

Phase Diagrams and Phase Chemistry

Phase diagrams

- provide a graphical means of presenting the results of experimental studies of complex natural process
- such that at a given _____ (T) and _____ (P) for a specific _____ the _____ or _____ present can be determined at _____.

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DEFINITIONS

SYSTEM

- _____
- _____
- _____ versus _____ systems

PHASE

- _____

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PHASE

A phase is any part of a system that is:

- _____
- _____, and
- _____

There exists a _____ surface between different phases

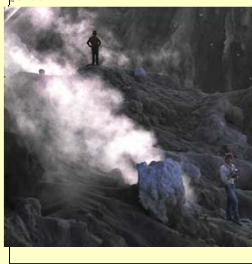
Phases may exist in a _____, _____ or _____ state

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Gas State

- Gases are completely _____ with each other, regardless of composition.
- There can only be _____ gas phase in a system at _____.



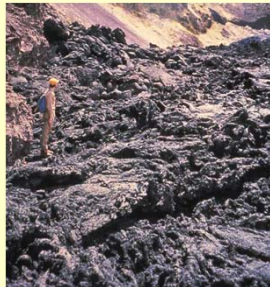
Liquid State

- Many liquids can be _____ in any proportion to form a _____ phase
- Liquids are _____ to _____ immiscible (do not mix).
- Such liquids remain as separate phases with a distinct boundary surface between them.



Solid State

- Some solids have very strict compositional limits
 - e.g. quartz - SiO_2 .
- Others exhibit a wide range in composition
 - plagioclase Ab to An
- Due to _____ limits of many solid phases, there are commonly more than one solid phase in a system.



Phase (continued)

• **Example:**

- A lava flow at _____ containing a mixture of ol and pl in liquid, contains _____ phases - ol, pl and liquid.

- _____:

- any _____ phase which can coexist with a liquid, i.e. it formed directly from the liquid

- _____:

- formed after all the liquid has crystallized, i.e. _____ minerals

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EQUILIBRIUM

- Condition of _____ energy for the system:

- such that the state of a _____ will not change with time
- provided T and P are kept _____

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EQUILIBRIUM (continued)

In Experimental petrology there are three practical criteria to test for equilibrium:

- _____
- _____
- _____

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EQUILIBRIUM (continued)

Approach equilibrium from two different directions

- e.g. the melting point of Albite.
 - begin with a liquid of Ab composition ($\text{Na}_2\text{O}-\text{Al}_2\text{O}_3-6\text{SiO}_2$) and cool until Ab crystallizes - $T=1100^\circ\text{C}$
 - begin with the same mixture of solid albite and heat it up until liquid forms - $T=1120^\circ\text{C}$
 - Melting point of albite = $1110^\circ\text{C} \pm 10^\circ\text{C}$.

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EQUILIBRIUM (continued)

Attainment of equilibrium by different procedures:

- using different reactants and procedures, determine the melting temperature of Albite
 - Grind a sample of pure albite ($\text{NaAlSi}_3\text{O}_8$)
 - Combine powdered oxides to give pure Ab composition ($\text{Na}_2\text{O}:\text{Al}_2\text{O}_3:6\text{SiO}_2$)
- Use both to determine Ab melting point.

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COMPONENT

- DEFINED - _____

- Components may be:
 - _____
 - _____
 - _____

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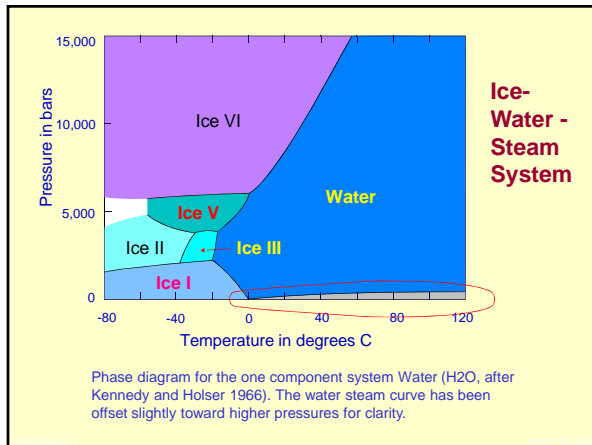
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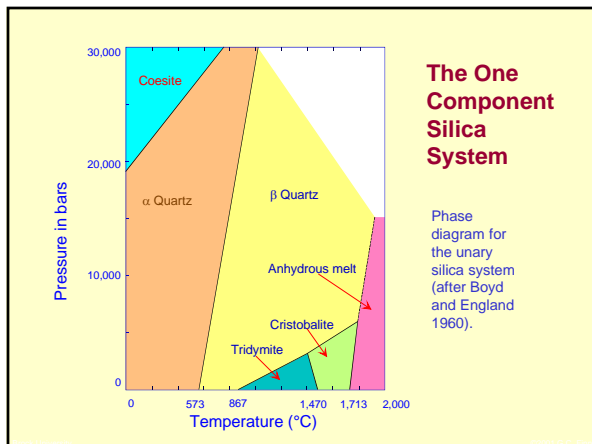
Phase Diagrams #1

ONE COMPONENT OR UNARY SYSTEMS

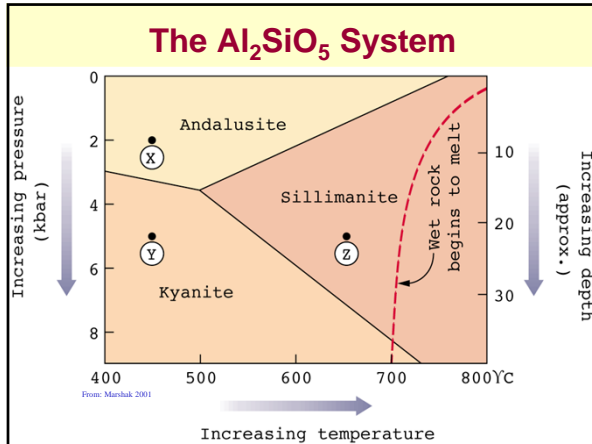
- Examples
 - Water - H_2O
 - Silica - SiO_2
 - Aluminosilicate - Al_2SiO_5

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Phase Diagrams #1



PHASE RULE

- For a system at equilibrium, the Phase Rule relates:
 - $P =$ _____
 - $C =$ _____, and
 - $F =$ _____
- Where:

$$P + F = C + 2$$
- Degrees of Freedom
 - environmental conditions which can be independently varied without changing the number of phases in the system.
 - Conditions include T, P, chemical composition, pH, Eh, oxygen fugacity.

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