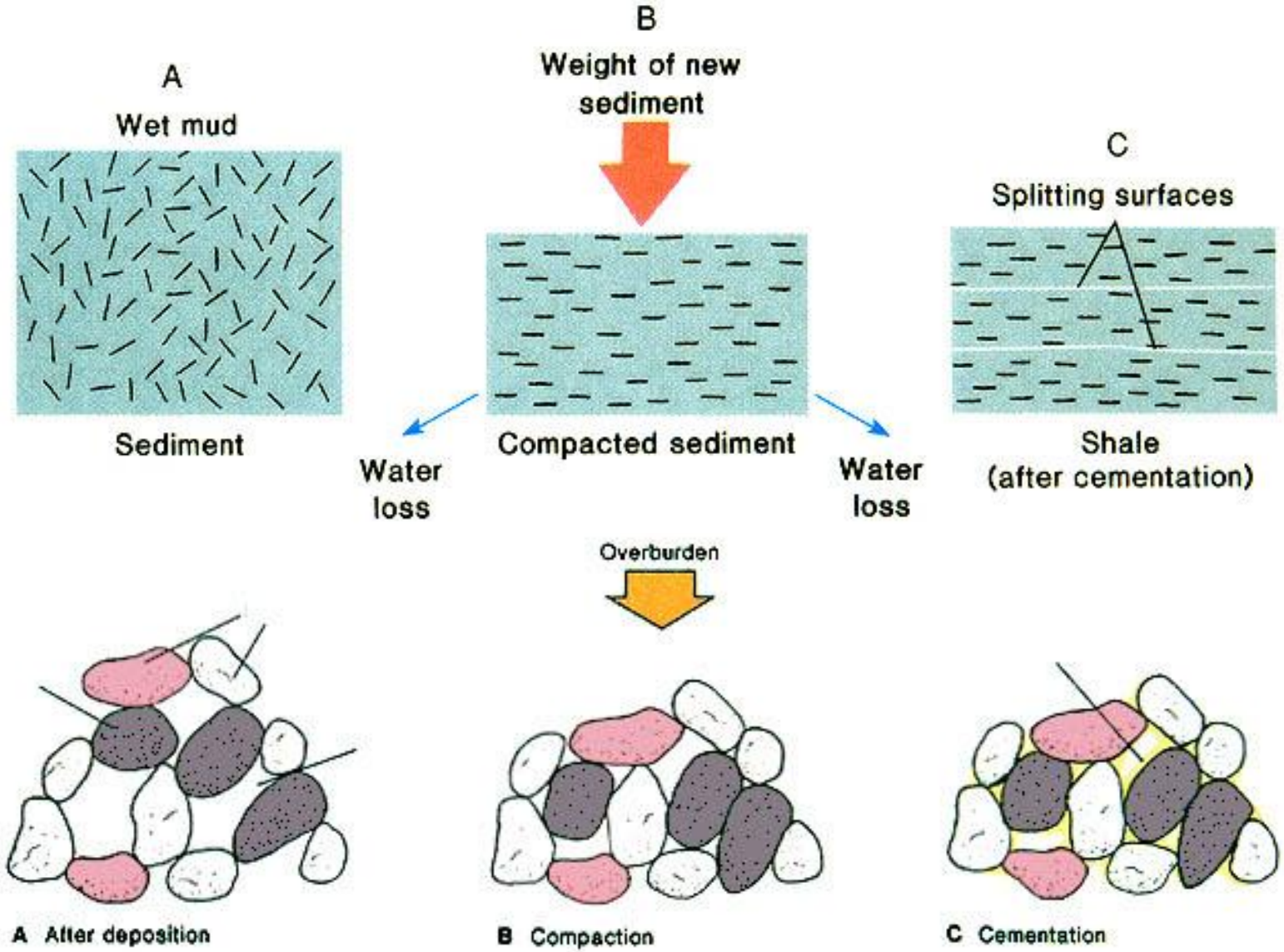
Oscillatory Zoned Plagioclase



Zoning in Minerals

SEDIMENTS & SEDIMENTARY ROCKS

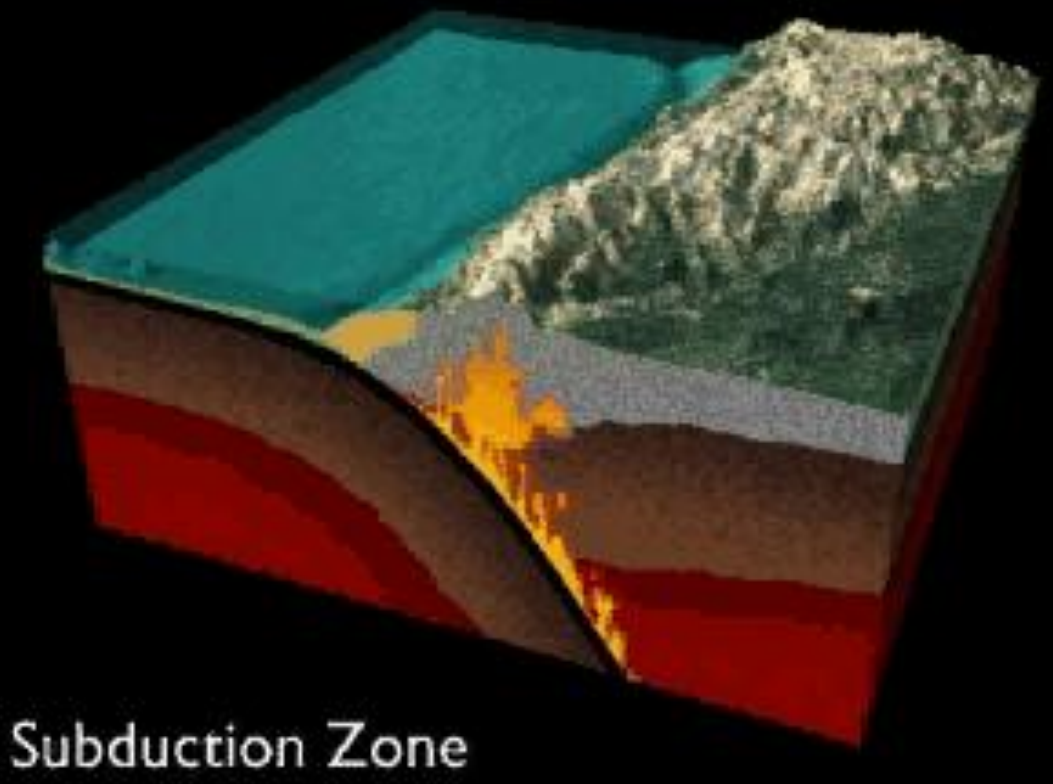
Clastic Sedimentary Rocks



Sandstone with Calcite Cement

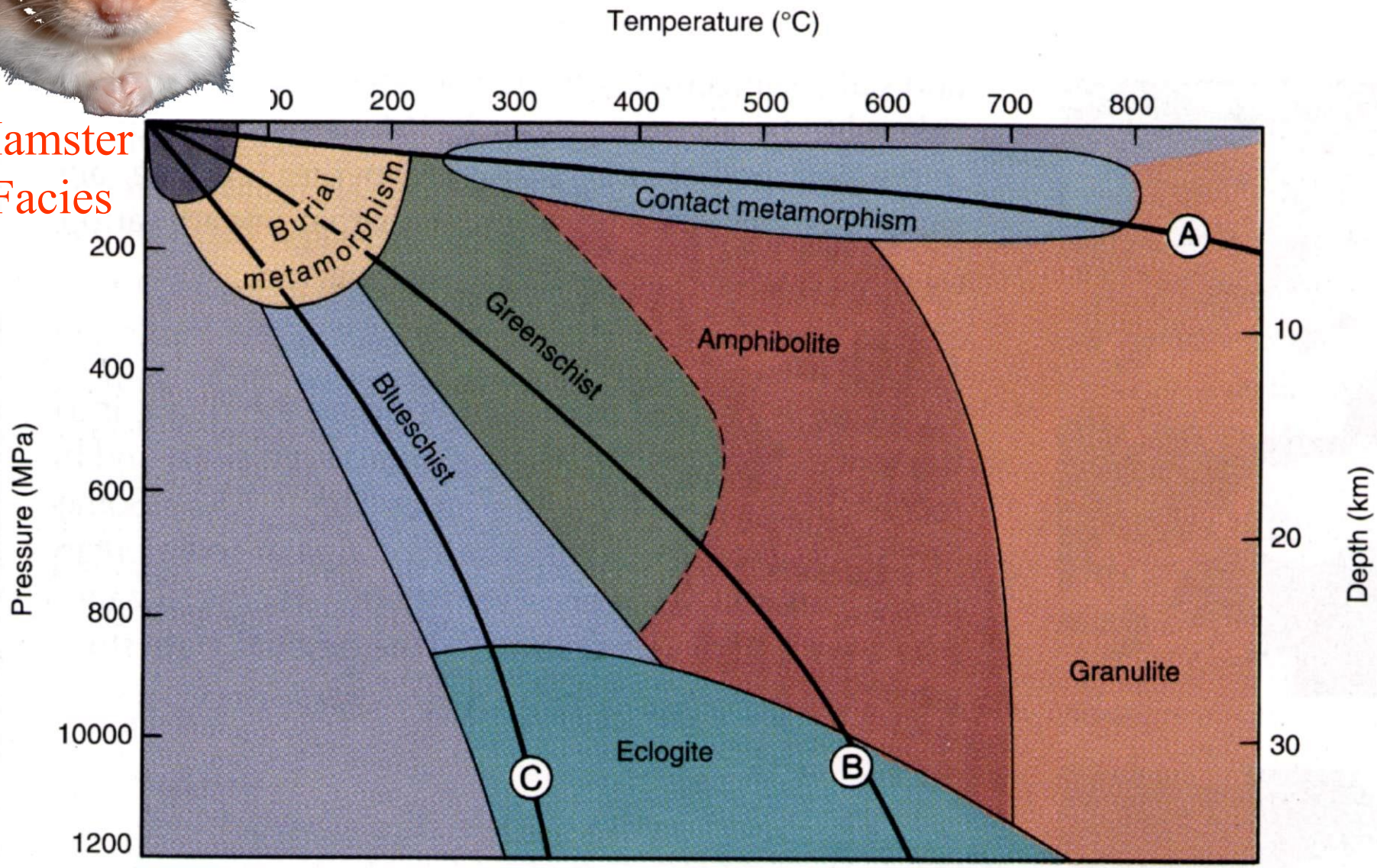
METAMORPHISM , METAMORPHIC ROCKS, & HYDROTHERMAL ROCKS

Metamorphism



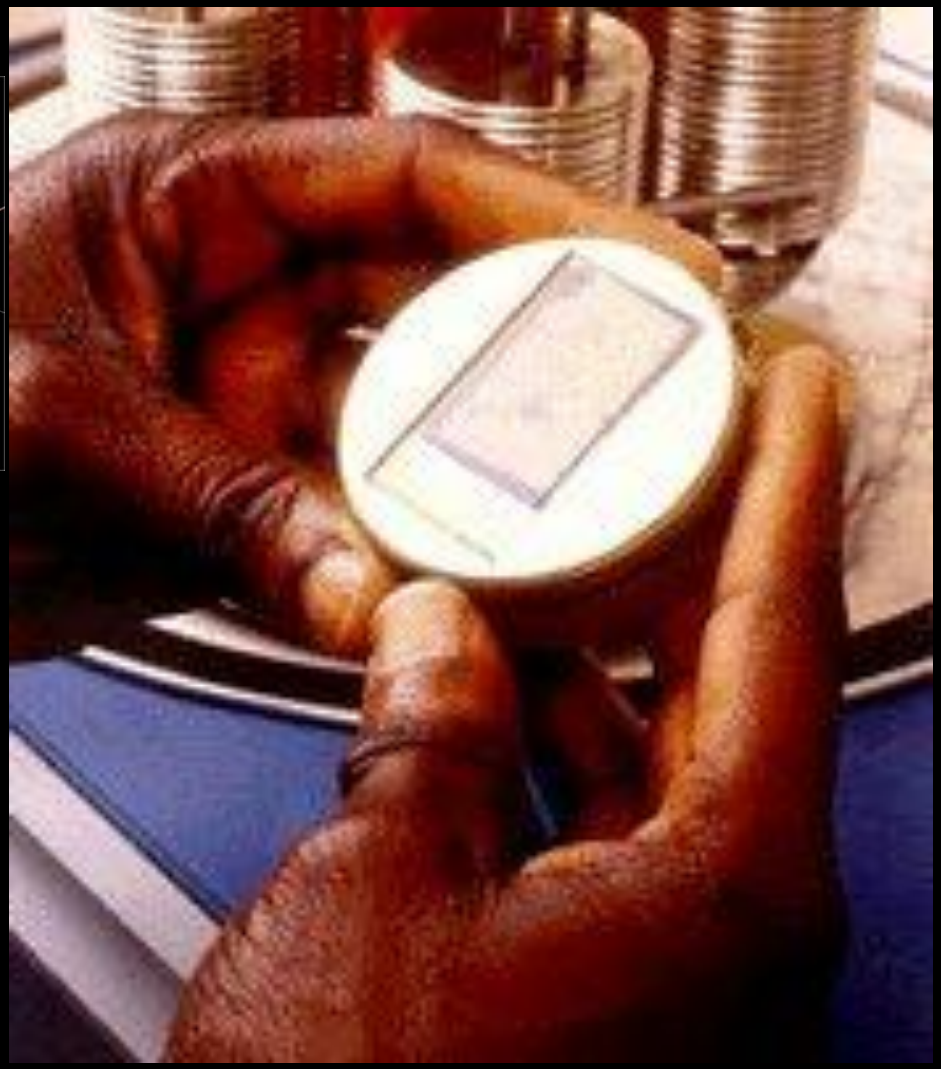
Metamorphic Facies

Hamster Facies



Augen Gneiss

The Zen of Thin Section Preparation

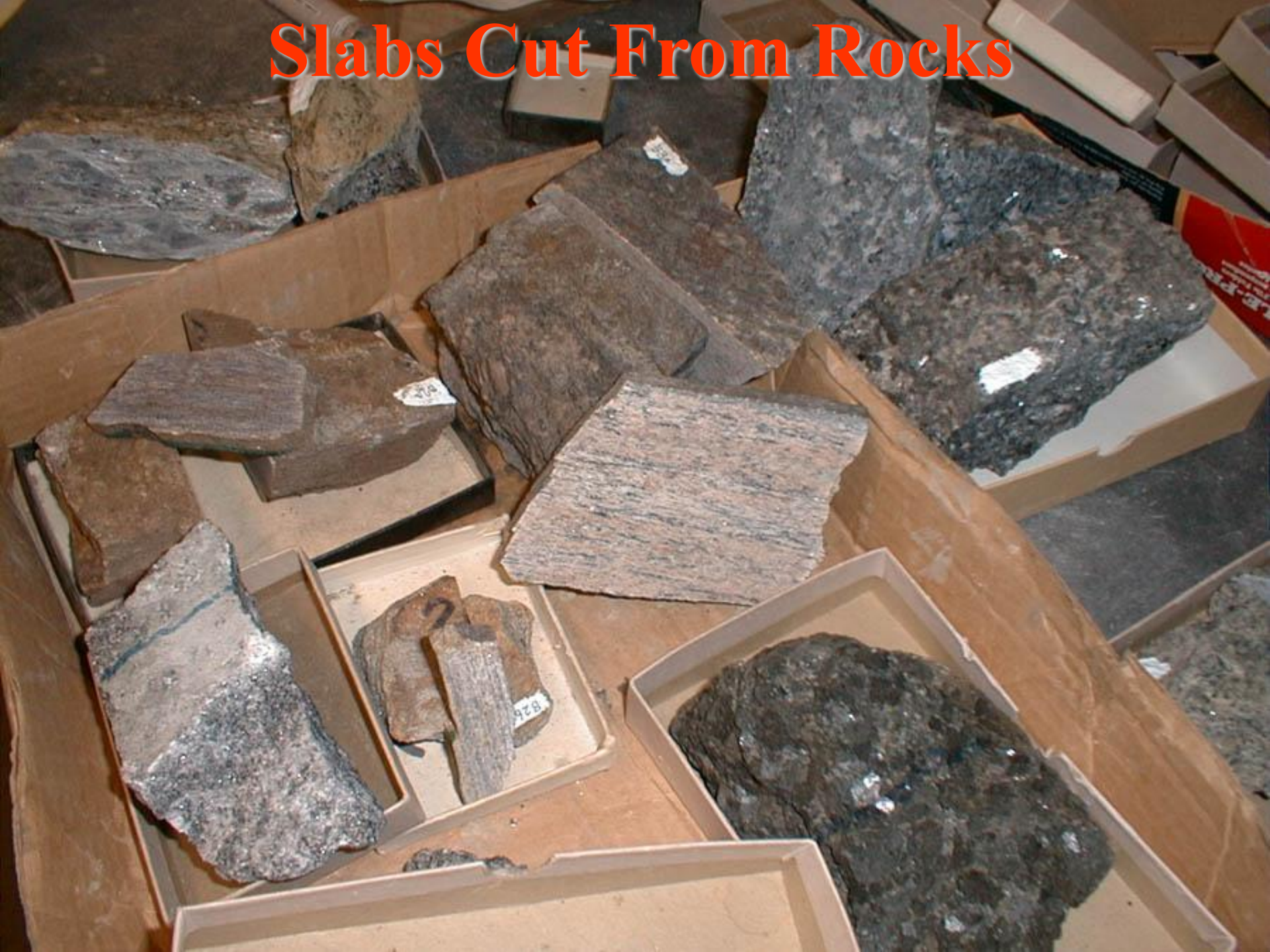


Thin Sections Start in the Field

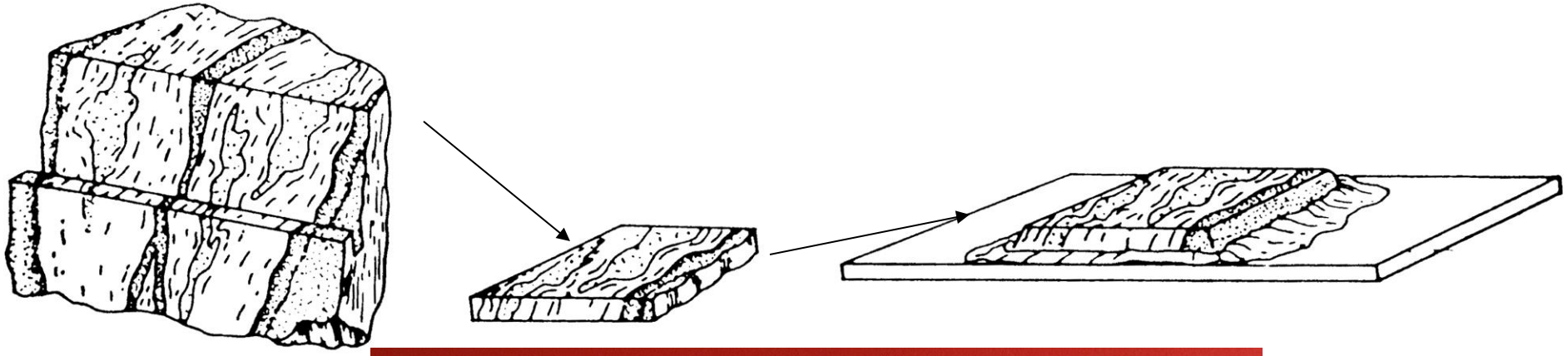
Cutting Field Specimens

Cutting a Thin Slab

Slabs Cut From Rocks



Thin Section Preparation

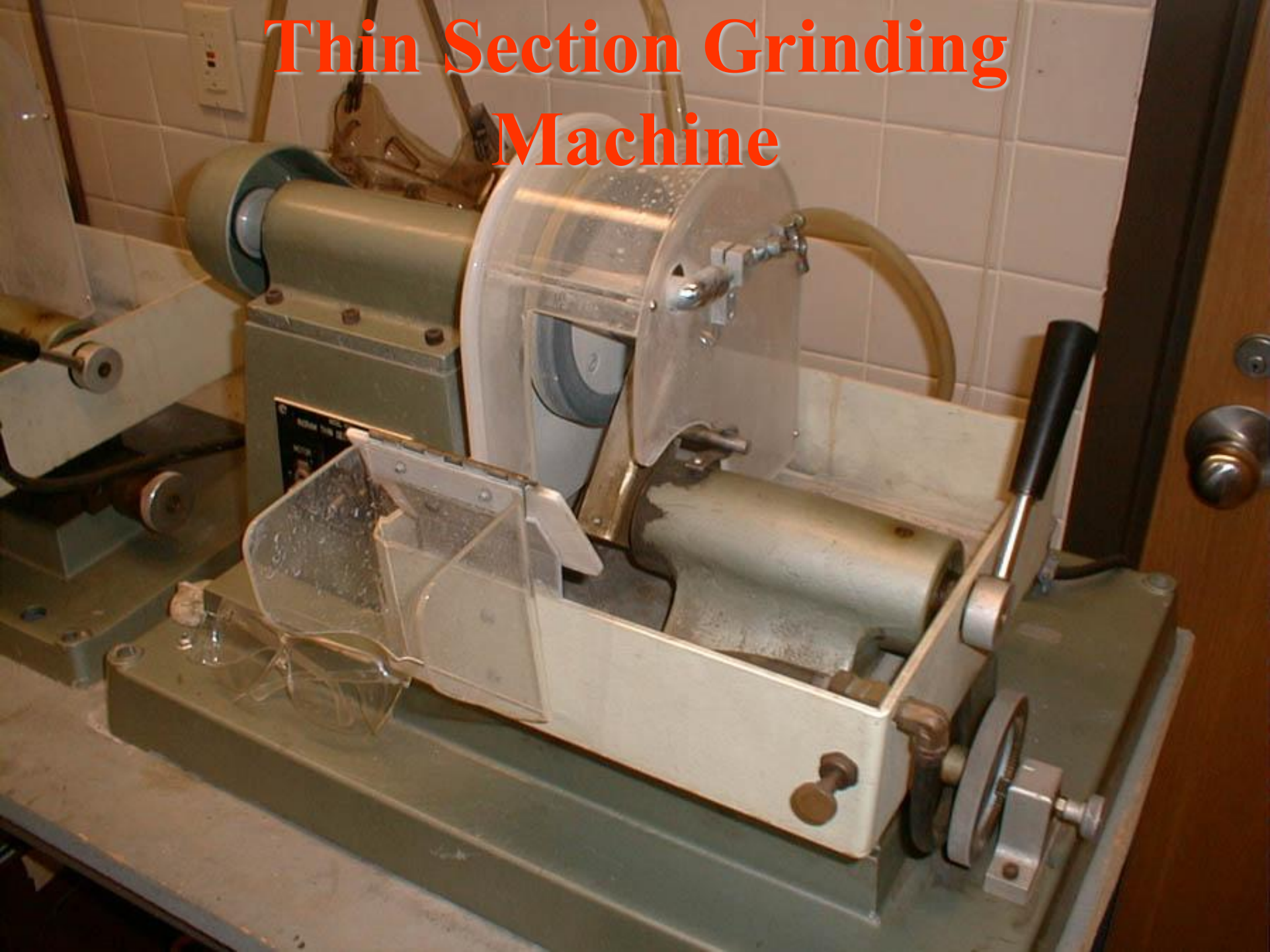


Thin Section Cut-off Machine

Cut-off Saw Detail

Cutting Mounted Slab from Slide

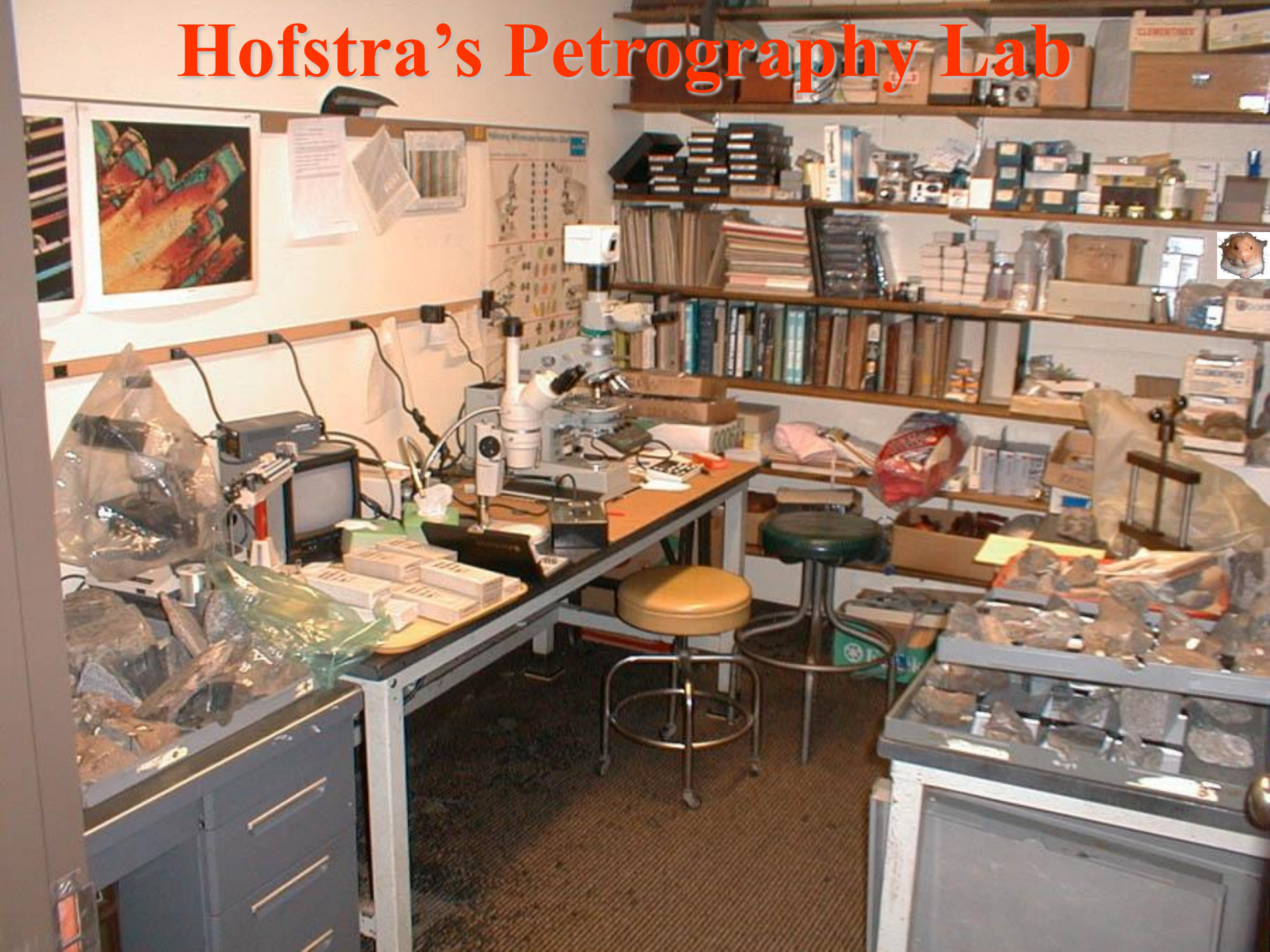
Thin Section Grinding Machine



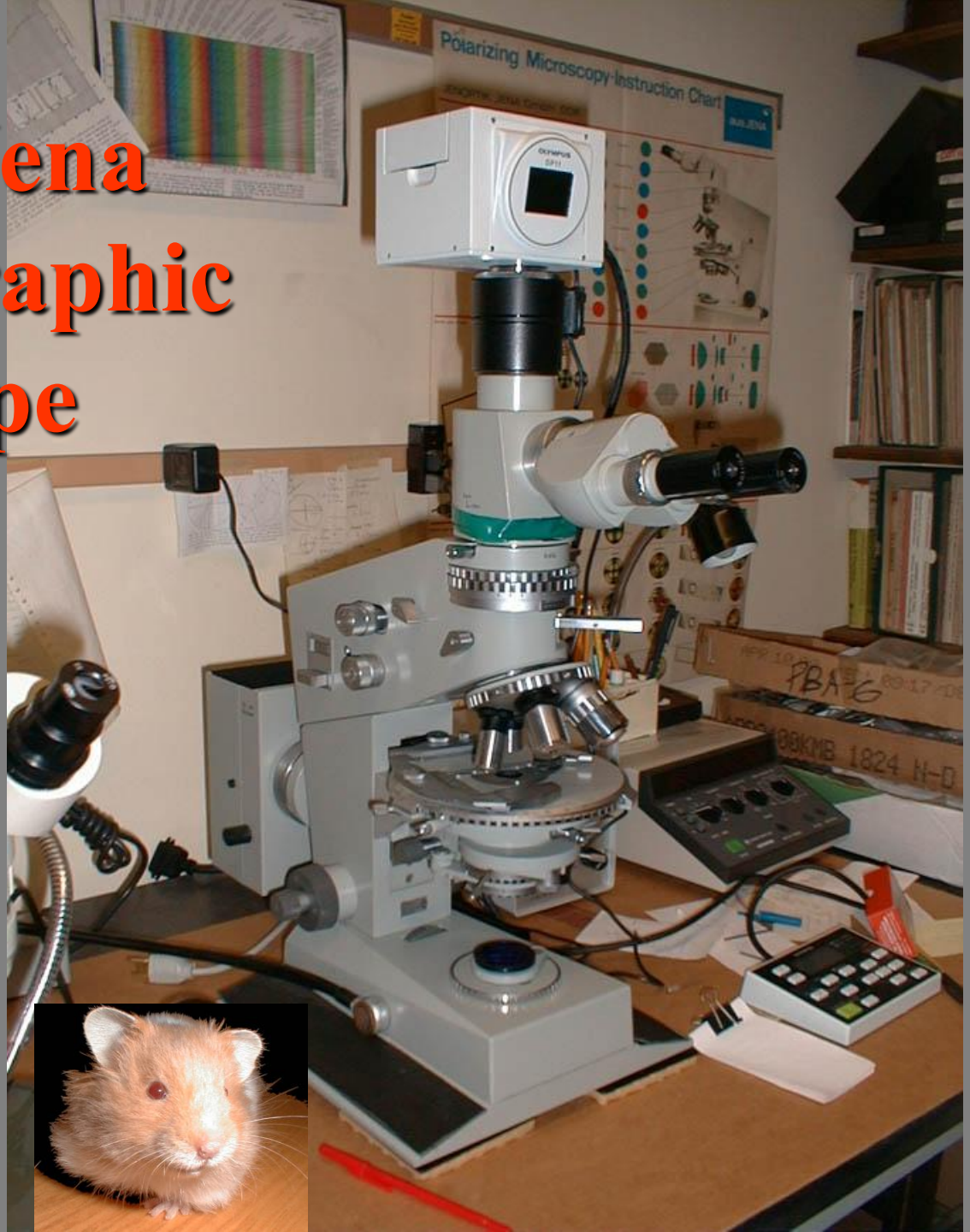
Section Grinding Machine Detail


NWA 301 - Hb

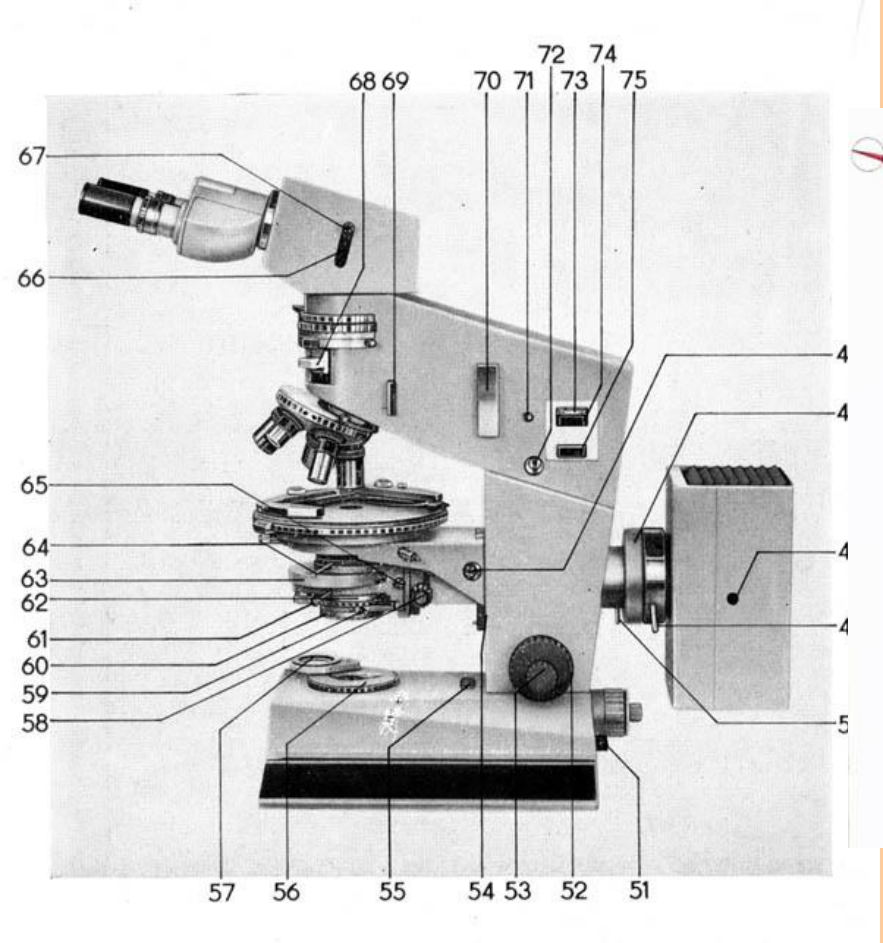
Hofstra's Petrography Lab

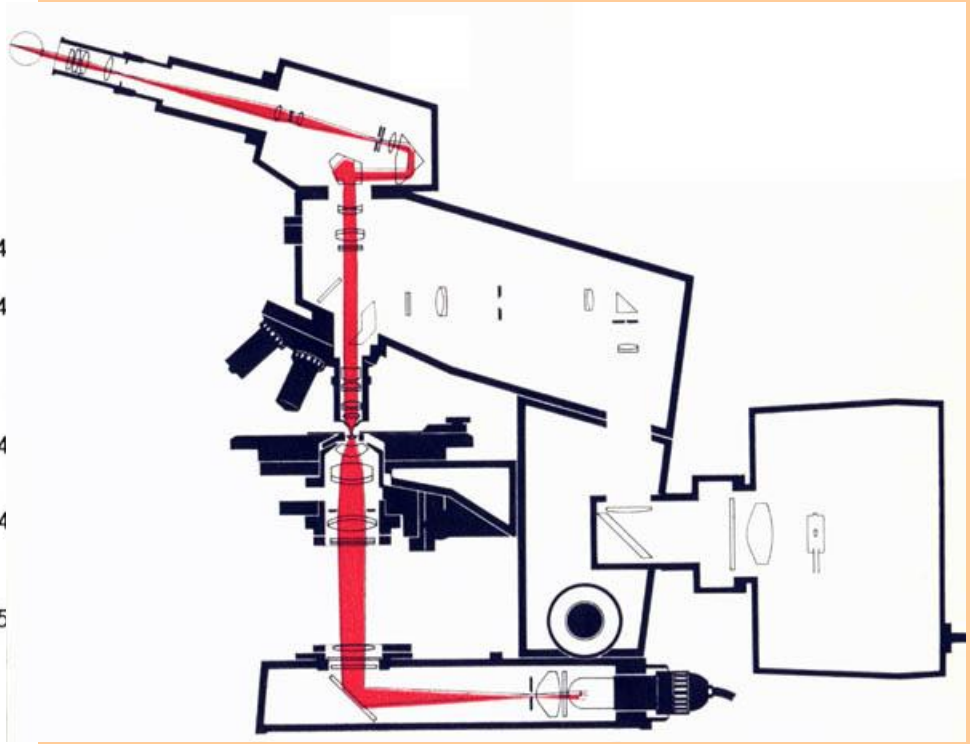


Aus Jena Petrographic Scope



Modern Petrographic Scope





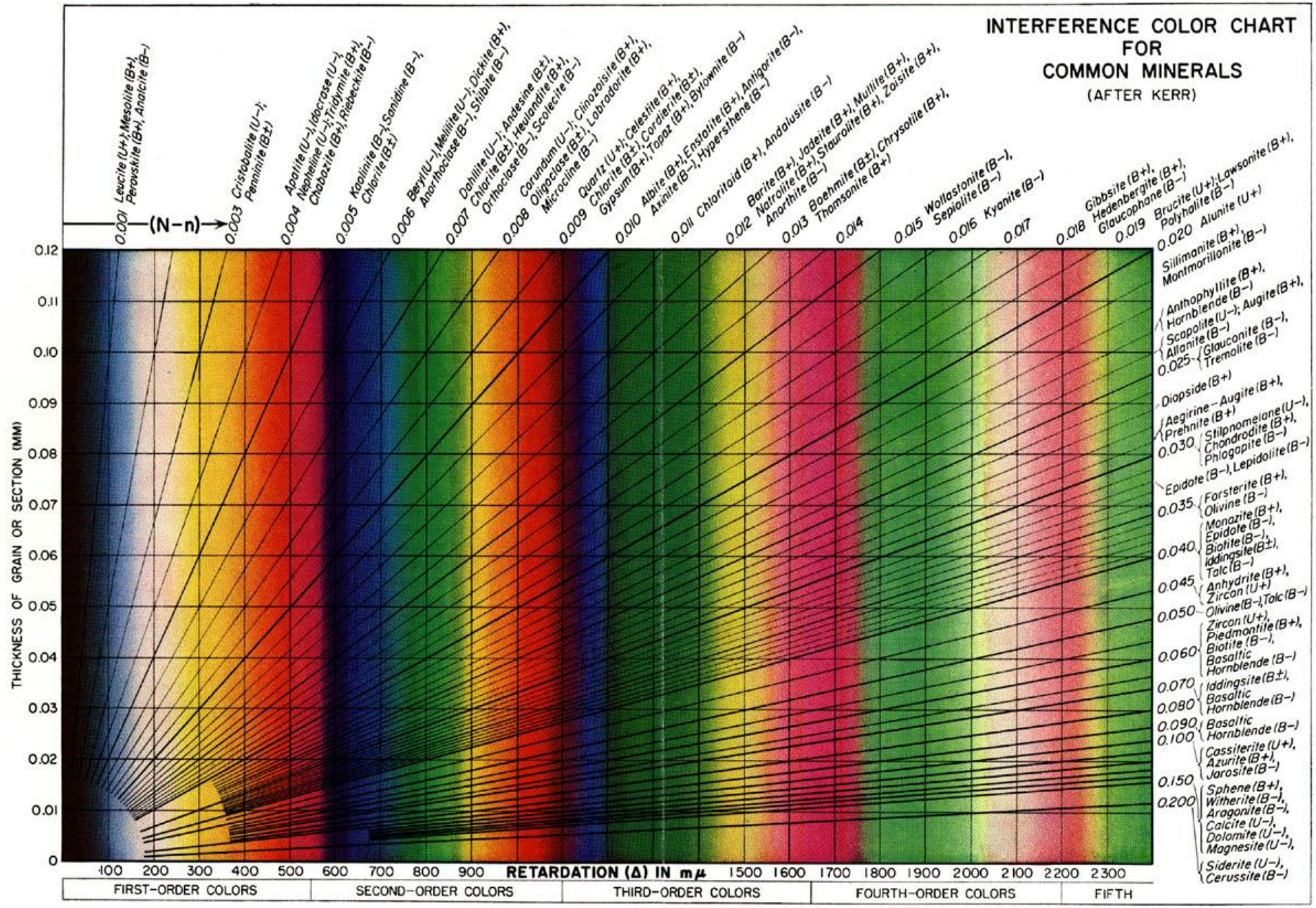
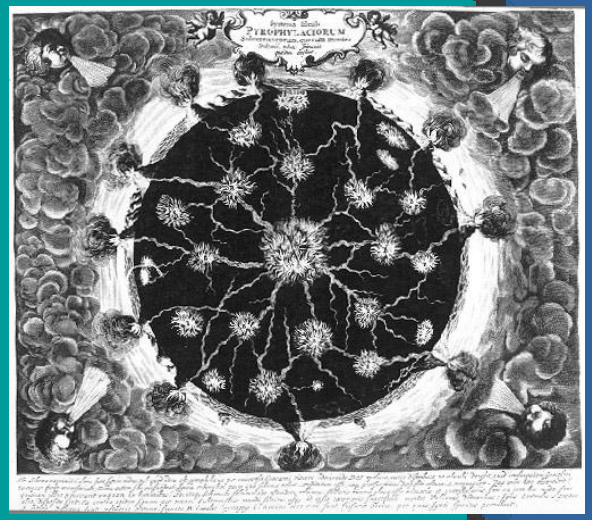


Fig. 8-17. The interference color associated with a particular value of retardation is shown as a vertical bar directly above that value. Thickness is plotted along the ordinate. The radial lines connect points of equal birefringence. As an example of the chart's use, note that the maximum interference color for quartz (birefringence, 0.009) in a thin section (thickness, 0.03 mm) is located at the intersection between the 0.009 radial and the horizontal line corresponding to 0.03 mm. The color determined is just barely first-order yellow.

Let's Take a Peek at Some Rocks

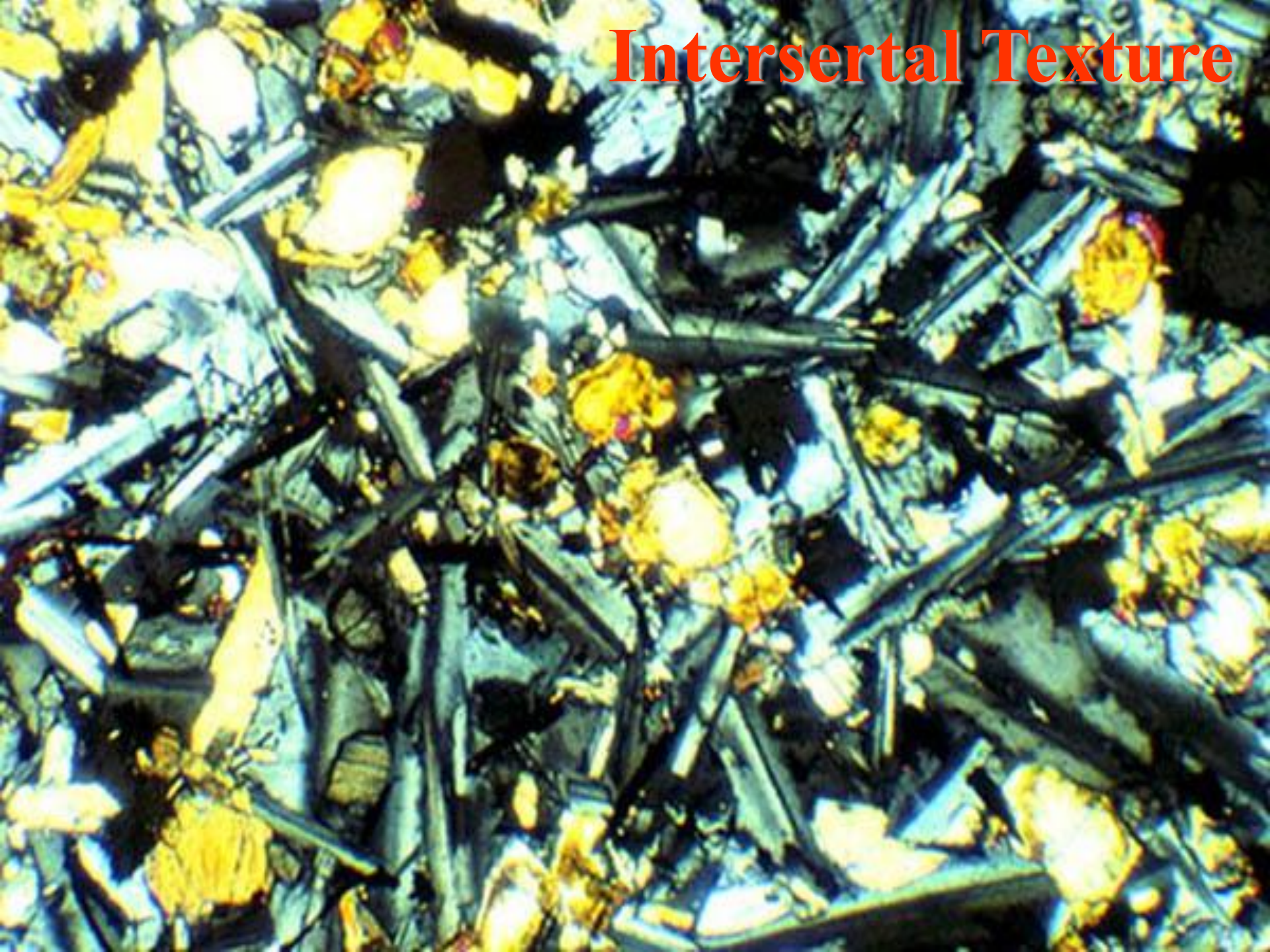


IGNEOUS ROCKS

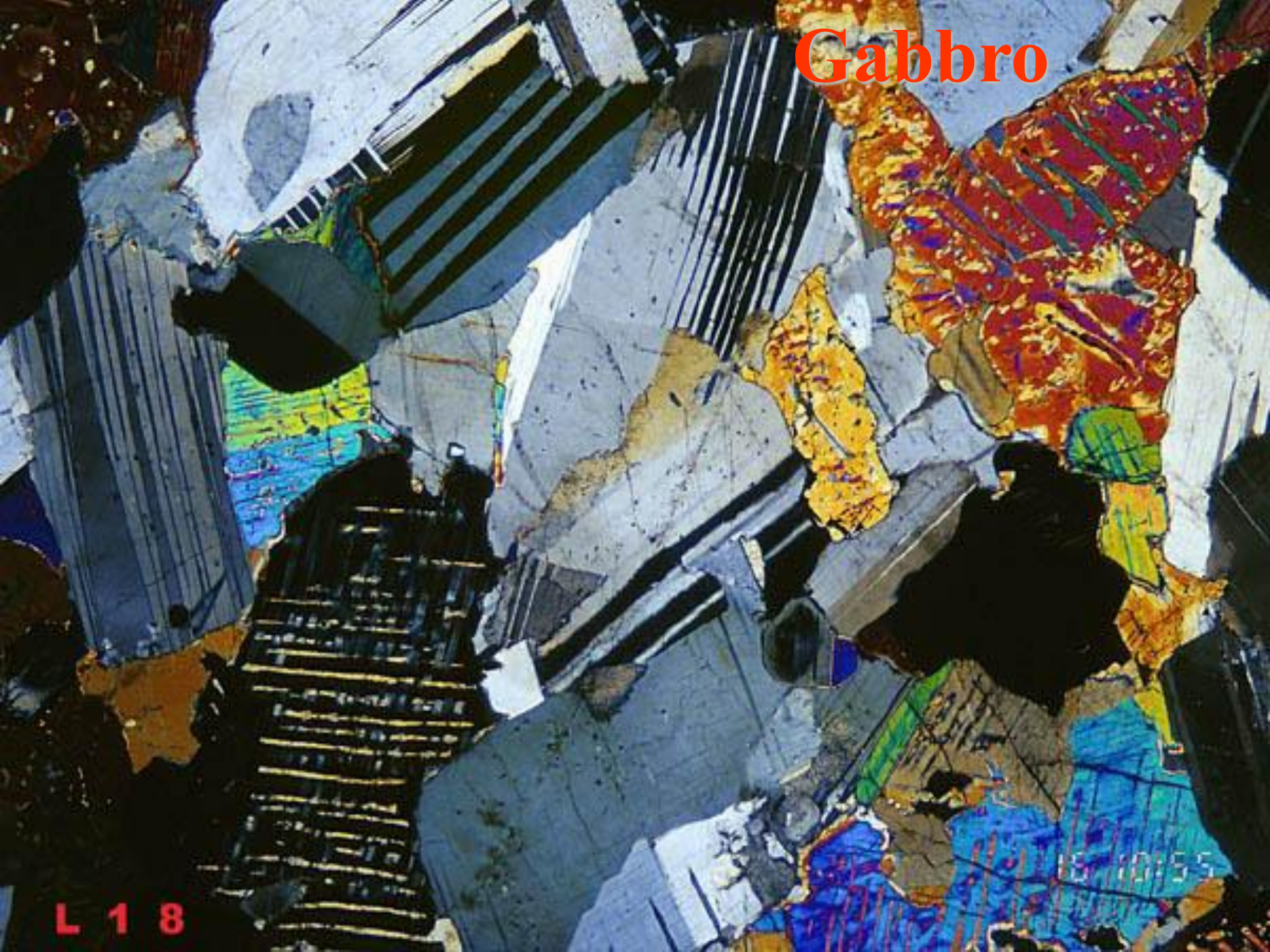
EXTRUSIVE (Volcanic)- Fine-grained

INTRUSIVE (Plutonic)- Coarse-grained

Intersertal Texture

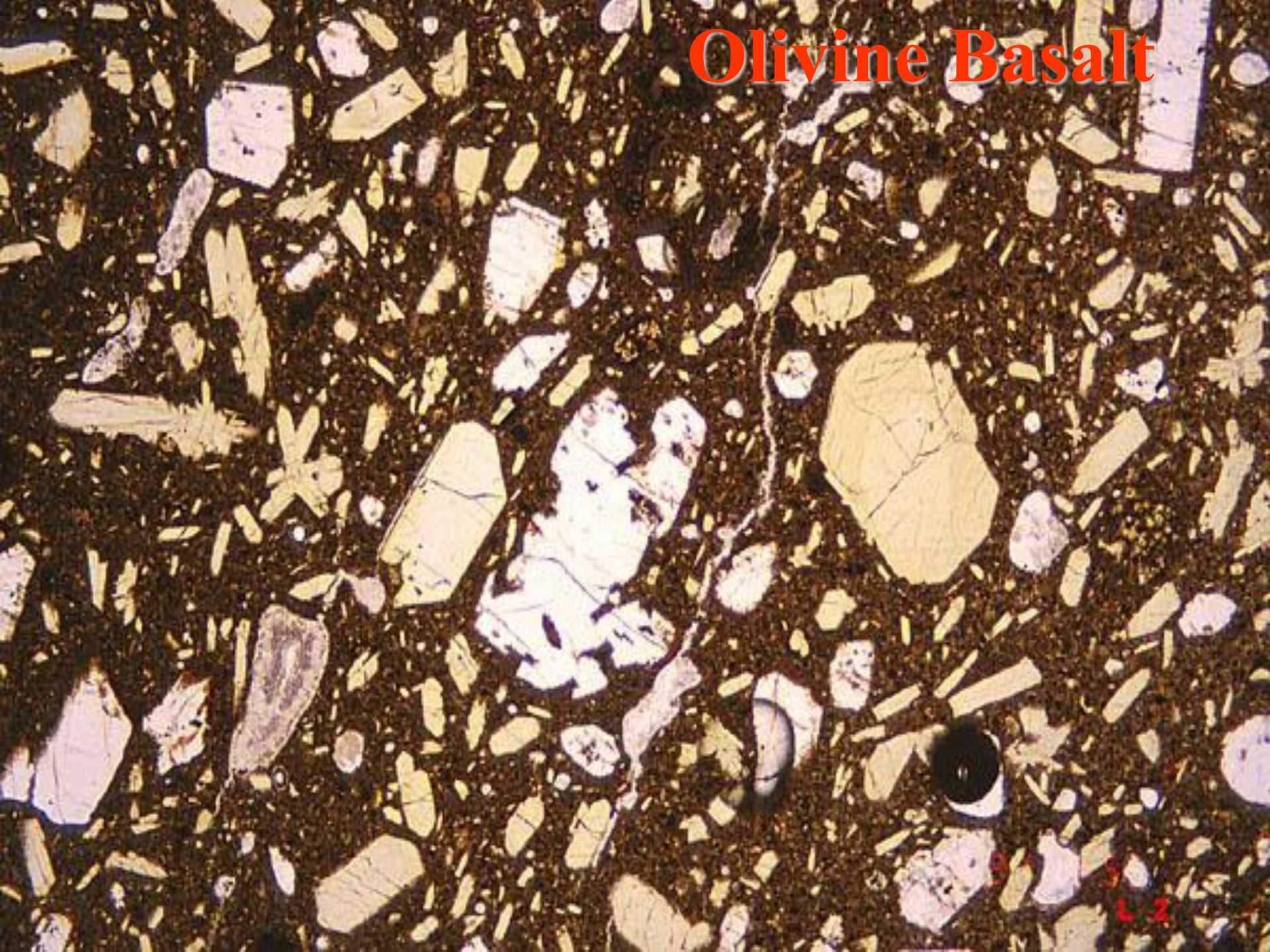


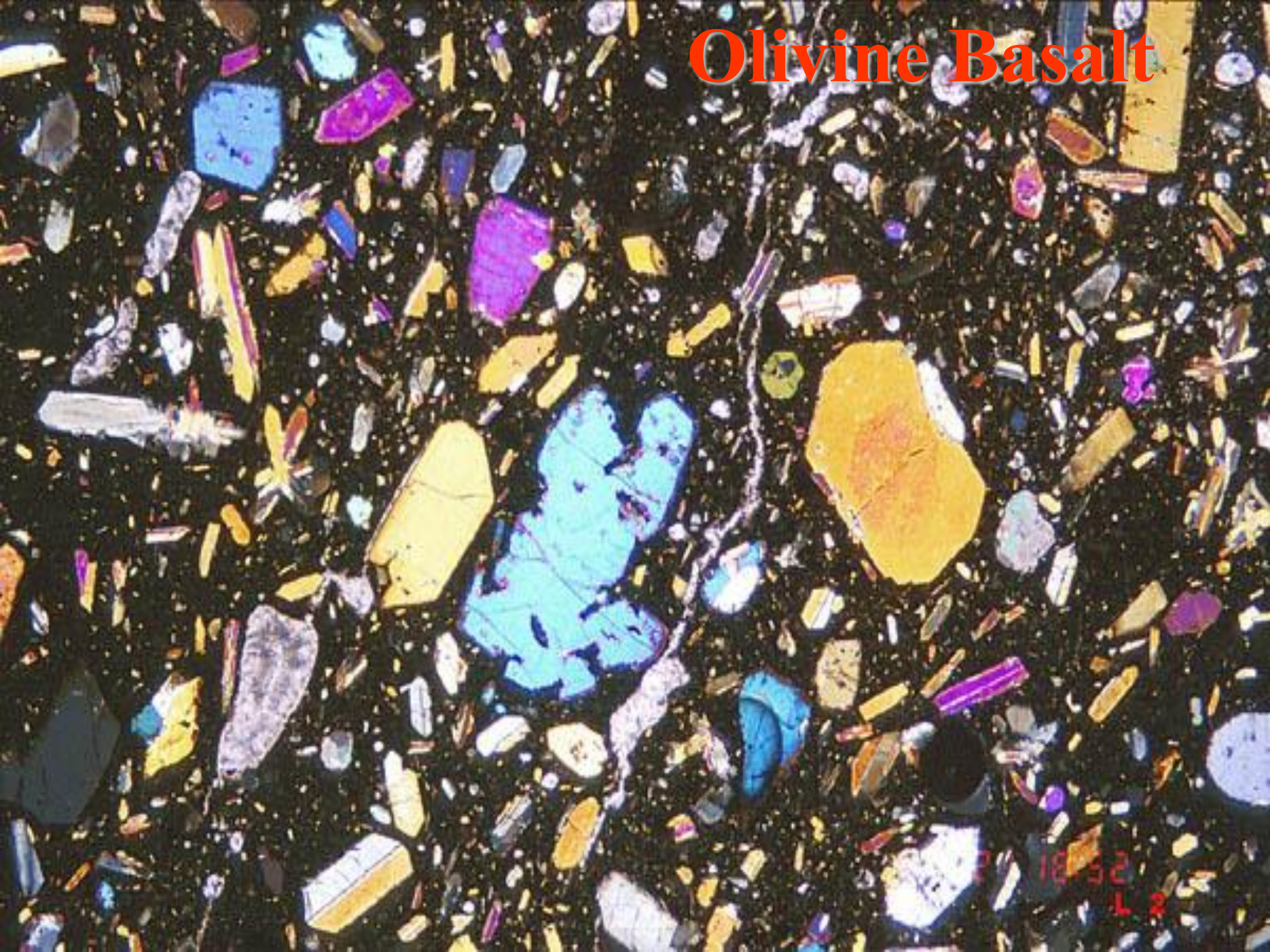

Gabbro
L 1 8


Gabbro
L 1 8


Bronzitite
0.5 mm


Bronzitite
0.5 mm


Olivine Basalt


Olivine Basalt


Hornblende Basalt
L 4 3

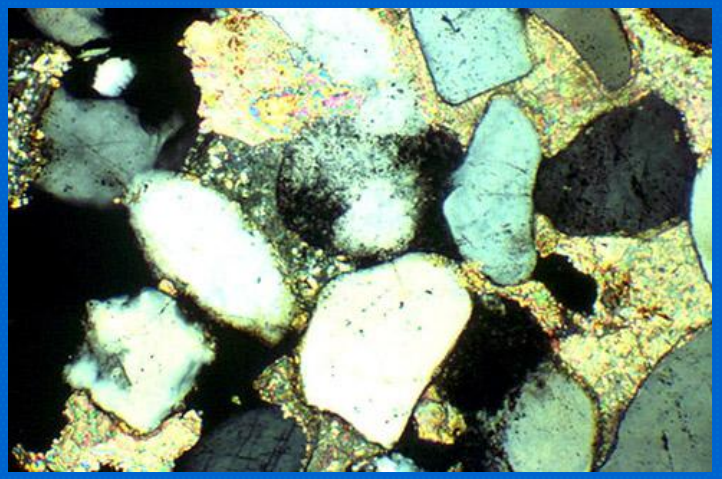
Hornblende Basalt


Trachyandesite
L 4 1


Trachyandesite
L 4,1

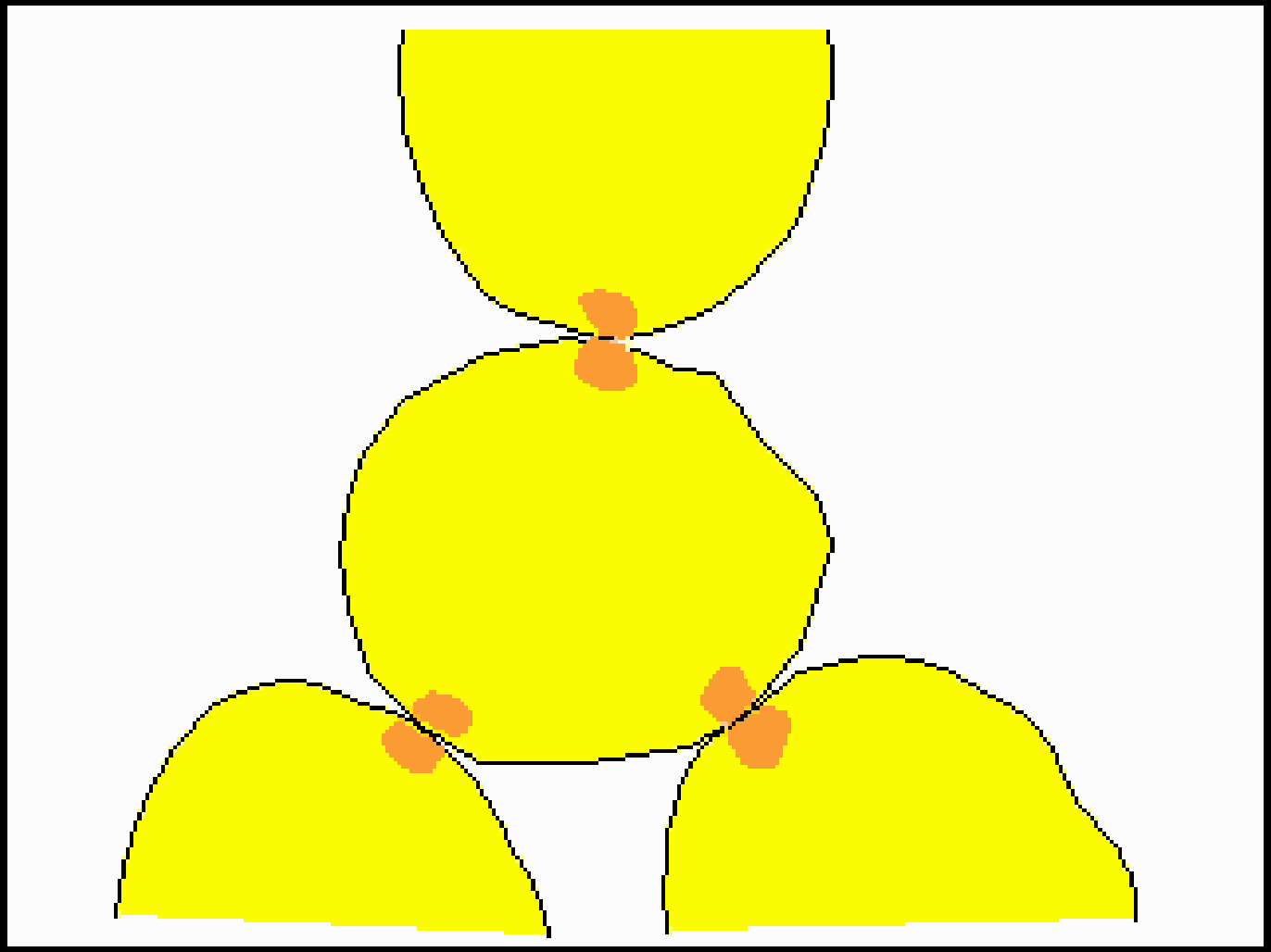
Spinifex - Komatiite

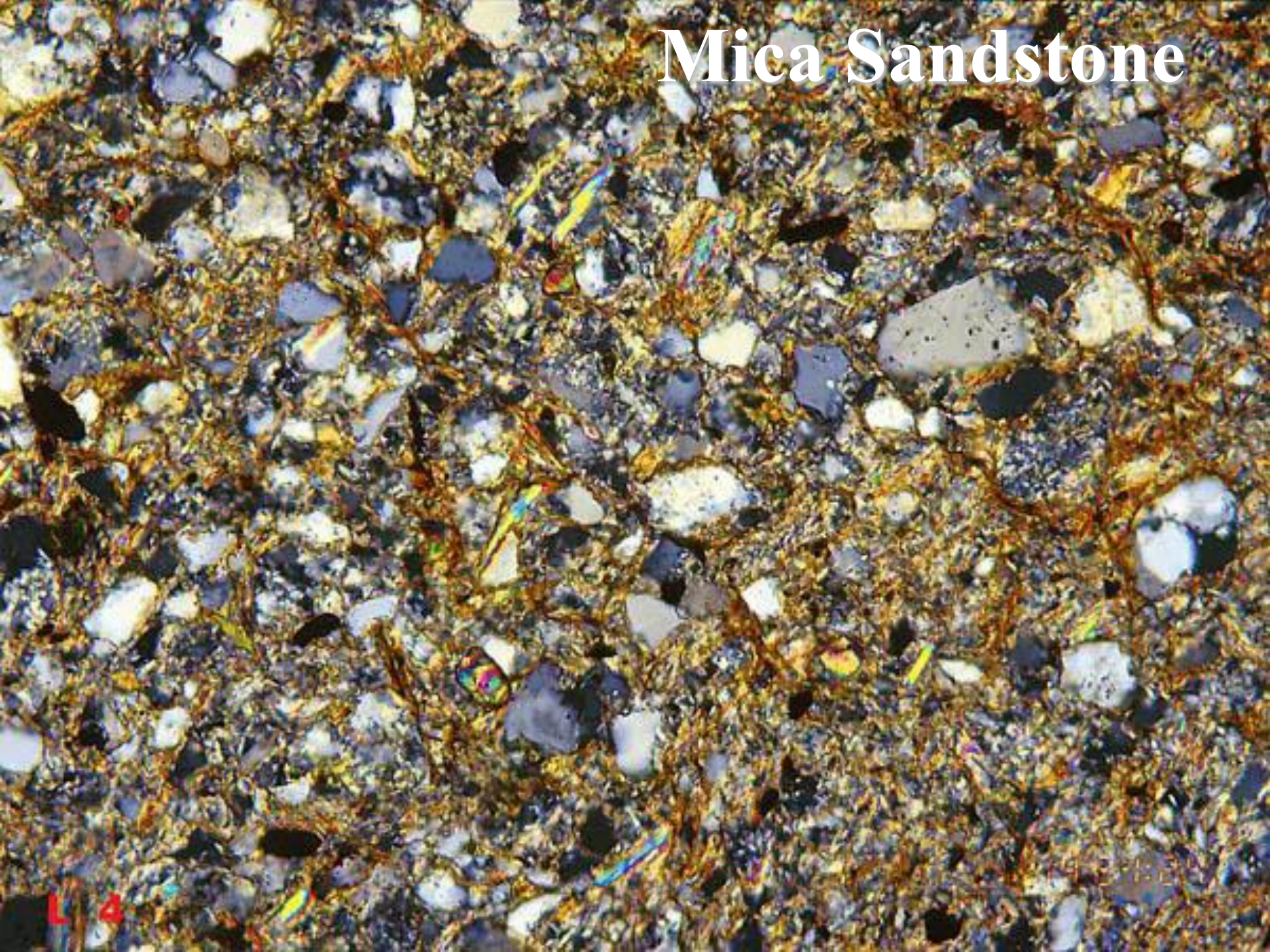
SEDIMENTS & SEDIMENTARY ROCKS



Clastic Texture

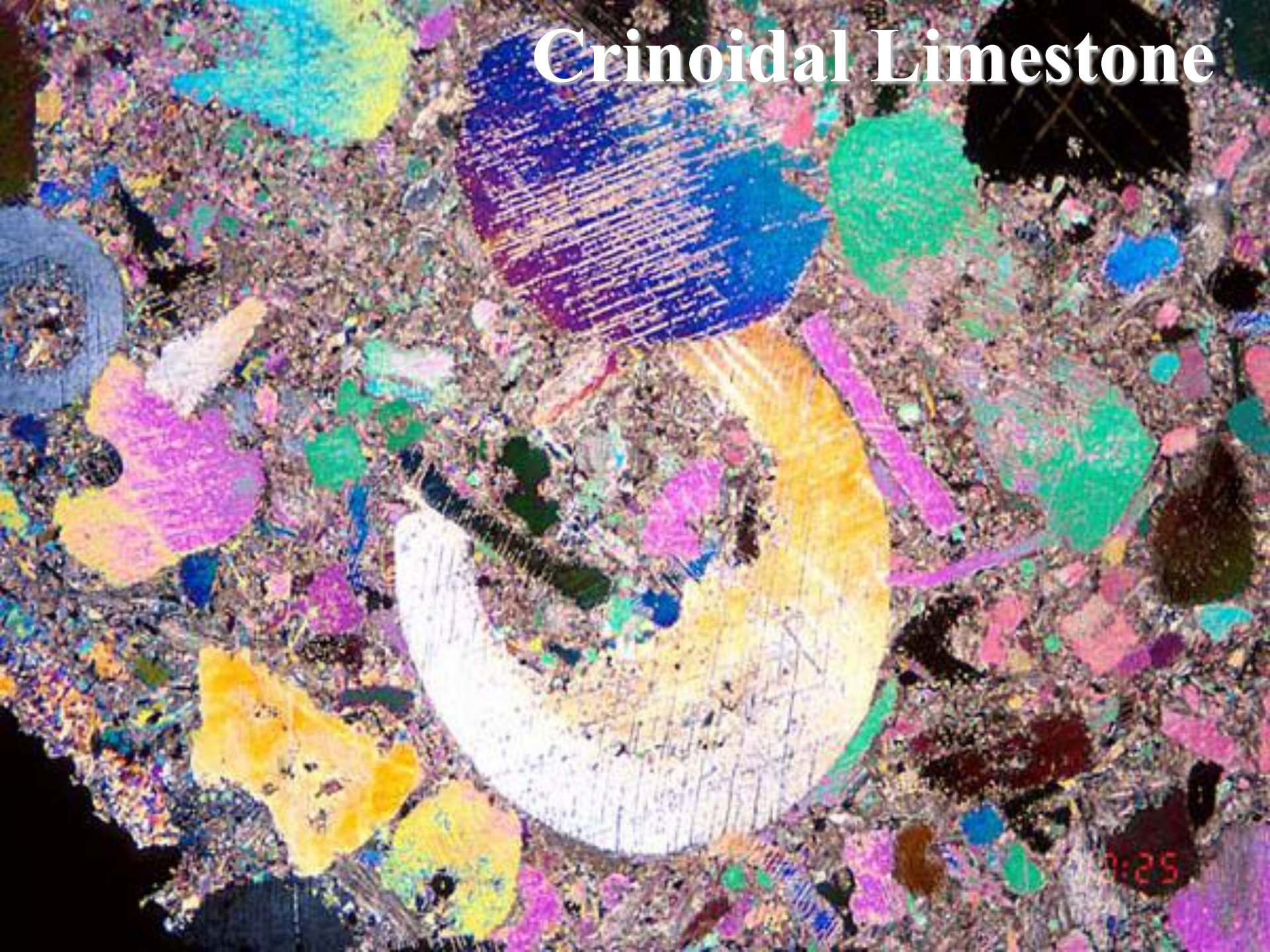
Pressure Induced Precipitation of Quartzose Cement

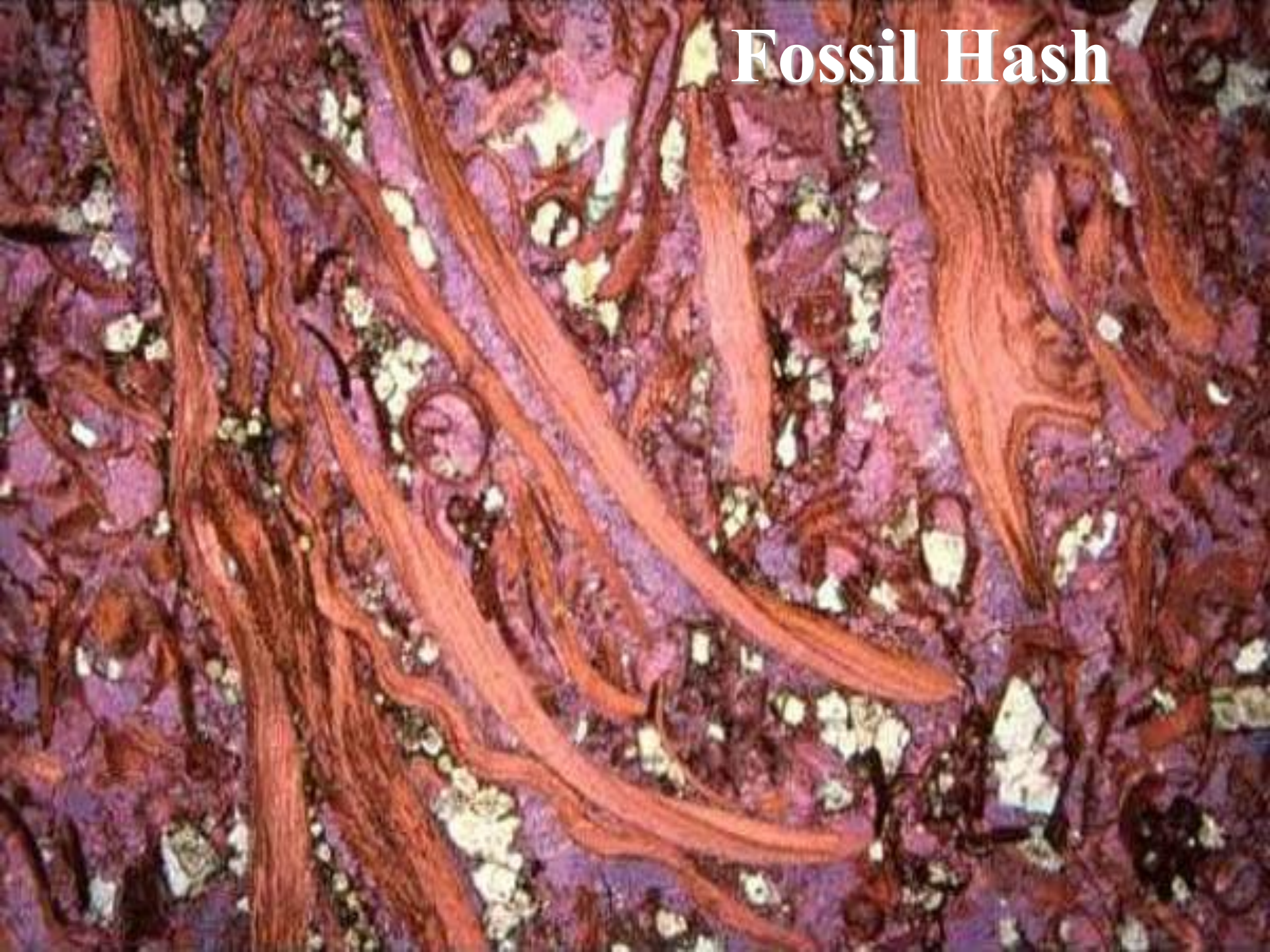


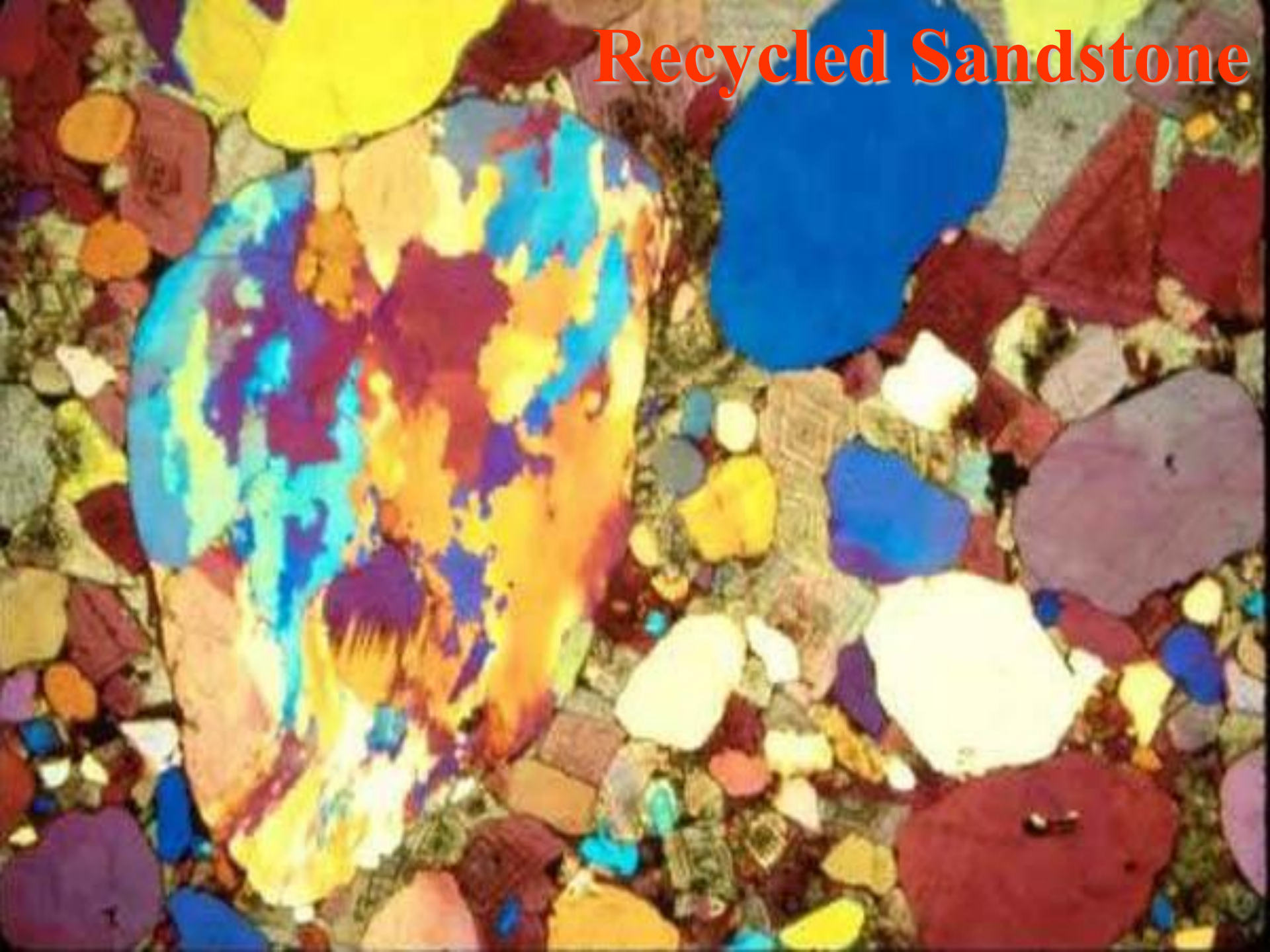

Mica Sandstone


Limestone
P Y

Crinoidal Limestone




Fossil Hash

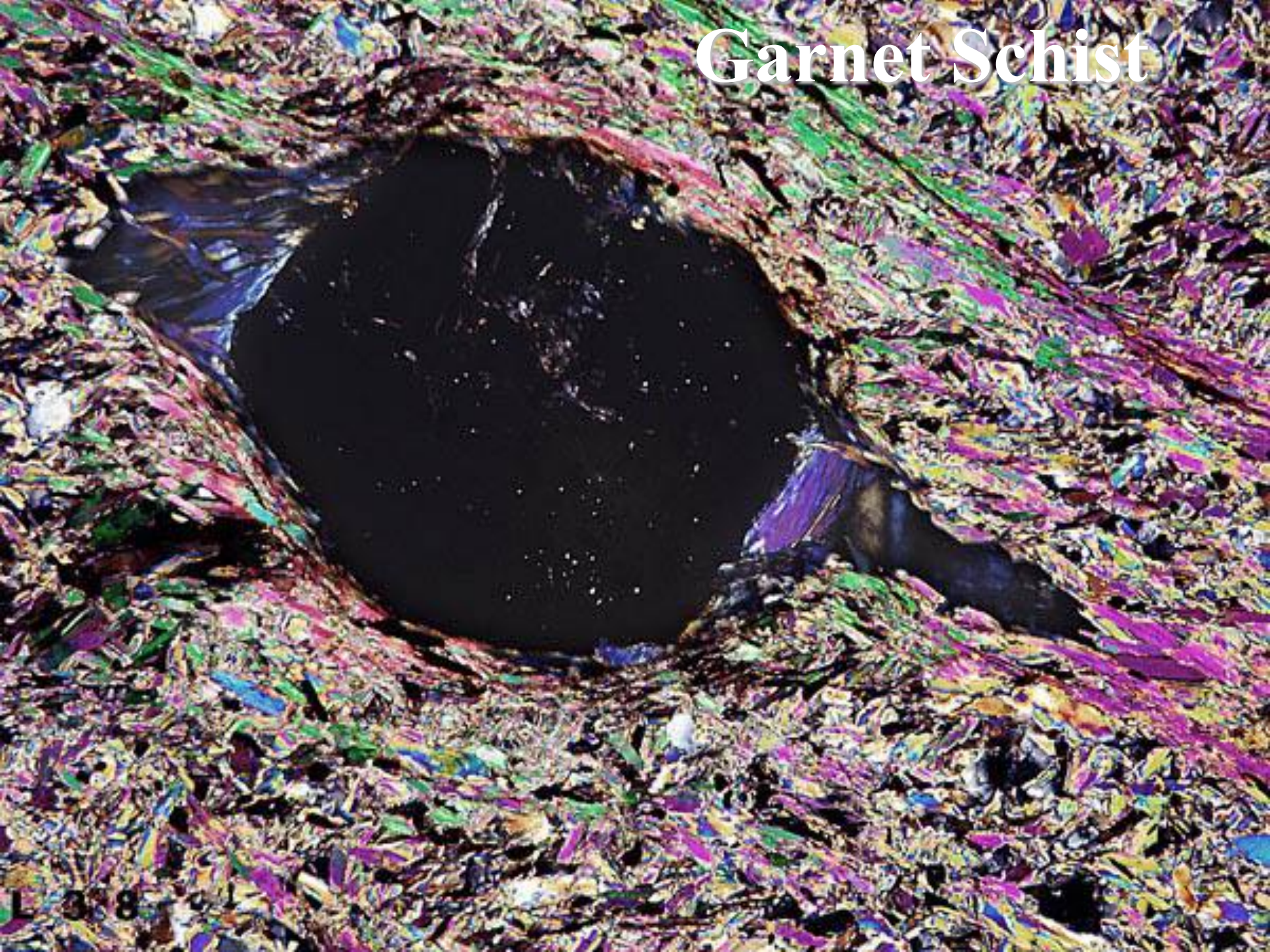

Recycled Sandstone

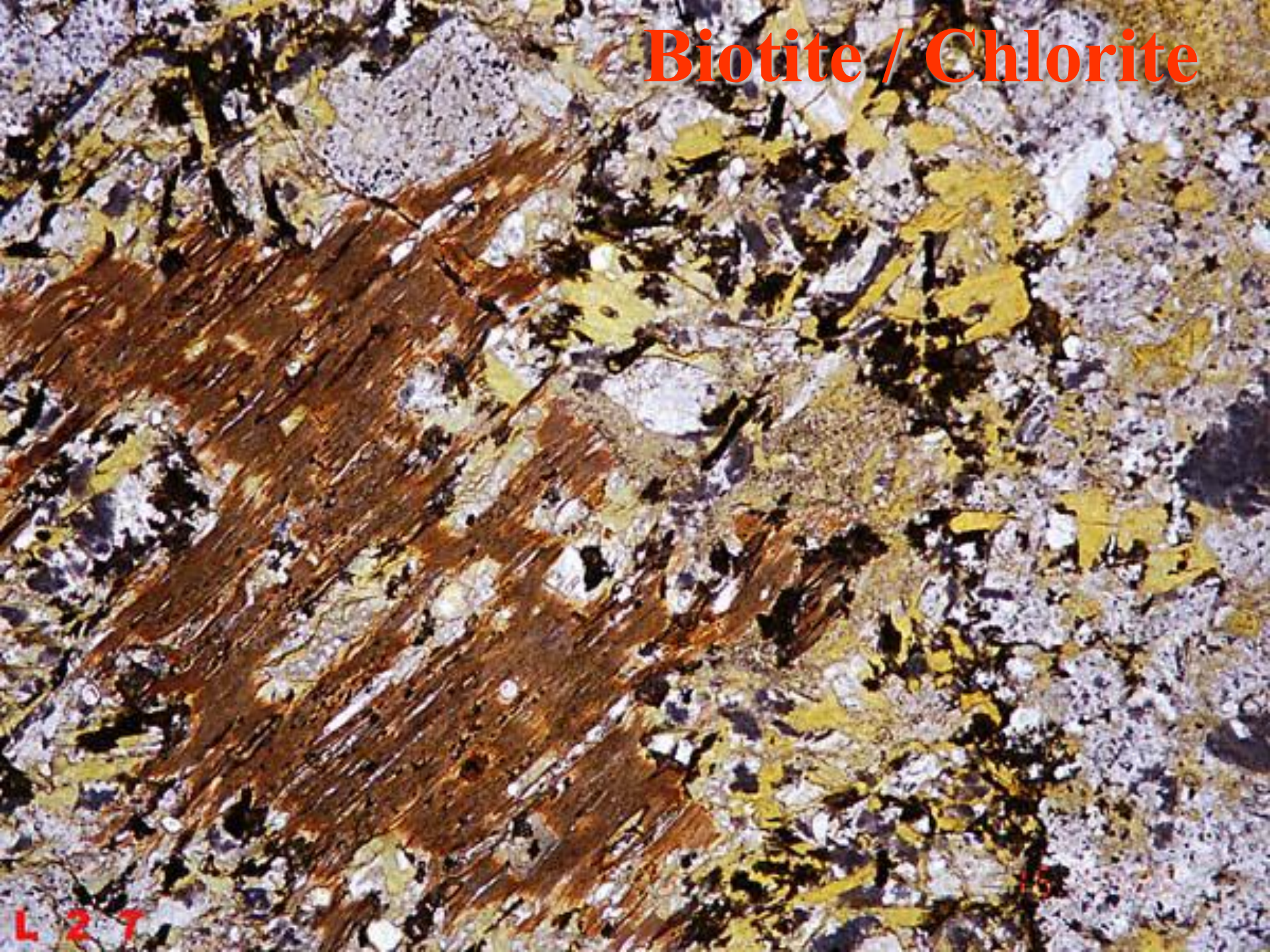
METAMORPHISM , METAMORPHIC ROCKS, & HYDROTHERMAL ROCKS

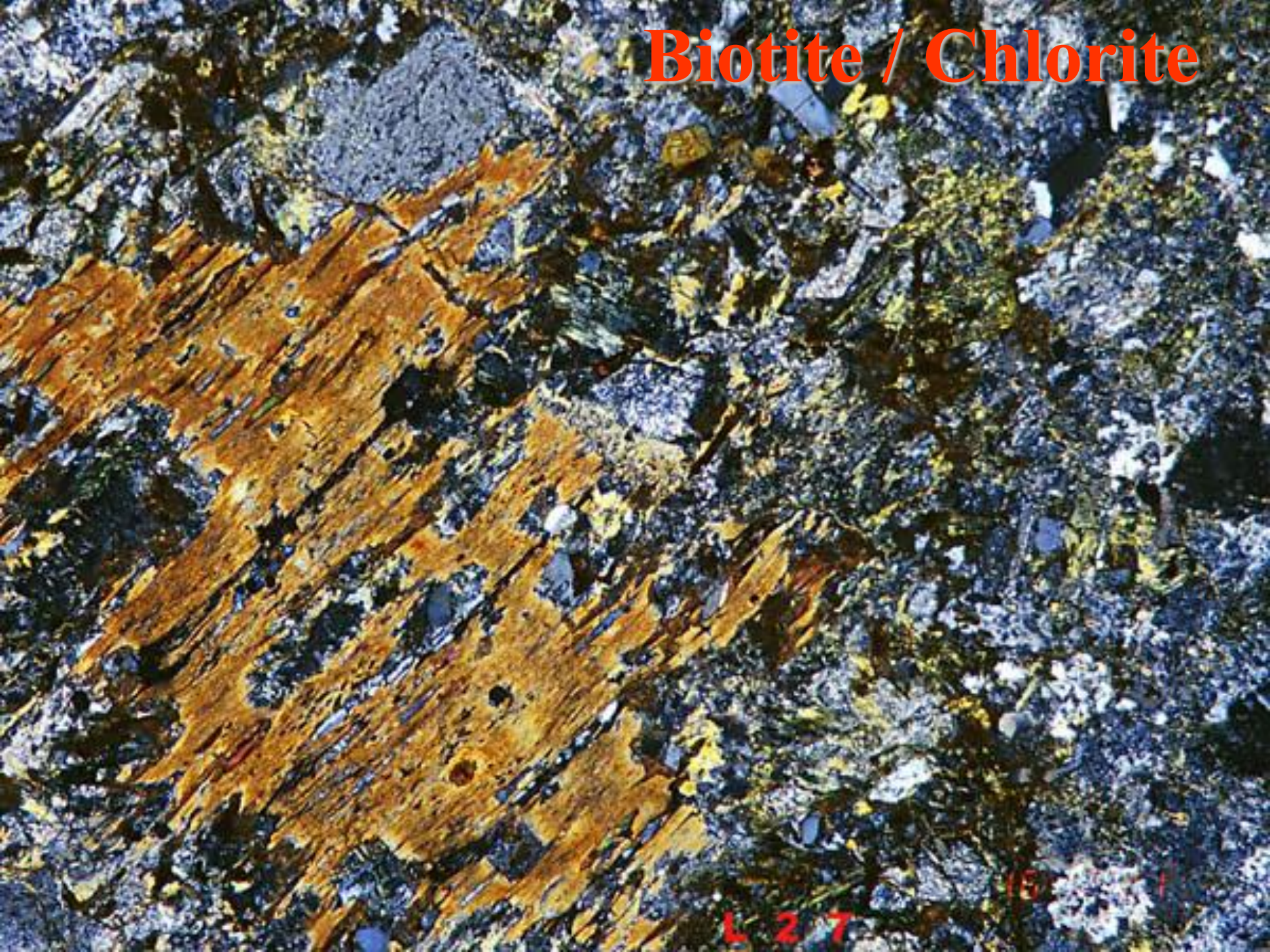
Biotite Gneiss


Biotite Gneiss

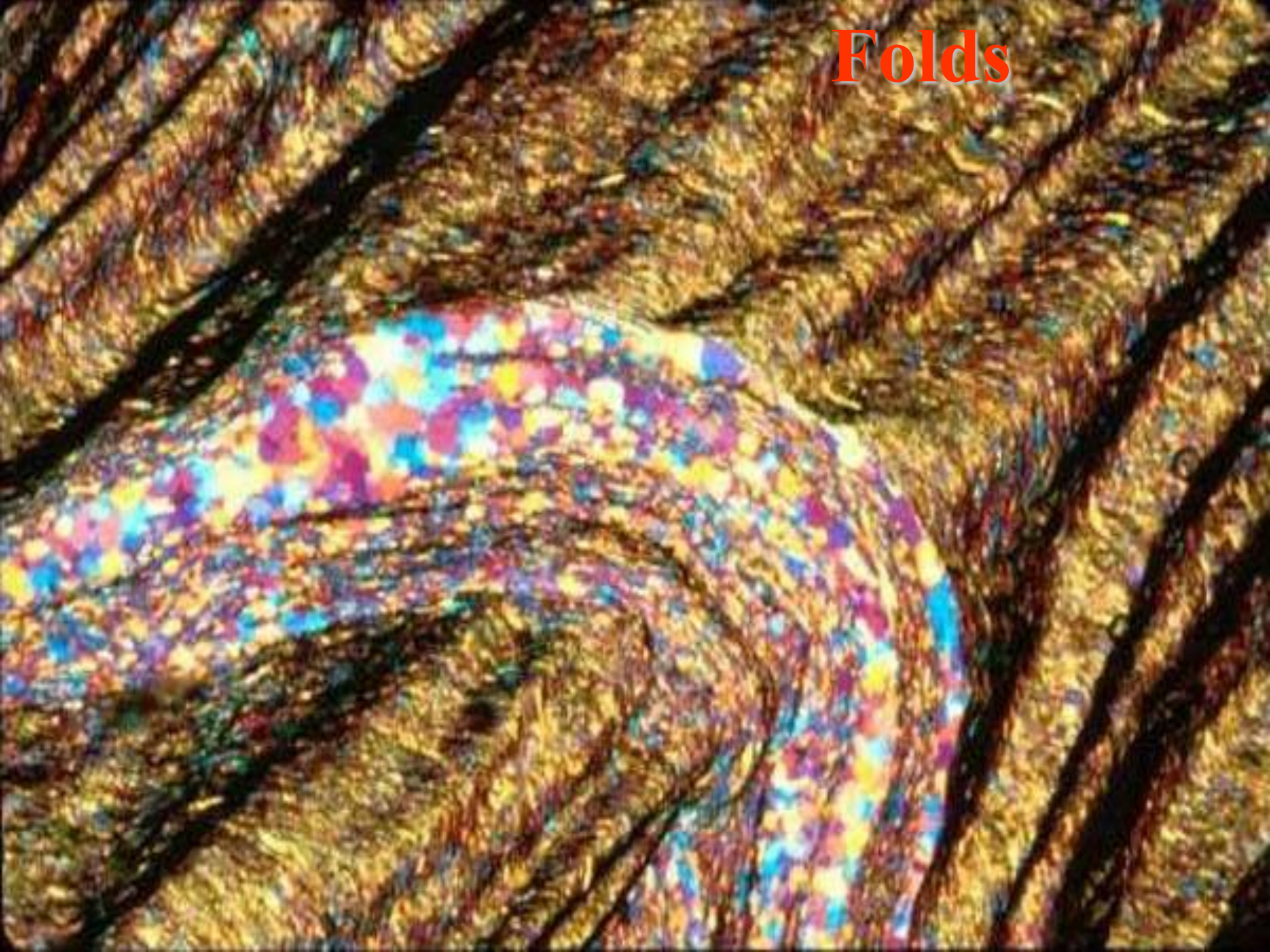

Garnet Schist
L 3 8


Garnet Schist

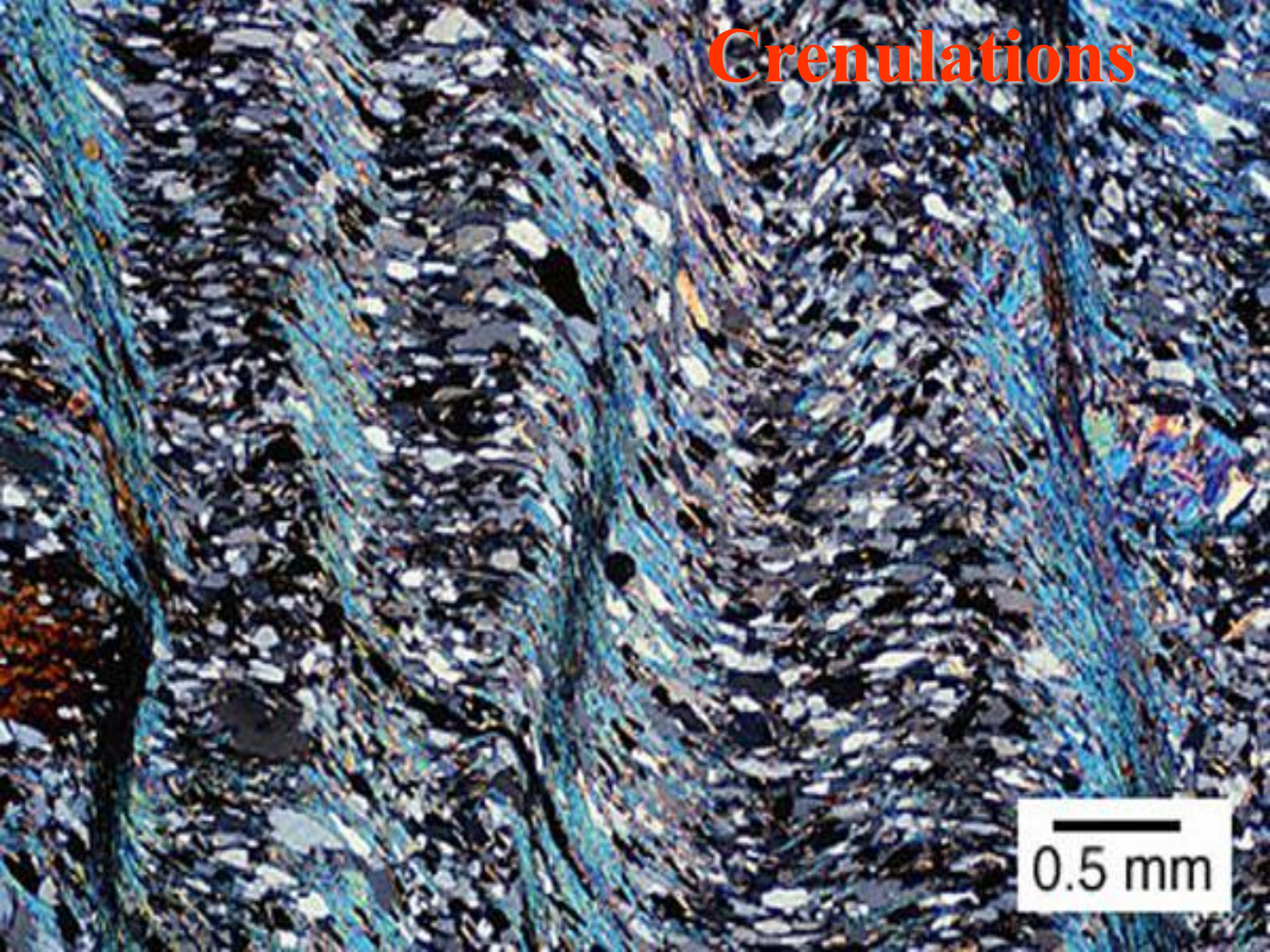

Biotite / Chlorite
L 2 T


Biotite / Chlorite

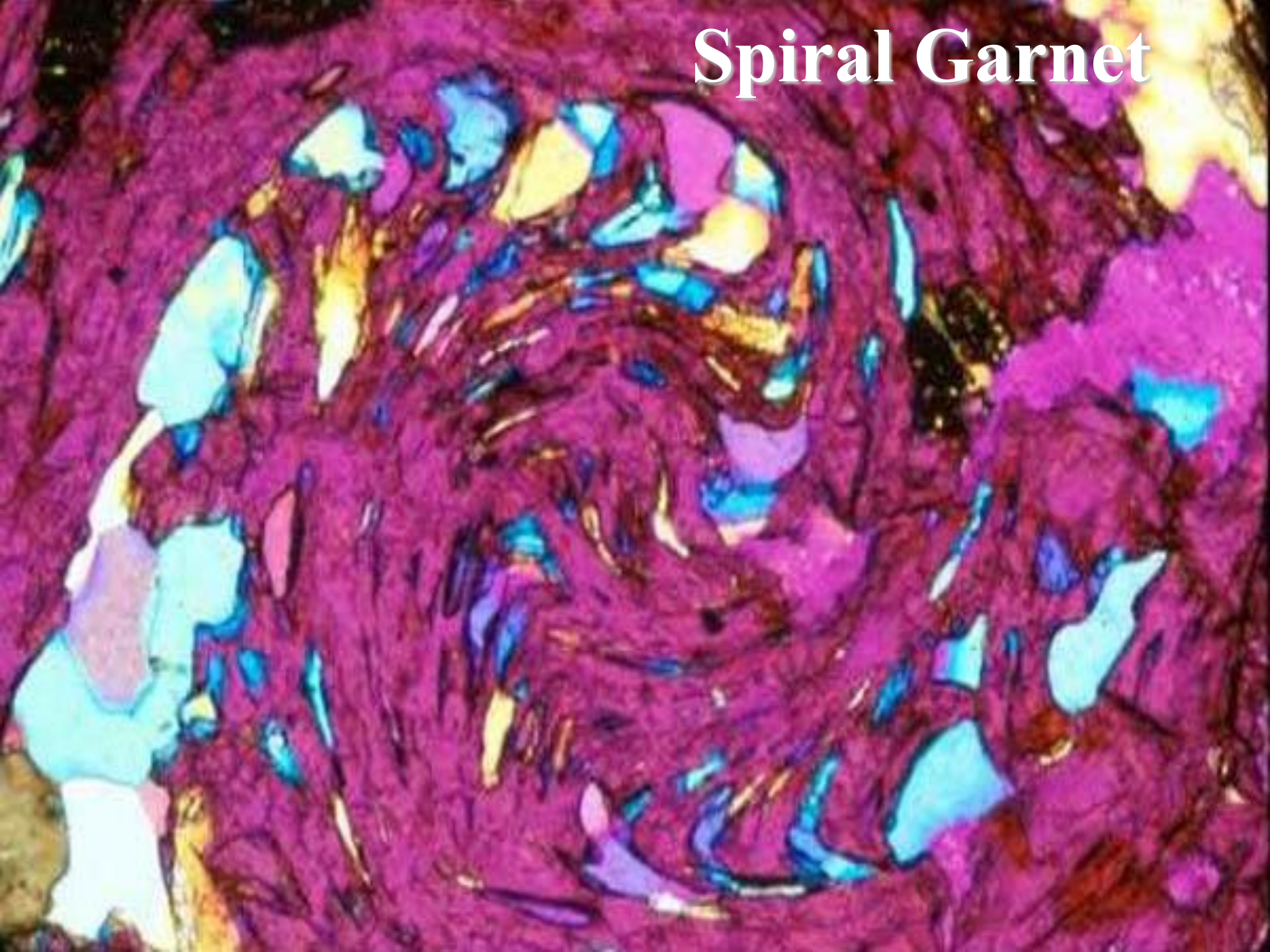

Mica Foliation


Folds

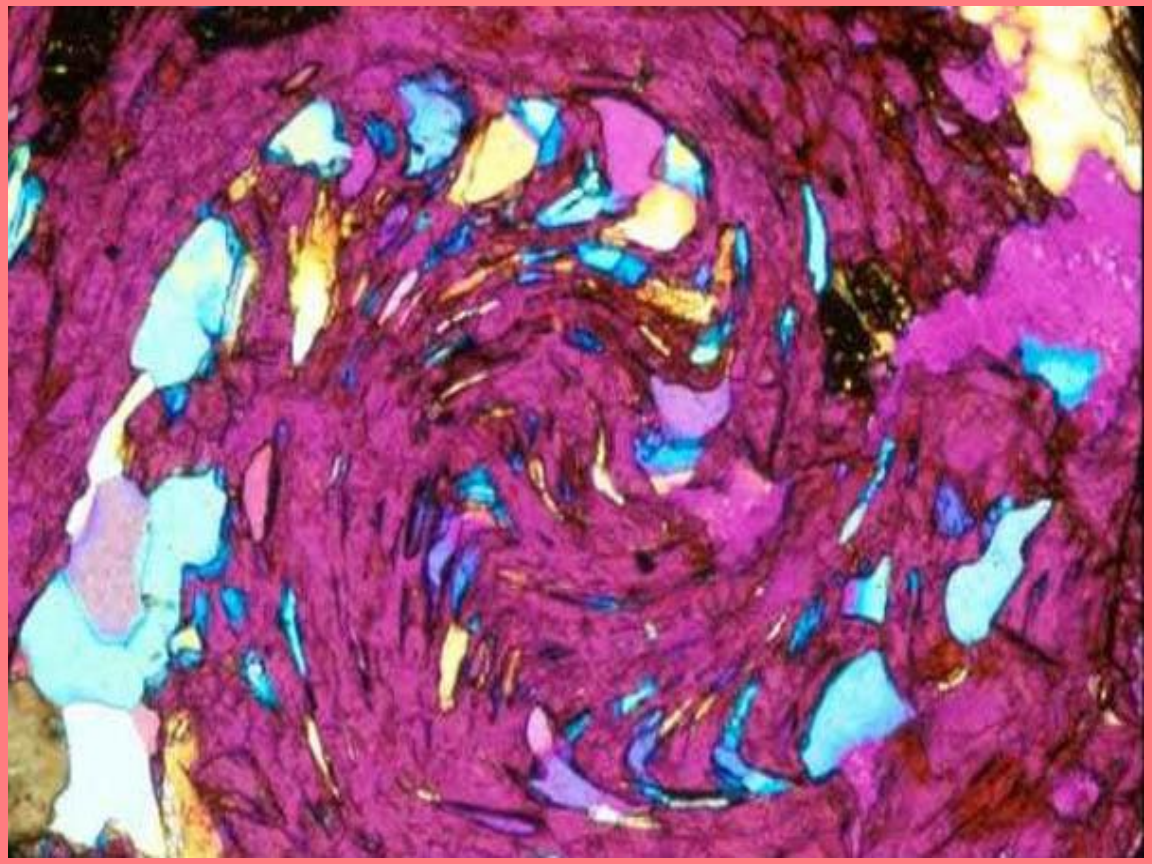
Crenulations



Spiral Garnet



Rotated Garnet Porphyroblast



Thanks For Coming Out
Happy Valentines Day!