UNIVERSITY OF SOUTH ALABAMA

GY 302: Crystallography & Mineralogy

Lecture 6: Polymorphism and Crystal Habit

Instructor: Dr. Douglas Haywick

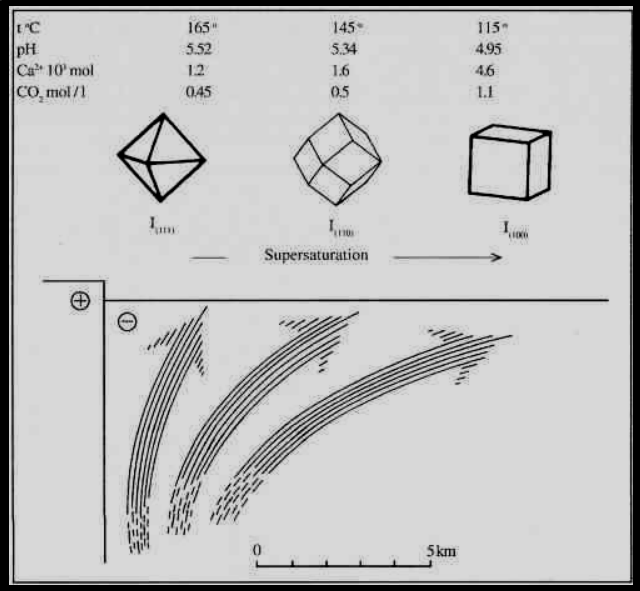
Online Lecture Review

1. Polymorphs and Polymorphism
2. Pseudomorphs and other definitions
3. Crystal Habit

Polymorphs & Polymorphism

Polymorphism: literally translates as “many forms”

In crystallography/mineralogy, it generally means that one mineral can exist in more than one crystal form under certain conditions (normally pressure/temperature).



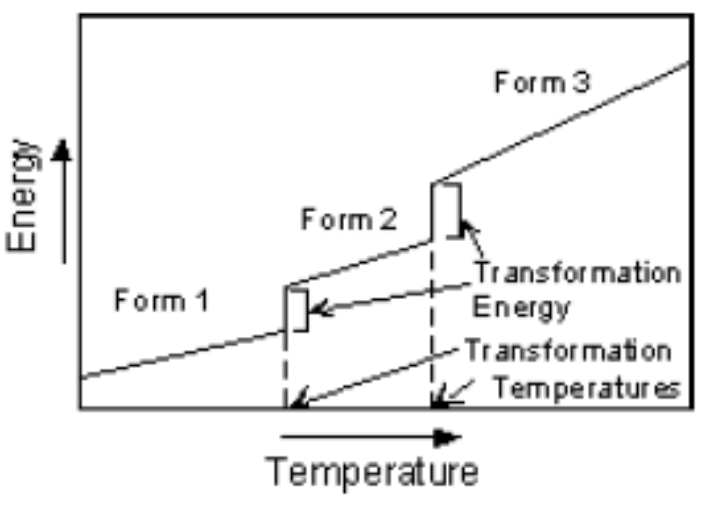
Crystal forms of fluorite versus temperature (this is not polymorphism. It is only a change of **Crystal Habit**)

http://www.clmc.bas.bg/minsoc/Crystal-morphological-evolution/Fluorit.jpg

Polymorphs & Polymorphism

Polymorphic transformations can occur in one of 3 ways:

1) Reconstructive: requires extensive breaking and recombining of chemical bonds in the crystal lattice. This transformation generally occurs only when the pressure/temperature threshold is reached and may be very slow*.



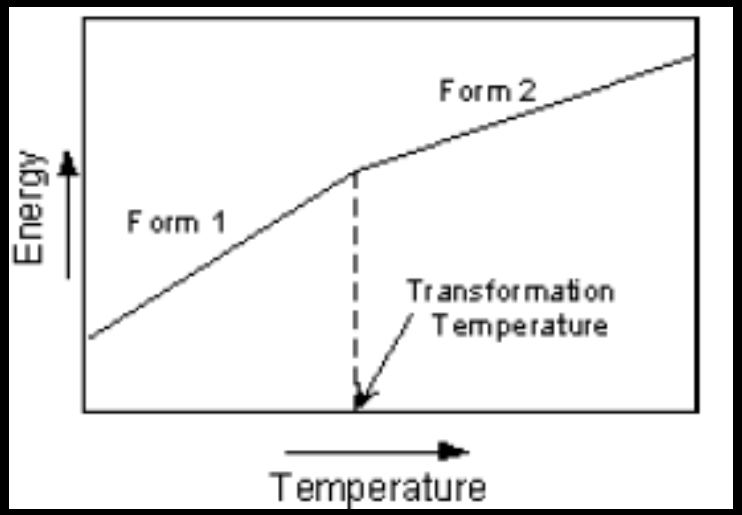
* really slow transformations may produce long-lived metastable Polymorphs (e.g., diamond)

Polymorphs & Polymorphism

Polymorphic transformations can occur in one of 3 ways:

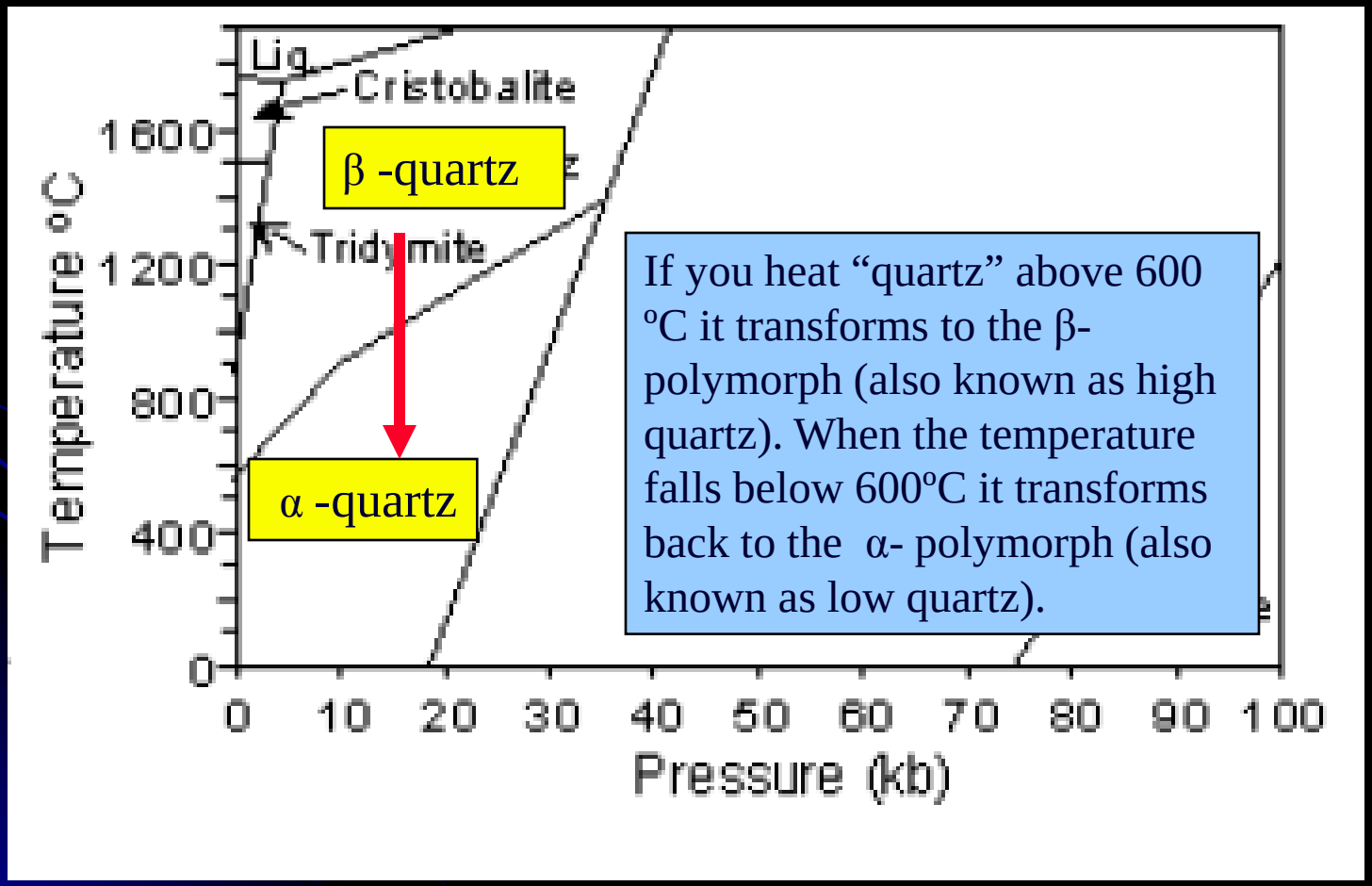
2) Displacive: requires relatively minor changes in the crystal lattice (e.g., modification of α, β or γ angles). There is generally no change in energy at the transformation threshold so polymorphic transformations are instantaneous and reversible.

No metastable polymorphics exist (e.g., α-quartz and β-quartz)



Polymorphs & Polymorphism

Quartz has 6 polymorphs related to pressure and temperature



Polymorphs & Polymorphism

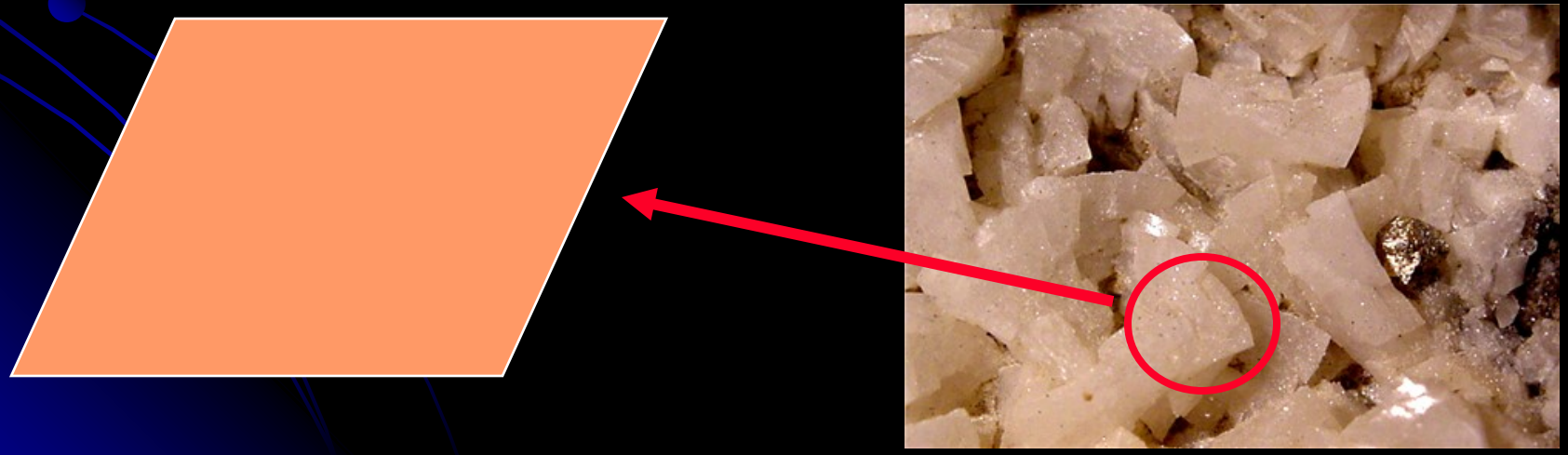
Polymorphic transformations can occur in one of 3 ways:

3) Order-Disorder transformations: all crystals have a certain amount of disorder to them (e.g., “saddle” dolomite) and in some cases, polymorphic transitions can occur once an appropriate level of order-disorder is attained.

Polymorphs & Polymorphism

Well ordered dolomite

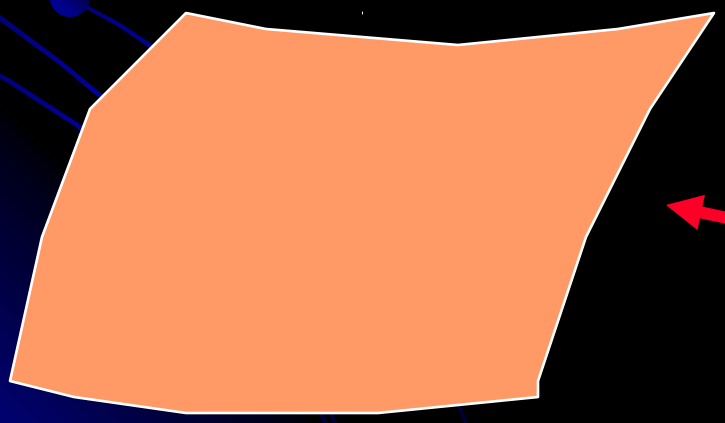
$CaMg(CO_3)_2$



Polymorphs & Polymorphism

Less well ordered dolomite

$CaMg(CO_3)_2$



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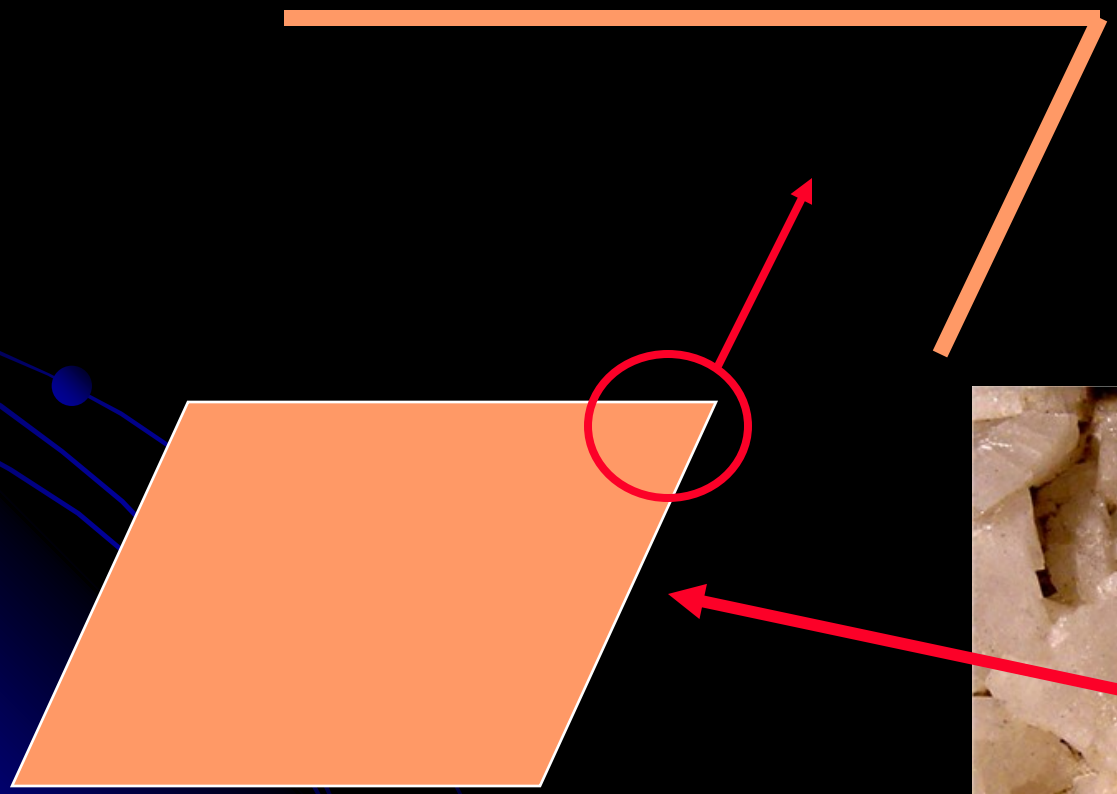
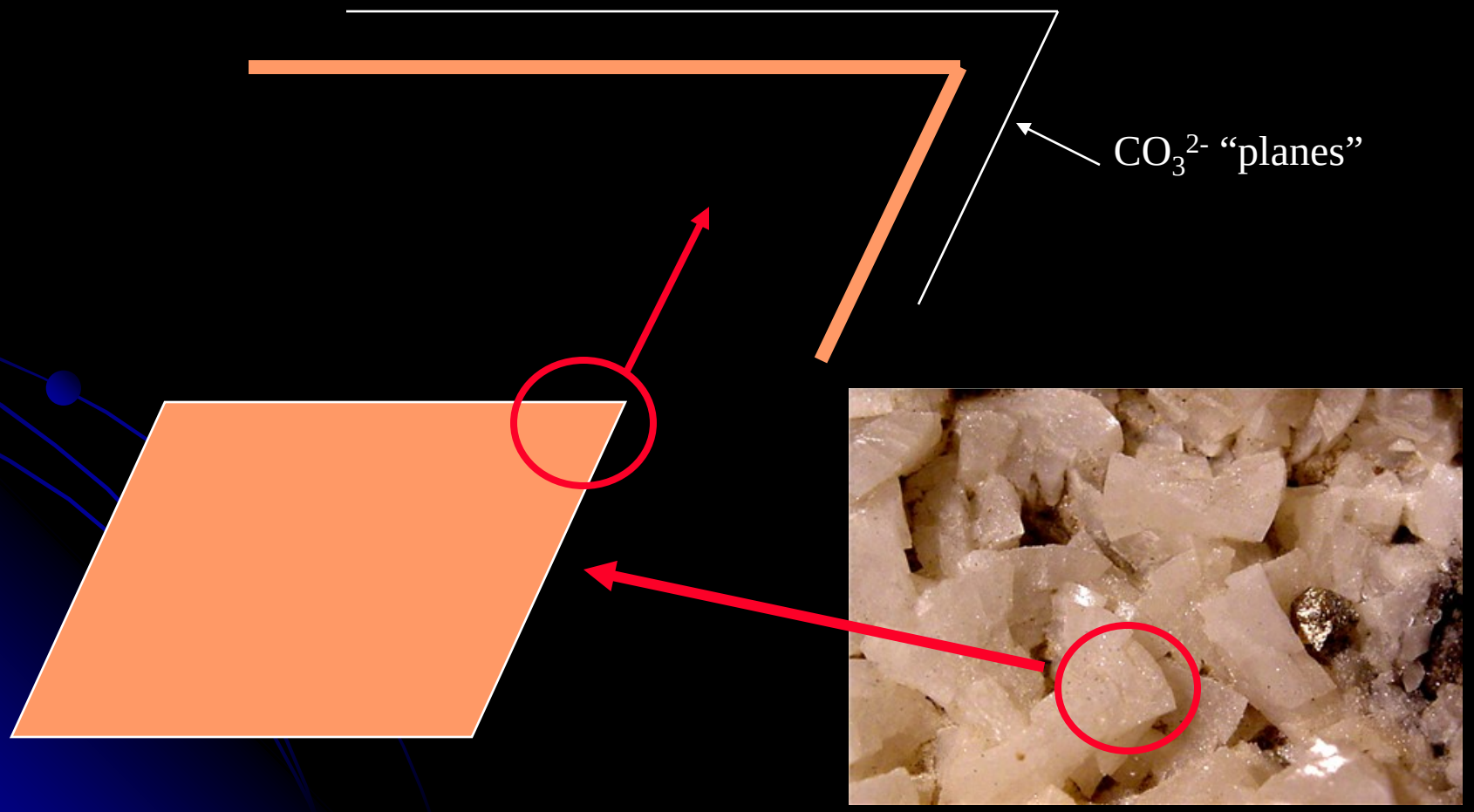


Polymorphs & Polymorphism



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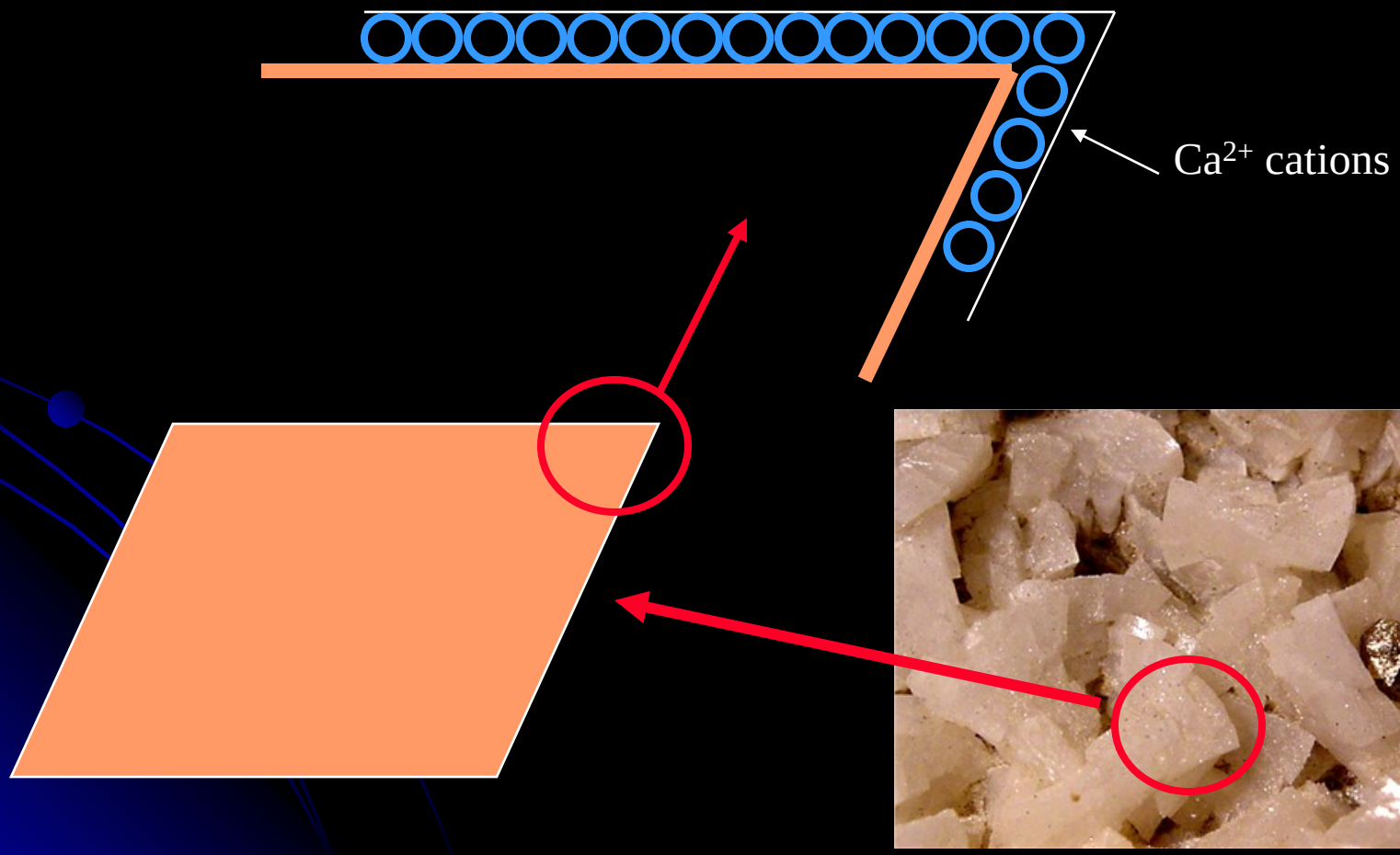

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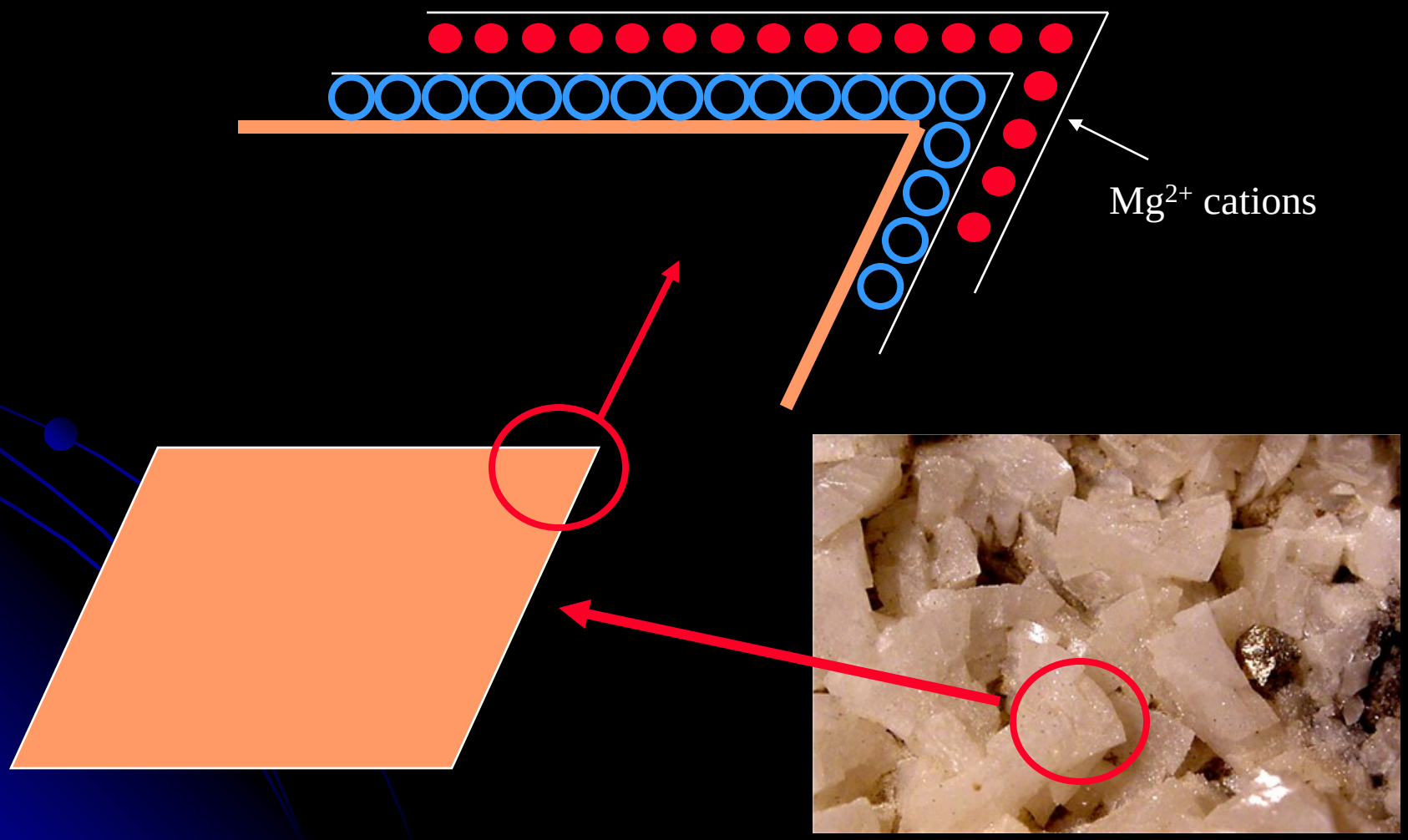

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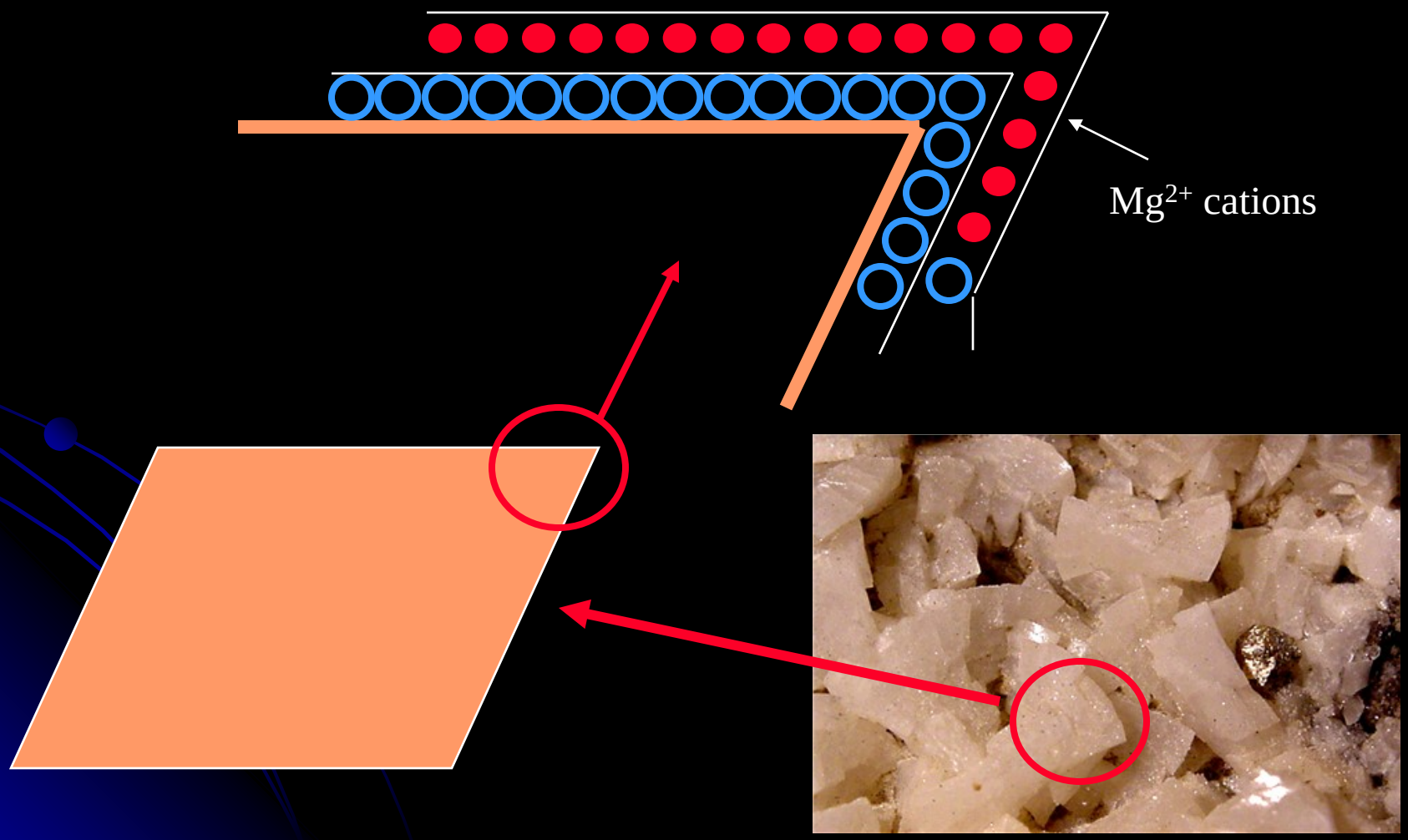

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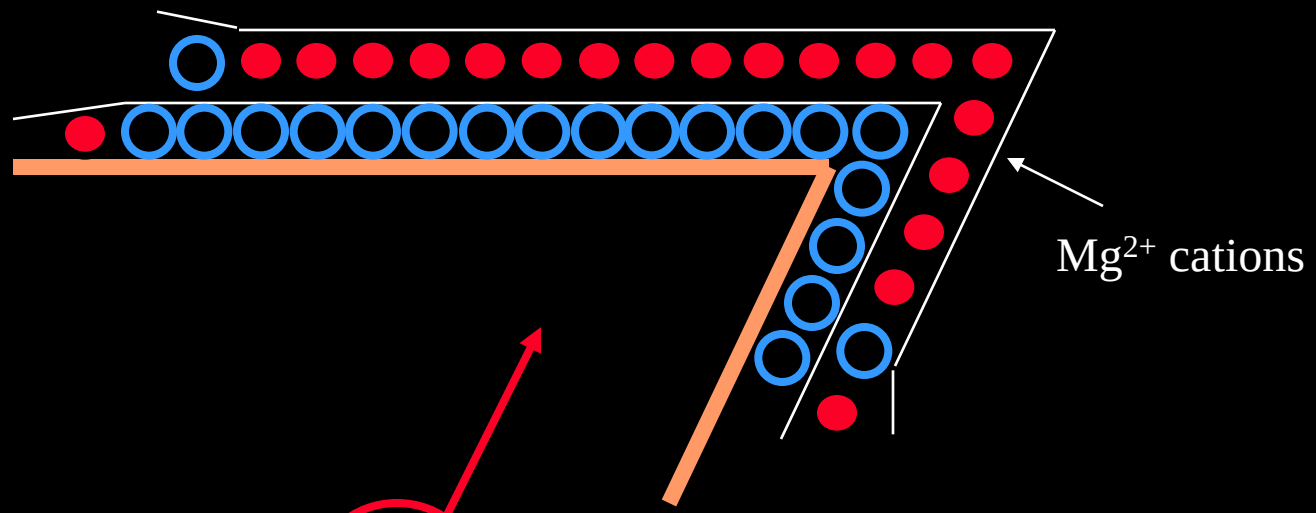
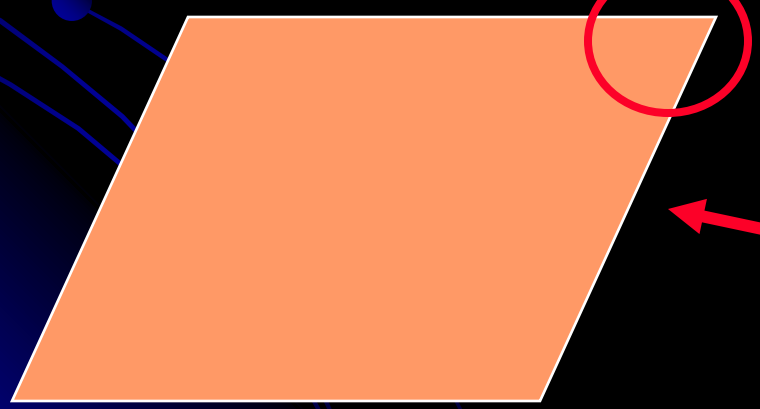
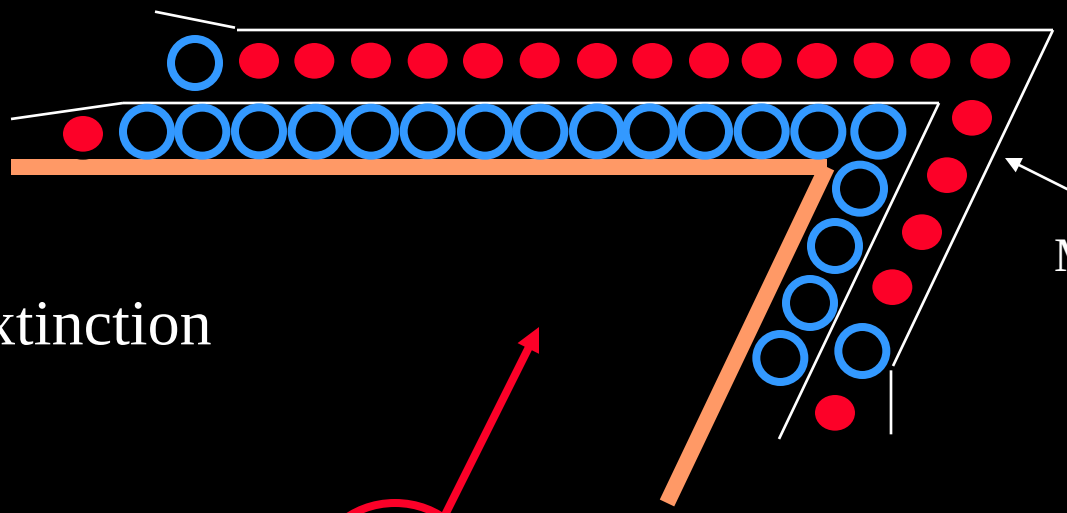
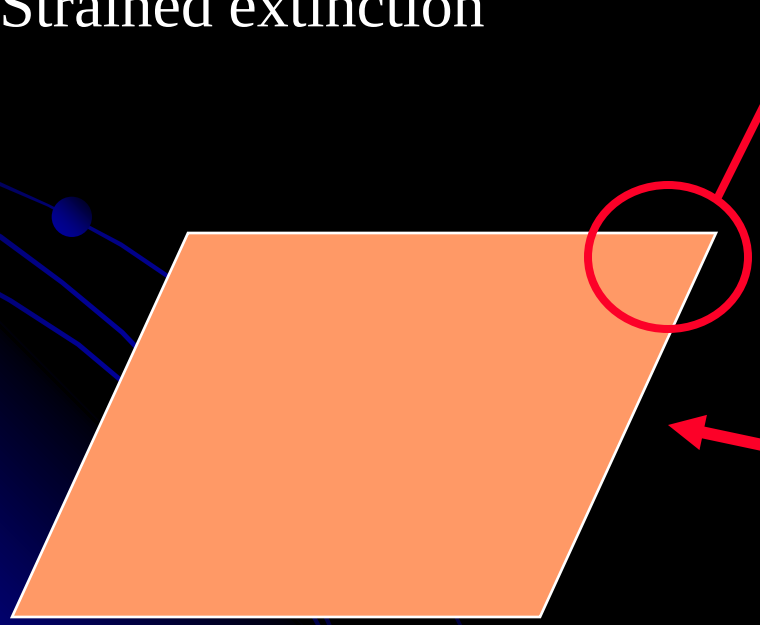




Polymorphs & Polymorphism



Strained extinction

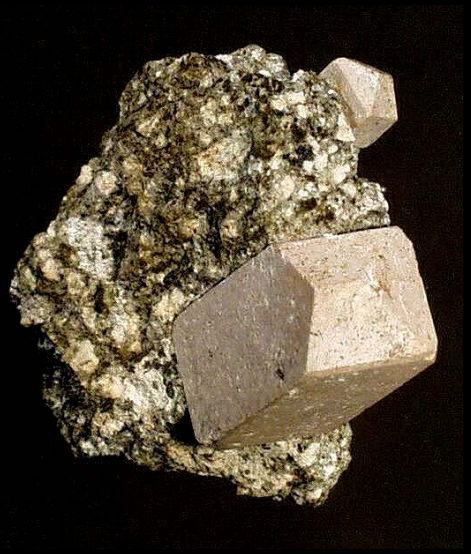


Polymorphs & Polymorphism

Polymorphic transformations can occur in one of 3 ways:

3) Order-Disorder transformations: all crystals have a certain amount of disorder to them (e.g., “saddle” dolomite) and in some cases, polymorphic transitions can occur once an appropriate level of order-disorder is attained. But…

… there is no threshold temperature or pressure for the transformation.



e.g., potassium feldspars

Polymorphs & Polymorphism

$KAlSi_3O_8$

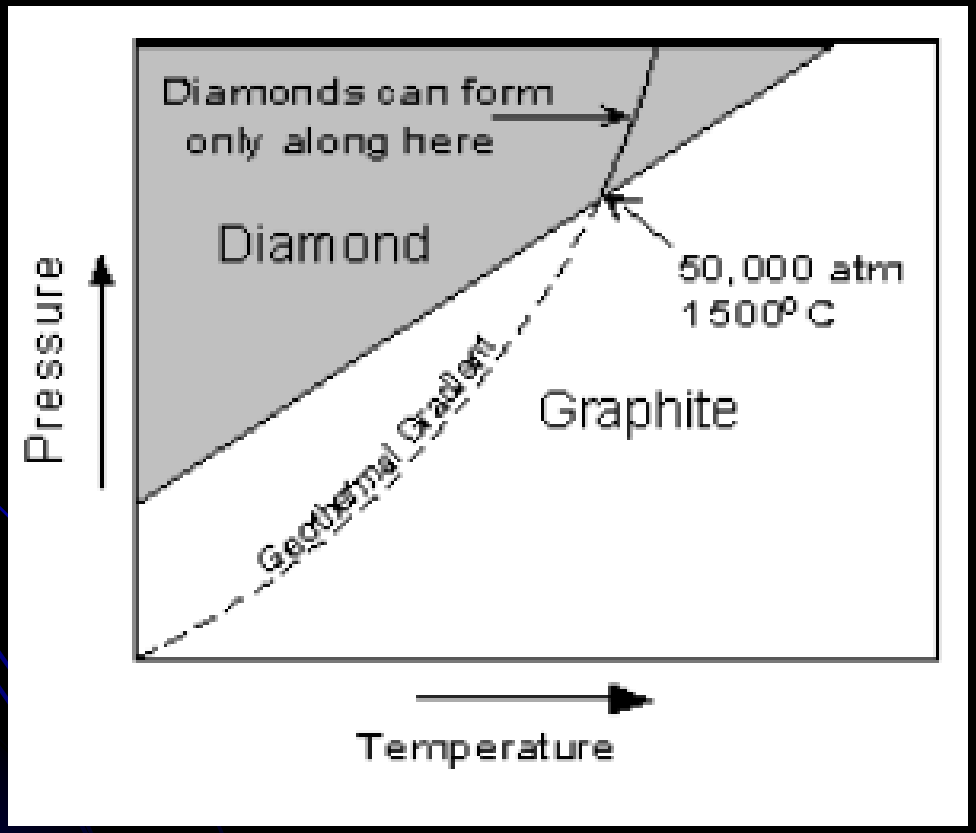
Sanidine → Orthoclase → Microcline

(triclinic) (monoclinic) (monoclinic)

High Temperature → Low Temperature

Polymorphs & Polymorphism

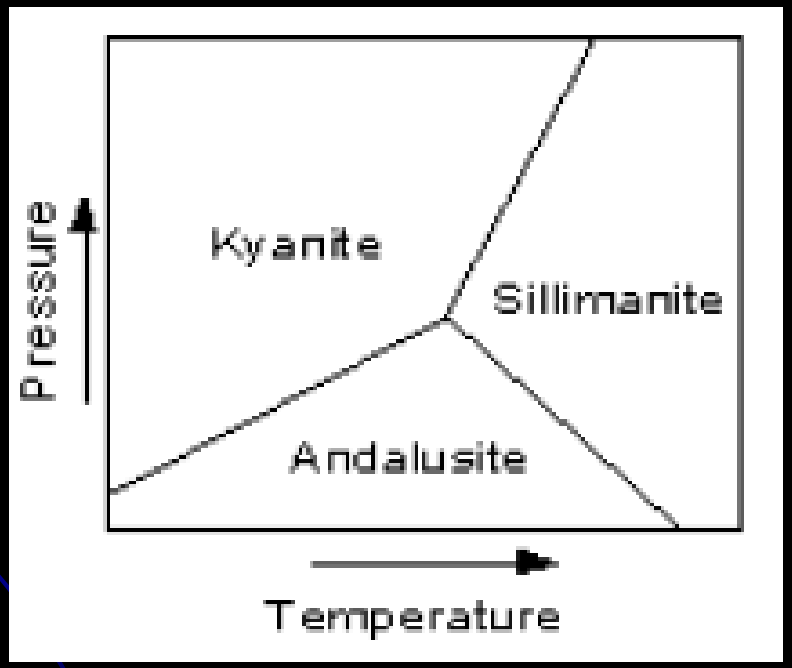
Examples of Polymorphs: 1) C- Diamond-Graphite (Reconstructive)



Polymorphs & Polymorphism

Examples of Polymorphs: 2) Al_2SiO_5

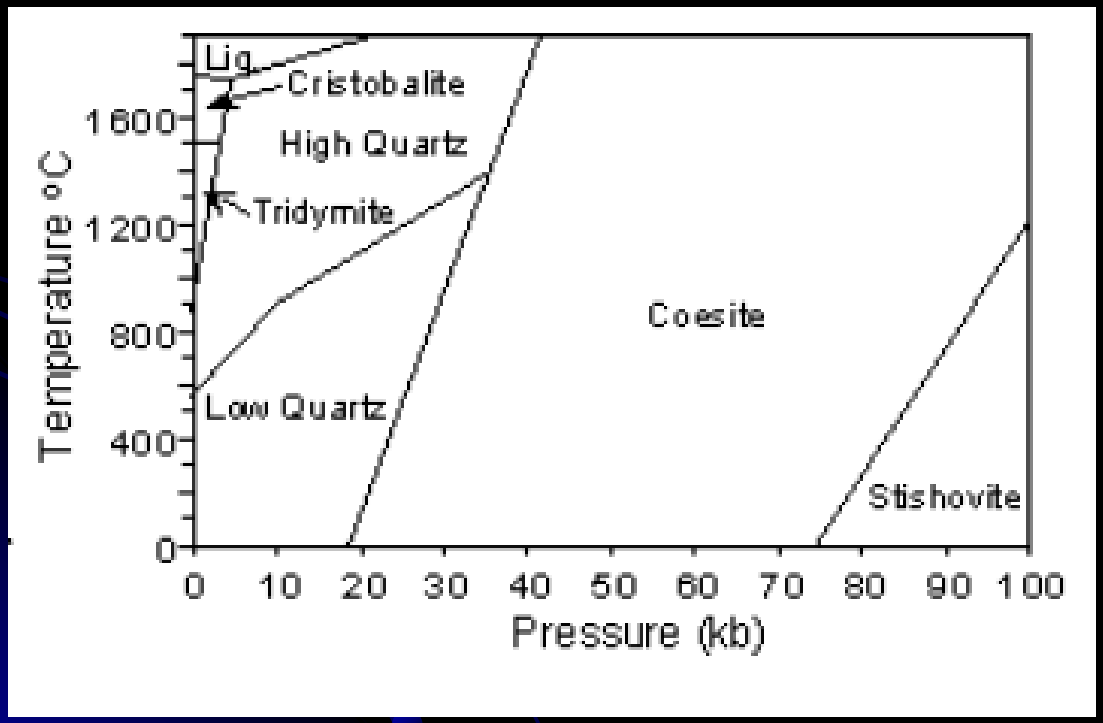
Kyanite-Sillimanite-Andalusite (Reconstructive)



Polymorphs & Polymorphism

Examples of Polymorphs: 3) SiO_2

(all reconstructive except α to β quartz)



Cristabolite: isometric

Tridymite: hexagonal

α, β: hexagonal

Coesite: monoclinic

Stishovite: tetragonal

Other Crystal "Structures"

Metamict Minerals: crystals with partially "nuked" lattices (e.g., zircon; $Zr(U,Th)SiO_4$).

Mineraloids: Amorphous minerals that do not have crystalline form (e.g., limonite: $FeOOH \cdot nH_2O$)

Pseudomorph: A mineral which has the crystal form of another mineral (nasty, sneaky minerals in disguise)- several types

Other Crystal “Structures”

Pseudomorphs: Form due to one of three mechanisms:

Dolomite crystals mimicking aragonite http://www.mindat.org/gallery-4223.html

Other Crystal "Structures"

Pseudomorphs: Form due to one of three mechanisms:

1) Substitution: molecule by molecule replacement of one mineral by another (e.g., quartz replacement of aragonite)

2) Encrustation: a coating of a new mineral top of an existing mineral (then the first mineral is dissolved; e.g., hematite on pyrite)

3) Alteration: Partial removal of one mineral and infilling by a second can also result in pseudomorphing (e.g., anhydrite in gypsum)

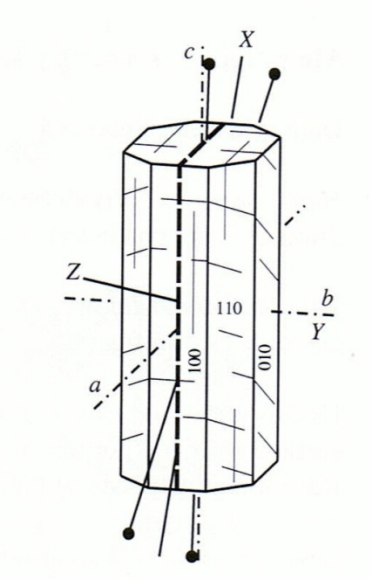
Terminology: anhydrite pseudomorphed after gypsum

Mineral Habits

Habit: The external appearance of a mineral (not necessarily the same as crystal form)

e.g., malachite
$Cu_2CO_3(OH)_2$

(monoclinic: 2/m)



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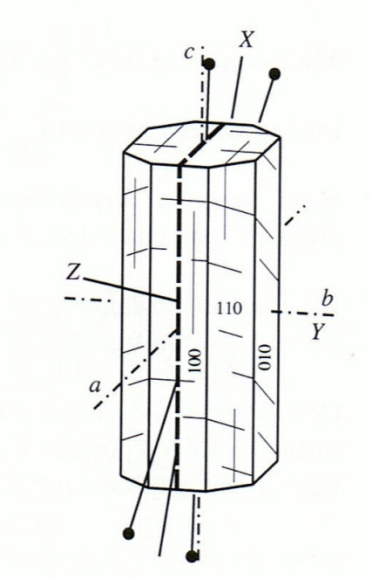

Today's Homework

1. Assignments 2 and 3 now next week
2. SI Session request by email (first come; first serve)
3. Study and organize: crystallography exam (take home) issued next Tuesday

Next Time

1. Optical Microscopy

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