The Gibbs Phase Rule

- The phase rule allows one to determine the number of degrees of freedom (F) or variance of a chemical system. This is useful for interpreting phase diagrams.

$$F = 2 + C - P$$

Where F is the number of degrees of freedom,

C is the number of chemical components and

P is the number of phases in the system. The number two is specified because this formulation assumes that both T and P can be varied.

Thermodynamics of Solutions

- **Phases:** Part of a system that is chemically and physically homogeneous, bounded by a distinct interface with other phases and physically separable from other phases.

- **Components:** Smallest number of chemical entities necessary to describe the composition of every phase in the system.

- **Solutions:** Homogeneous mixture of two or more chemical components in which their concentrations may be freely varied within certain limits.

Mole Fractions

$$X_A \equiv \frac{n_A}{\sum n} = \frac{n_A}{(n_A + n_B + n_C + \cdots)},$$

where X_A is called the "mole fraction" of component A in some phase.

If the same component is used in more than one phase, Then we can define the mole fraction of component A in phase i as X_A^i

For a simple binary system, $X_A + X_B = 1$

Phase Rule Significance for Phase Diagrams

- For two dimensional phase diagrams:
  - **Stability fields:** Areas (T-P, T-X, P-X space) where a phase or phase assemblage (more than one phase) is stable.

  - **Equilibrium boundary lines:** These define the limits of stability fields. These represent values of parameters where phases in adjacent fields coexist.

  - **Triple points:** Points where equilibrium boundary lines meet. All phases in the adjacent stability fields must coexist.

Binary Phase Relations - Definitions

- **Liquidus line**: the line that represents the locus of depressed freezing points as a second component is added to the system. Solid phases are not stable at temperatures above those defined by the liquidus line or surface.
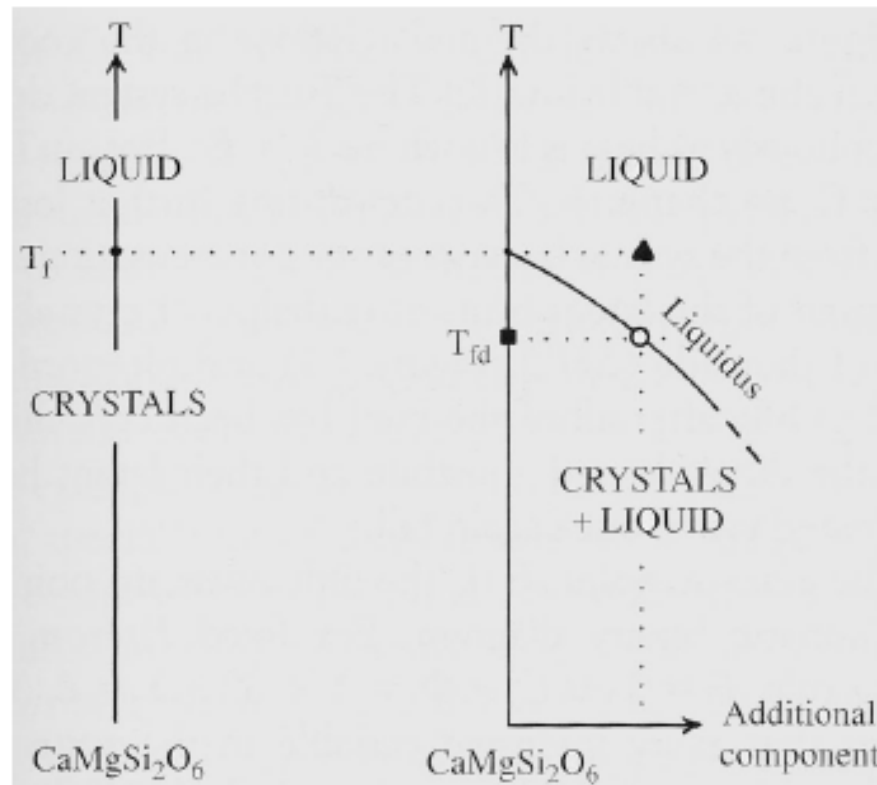
Binary Phase Diagram Definitions

- **Eutectic point:** Lowest T point on the liquidus at which a unique melt of fixed composition is in equilibrium with two or more phases.

- **Isopleth:** line of constant chemical composition.

- **Isotherm:** line of constant temperature

- **Tie line:** portion of isotherm that connects two stable coexisting phases, in this case L (representing the silicate liquid) and S (pure crystalline anorthite feldspar)

Di-An Binary Eutectic Phase Diagram