Binary System with a Peritectic

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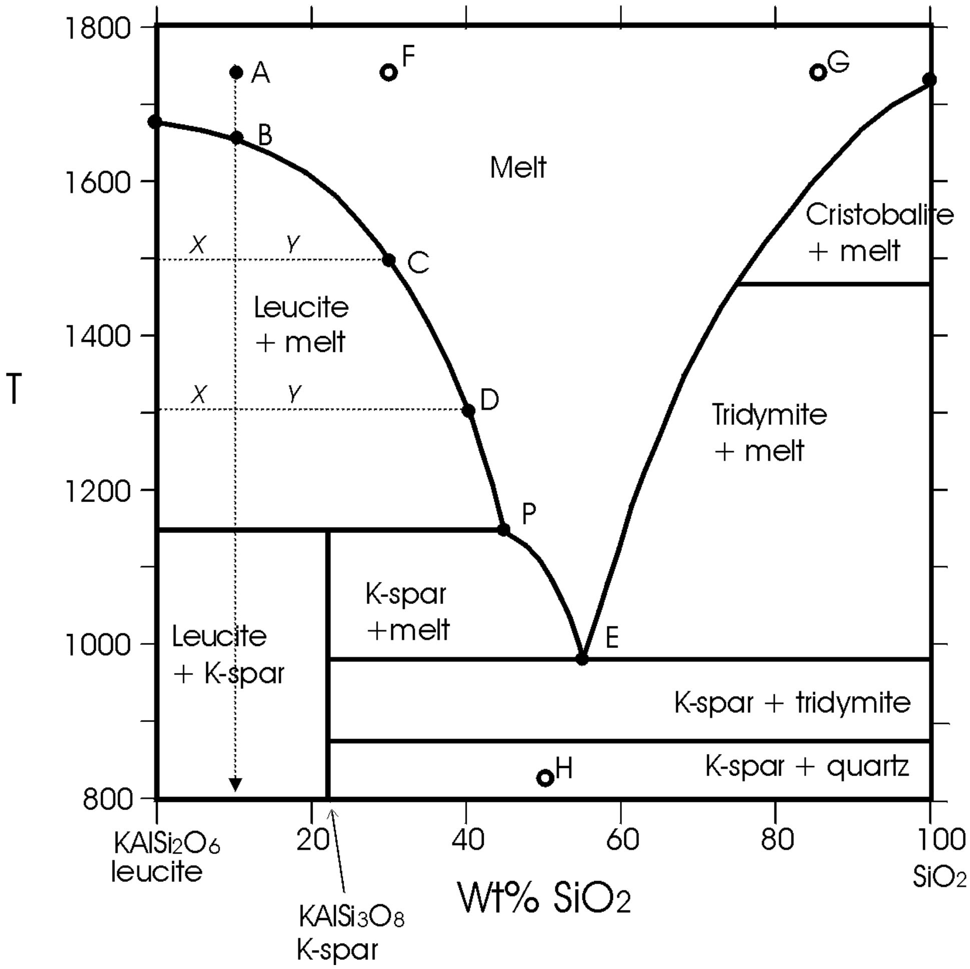

The drawing shows the system $KAlSi_2O_6$-SiO_2. It includes the minerals leucite, K-spar, and three SiO_2 polymorphs (cristobalite, tridymite, and quartz).

Note that the bottom axis is in wt%, not mole%. (This explains why K-spar does not plot half way between leucite and SiO_2.)

Eutectic

Note the eutectic (point E) at about 1000 °C. Point E depicts the composition of the lowest temperature melt that can occur in this system.

Congruent Melting, Incongruent Melting, and the Peritectic

Leucite melts congruently at about 1680 °C; cristobalite melts congruently at about 1730 °C. This means that the melts produce are the same composition as the mineral that melts. (This diagram does not tell us anything about the melting temperature of tridymite or quartz, but they too melt congruently.)

K-spar, in contrast with leucite and cristobalite, melts incongruently at 1150 °C to produce a liquid more siliceous than K-spar and the less siliceous compound, leucite. Point P, the composition of the melt when K-spar melts, is called a peritectic.

SiO_2 Polymorphs

Note that cristobalite reacts to form tridymite at about 1470 ^{o}C, and tridymite reacts to form quartz at a subsolidus temperature (about 860 ^{o}C).

Cooling Path Example

Consider a cooling melt of composition A at high temperature (figure on previous page). The first crystals will begin to form as it enters the leucite+melt field at point B, about 1675 ^{o}C.

To follow the crystallization, note the dotted arrow descending from point A. It passes through the leucite+melt field until it reaches the peritectic temperature at about 1150 ^{o}C. A horizontal tie line at any temperature between 1675 ^{o}C and 1150 ^{o}C intersects the left hand axis (leucite) and the curve (BCDP) that gives the composition of the melt. So, as cooling continues down to 1150 ^{o}C, leucite crystallizes and the melt will undergo continuous reaction, changing composition from B=>C=>D=>P. The lever rule applies, and the % melt is always given by 100 $X/(X+Y)$.

When the melt reaches the peritectic P, at about 1150 ^{o}C, a discontinuous reaction occurs as K-spar crystallizes along with leucite. Even if heat is leaving the system, temperature will not decrease until the last drop of melt is gone. Once all melt is gone, the mineral assemblage is close to an equal mix of leucite and K-spar, and temperature can decrease again. Be sure to note that, for starting composition A, the melt composition never reaches the eutectic (E).

Problems

1. Consider a melt of composition F. Describe its cooling and crystallization as was done above for composition A.

2. Consider a melt of composition G. Describe its cooling and crystallization as was done above for composition A.

3. Consider a rock composed of 50 wt% $KAlSi_3O_8$ and 50 wt% SiO_2 at about 830 ^{o}C (point H). Describe its melting as temperature increases slowly to 1800 ^{o}C. Be specific about the amounts of melt and crystals, and the composition of the melt, at all temperatures.