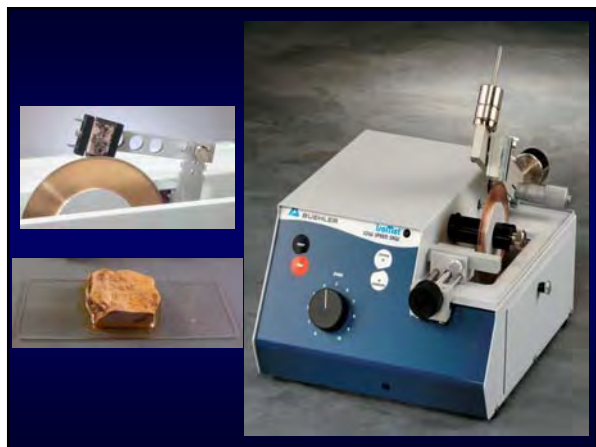


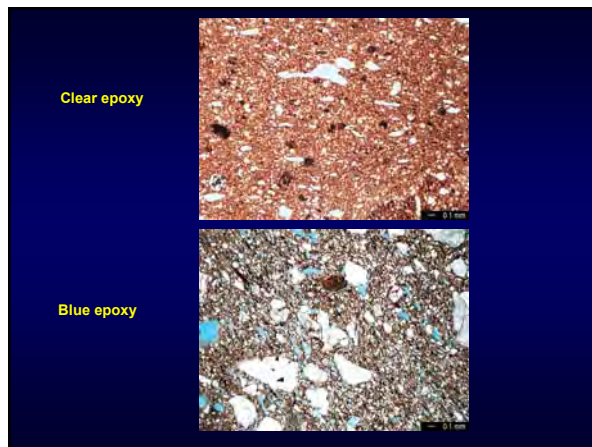
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2



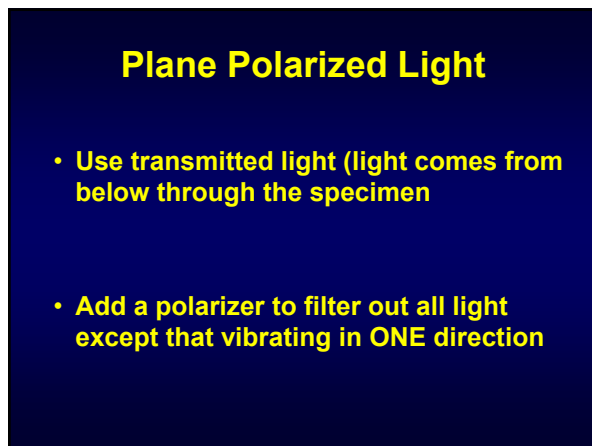
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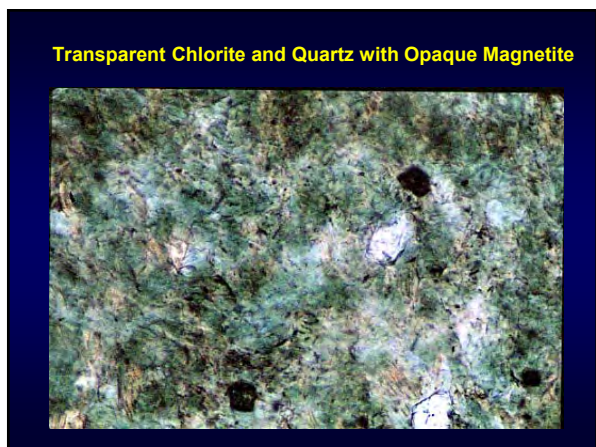
MINERAL FEATURES IN PLANE POLARIZED LIGHT

- Transparency or Opacity
- Color
- Refractive Index
- Relief (how visible it is)
- Morphology (size and shape)
- Cleavage (breakage pattern)

7

<h3>TRANSPARENT</h3> <ul style="list-style-type: none"> • Some light is transmitted through the grain • The grain is either clear or colored in plane polarized light 	<h3>OPAQUE</h3> <ul style="list-style-type: none"> • Does not transmit any visible light • Black in plane polarized light • Need reflected light for further identification
---	--

8



9

COLOR

- May be a distinctive feature
- Minerals may be deeply colored OR have pale, subtle tints

10



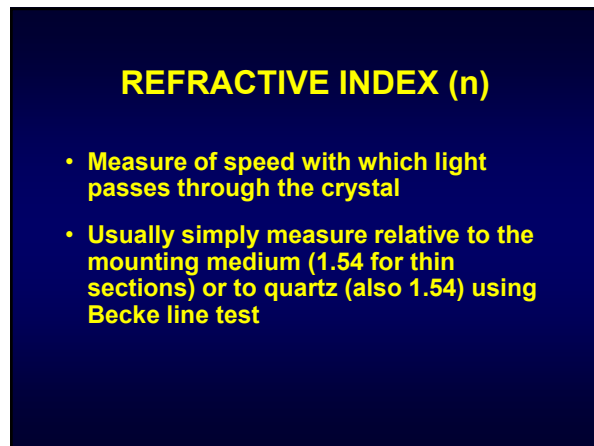
11



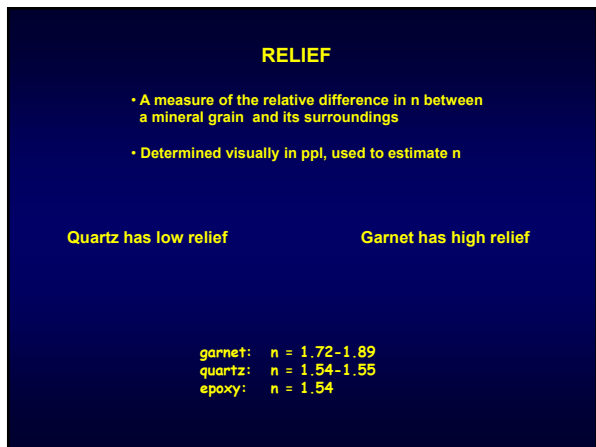
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13



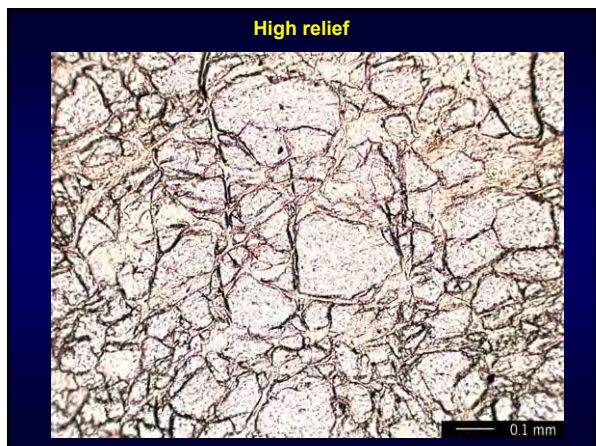
14



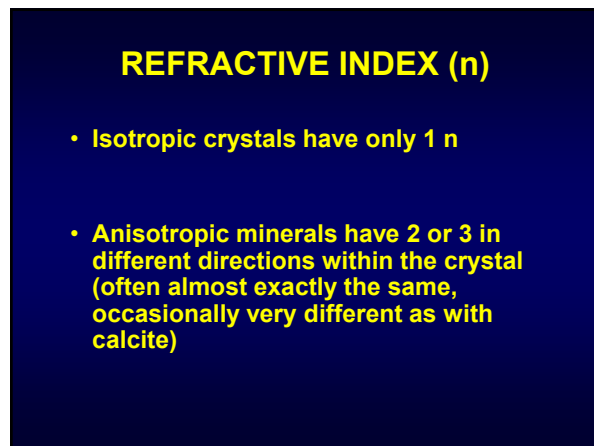
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17



18

Calcite varies in relief depending on degree of microscope stage rotation



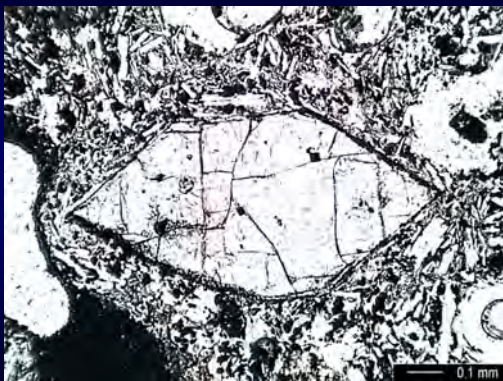
19

MORPHOLOGY

- Grain Size
- Grain Shape

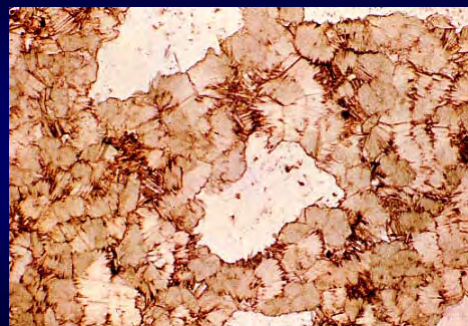
20

6-sided grain of olivine



21

Large Blobbly Quartz and Small Radiating Fans of Chlorite



22

Platy tablets and elongated grains of biotite mica



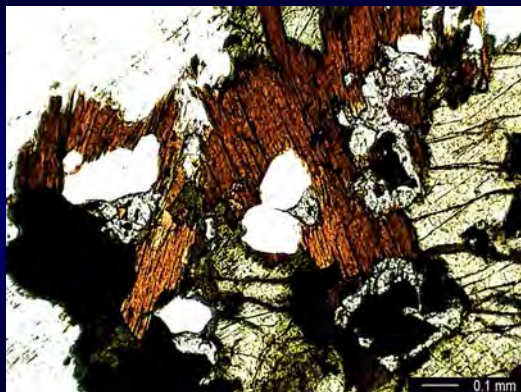
23

CLEAVAGE

- Ability of a mineral to separate into smaller and smaller particles along a smooth plane surface
- Example: Micas have 1 good cleavage, peels off in perfect layers
- In thin section, mica cleavage planes appear as parallel lines if grain is oriented side up; if looking down onto the top surface of the grain it will just be very flat

24

Mica: side orientation showing single good cleavage



25

Mica from top, smooth surface



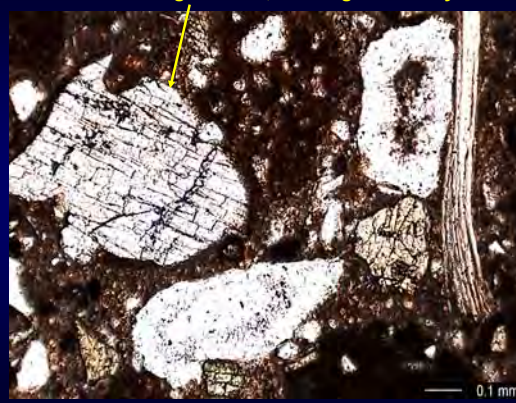
26

Cleavage Variables

- Presence/absence of cleavage
- Number of cleavage directions
- Angle between two cleavage directions
- Cleavage orientation relative to morphology (parallel to short or long direction)
- Cleavage quality (good or poor)

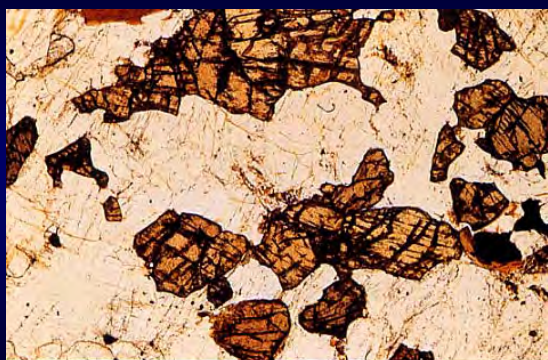
27

Two Cleavages at 90°, One Higher Quality



28

Two Cleavages, 60/120°



29

CROSSED POLARIZED LIGHT (cpl)

- Uses two polarizing plates with their allowed planes of vibration at right angles to each other
- Creates a different set of optical properties that can be observed in thin sections

30

ISOTROPIC

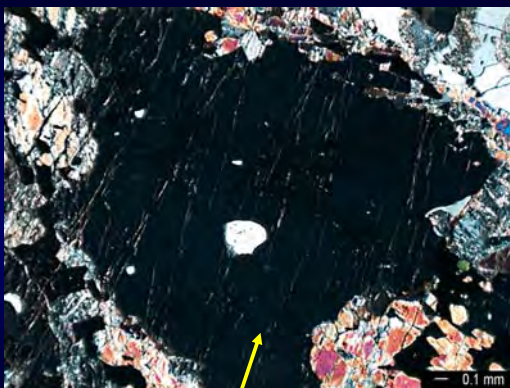
- Random or uniform arrangement of atoms in all directions
- Light moves with equal velocity in all directions, so there is only 1 refractive index (n)
- Dark in crossed polars

31



Garnet, ppl

32



Garnet, cpl

33

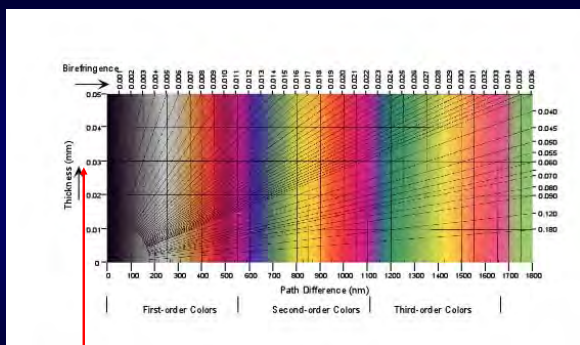
ANISOTROPIC

- Visible in crossed polarized light except at 4 positions of extinction as you rotate the stage
- Colors called interference colors or birefringence colors
- Color seen depends on retardation (slowness) (Δ) of 1 set of light waves compared to the other
- Also depends on crystal thickness (d)

$$\Delta = d (n_2 - n_1)$$

34

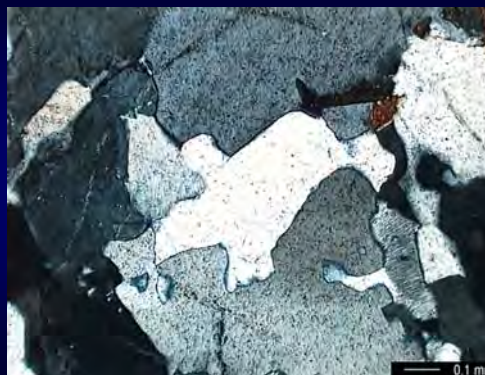
Michel-Levy Color Chart To Determine Birefringence (Δ , $n_1 - n_2$)



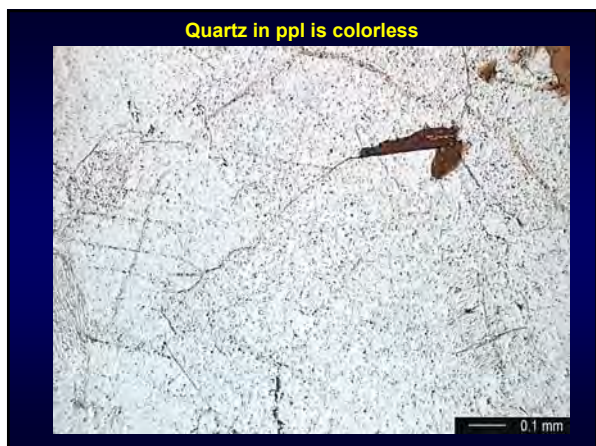
Go to 0.03 thickness for standard thin sections, move right across to color you see under microscope, then follow the angled line to determine birefringence

35

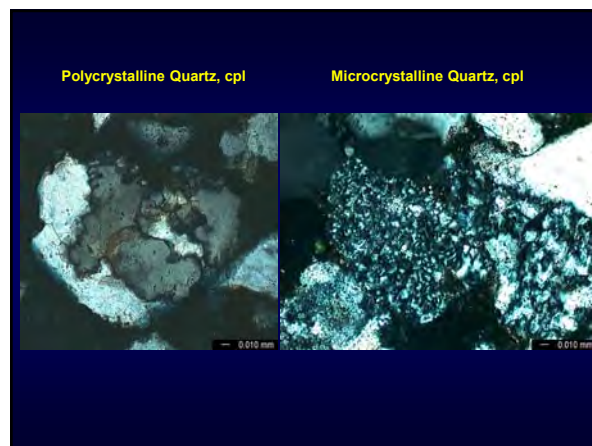
Quartz in cpl, Low Interference Colors



36



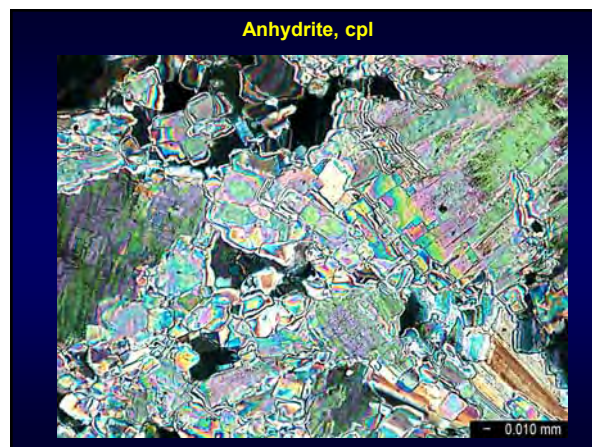
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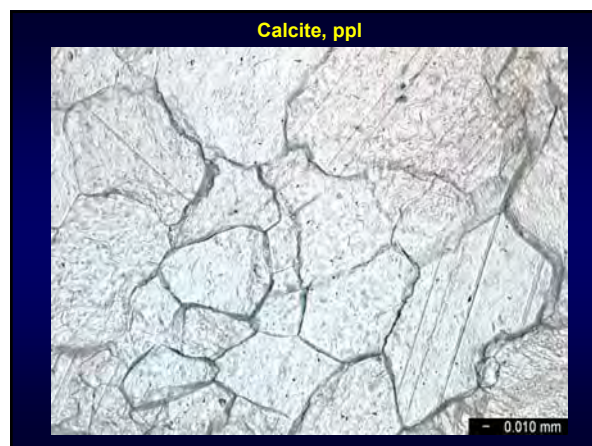
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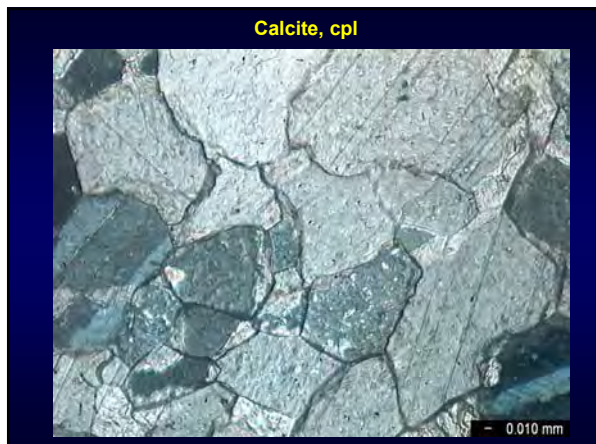
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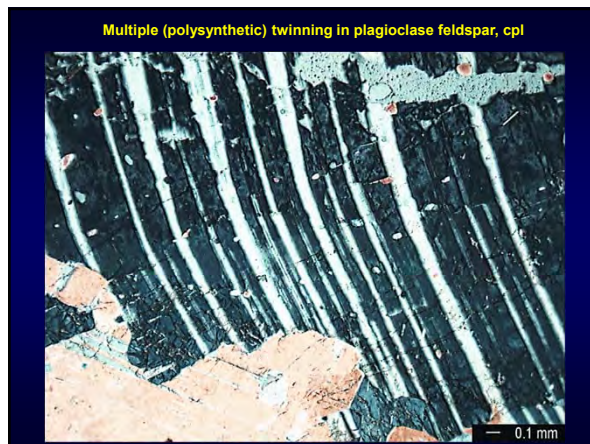
41



42



43



44



45

Major Rock-Forming Minerals

- <40 of the more than 2,400 minerals known
- Most are silicates (contain SiO_4)
- Another 30 occur as accessory minerals



A small, rectangular mineral specimen with a reddish-brown, crystalline texture, likely a common rock-forming mineral.

46



47



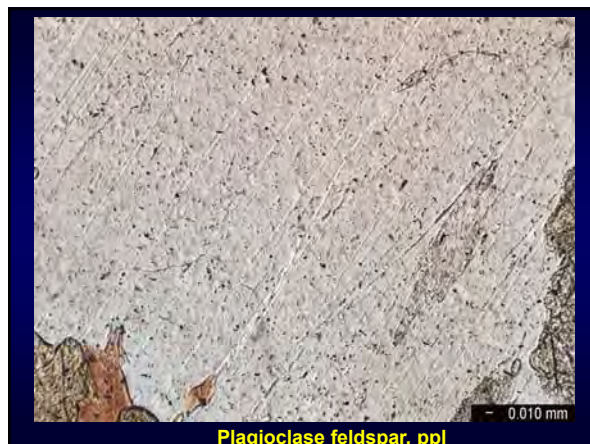
48

PLAGIOCLASE FELDSPARS

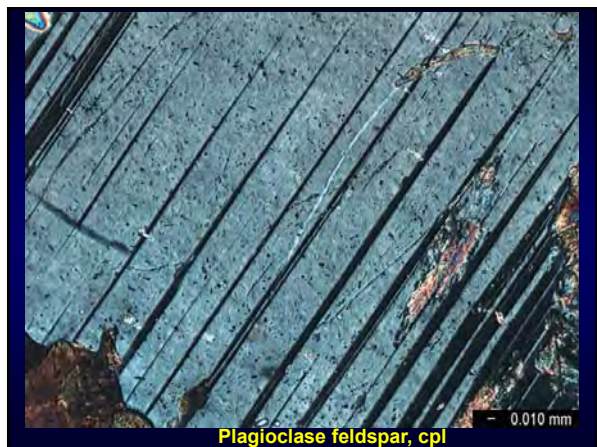
Solid solution

Albite $\text{Na (AlSi}_3\text{O}_8)$ Anorthite $\text{Ca (Al}_2\text{Si}_2\text{O}_8)$

49



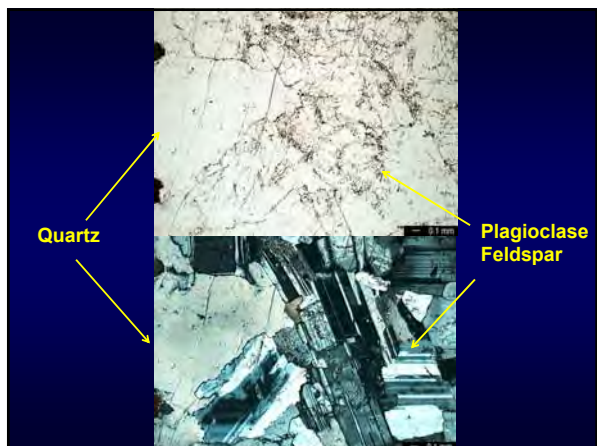
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51



52



53



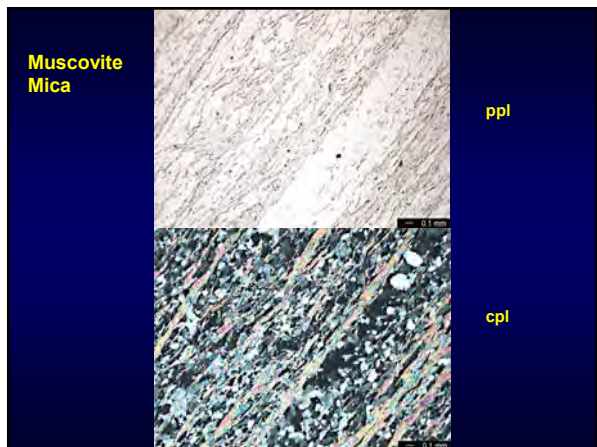
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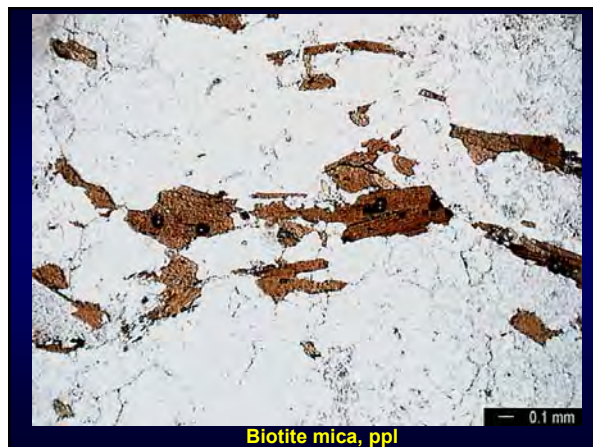
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56



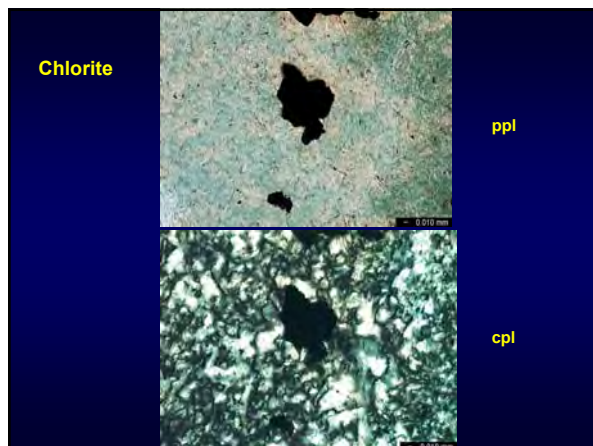
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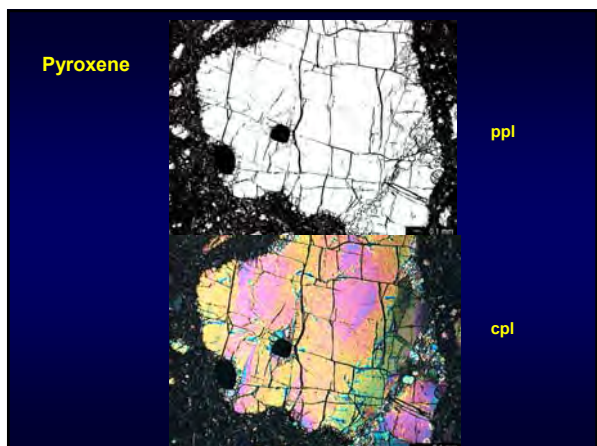
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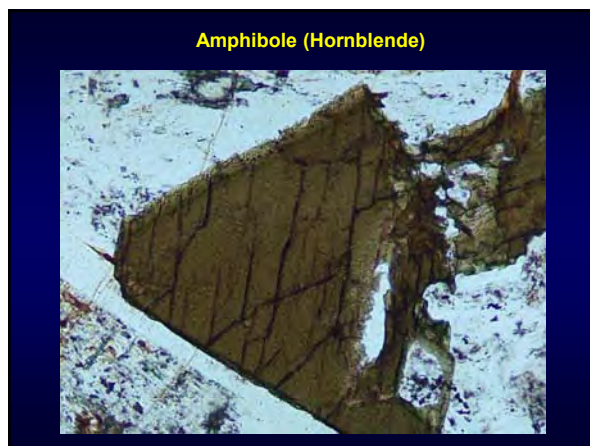
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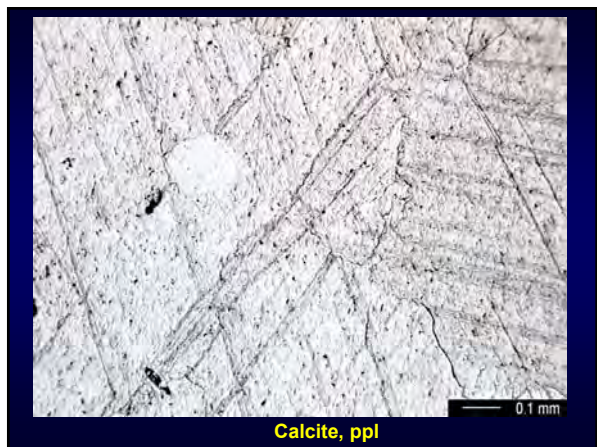
60



61



62



63



64

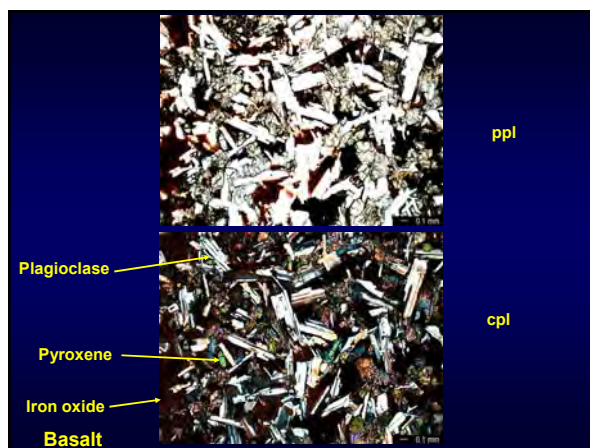
IGNEOUS ROCKS

Volcanic

Magma erupts onto surface of the earth, cools rapidly, forms fine-grained rocks (or even glass if cools too quickly to form mineral crystals)

Example: Basalt

65



66

IGNEOUS ROCKS

Plutonic

Formed deep within the earth from magma which has a chance to cool slowly and so more coarse-grained rocks are formed

Example: Granite

67

Biotite mica

Quartz

Microcline feldspar

ppl

cpl

Granite

68

Detrital Sedimentary Rock Examples

- Shale
- Siltstone
- Sandstone
- Conglomerate and Breccia

Fine

↓

Coarse

69

Shale: Mainly clay-sized grains (<0.005 mm)

70

Shale (ppl)

71

Siltstone
(0.005 - 0.0625 mm)

ppl

cpl

72



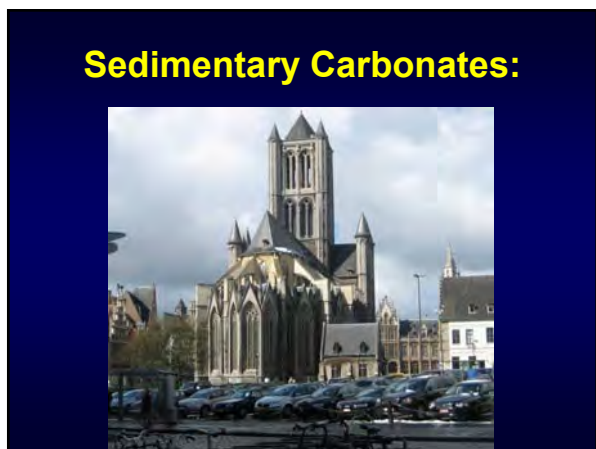
Sandstone

73



Sandstone (lithic grain), cpl

74



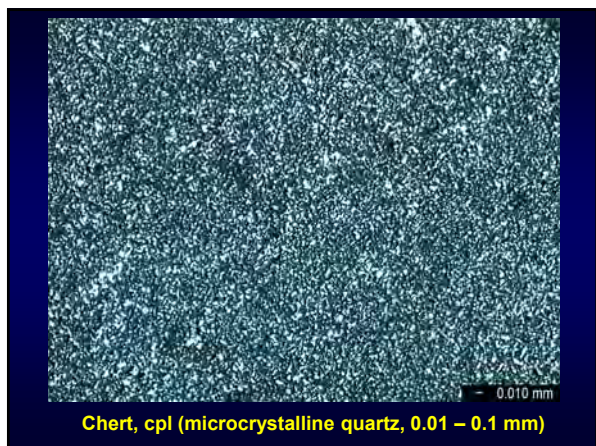
Sedimentary Carbonates:

75



Limestone with microfossils, ppl

76



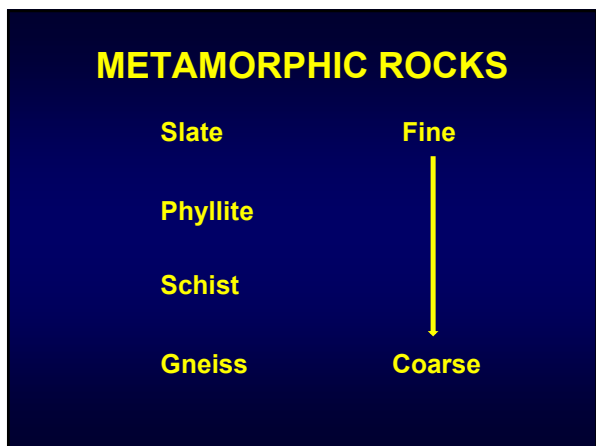
Chert, cpl (microcrystalline quartz, 0.01 – 0.1 mm)

77

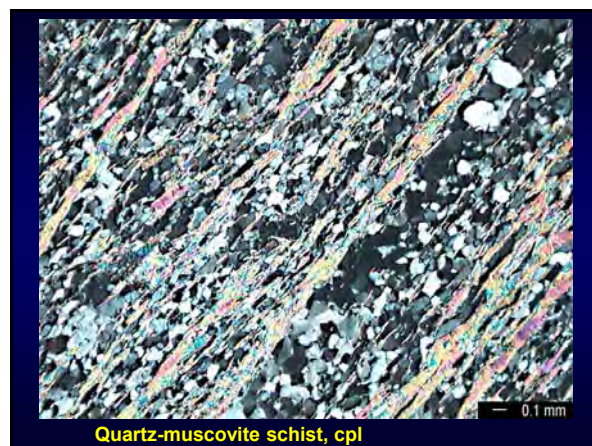


Chalcedony, cpl (cryptocrystalline quartz, < 0.01 mm)

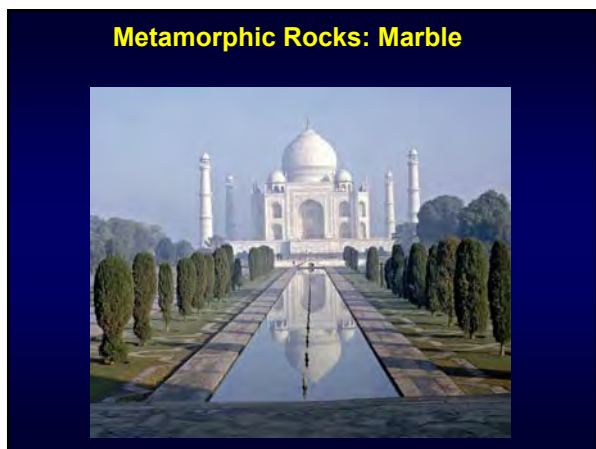
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79



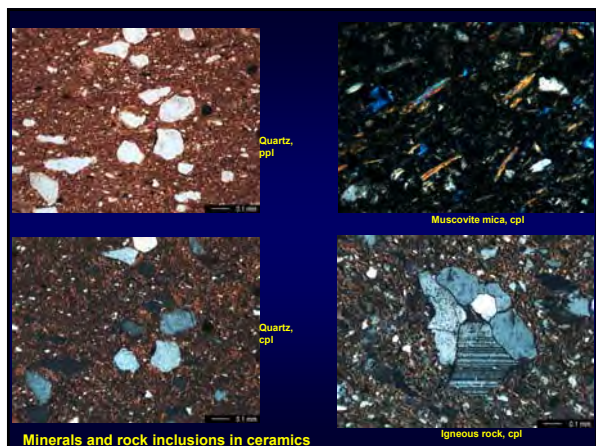
80



81



82



83