

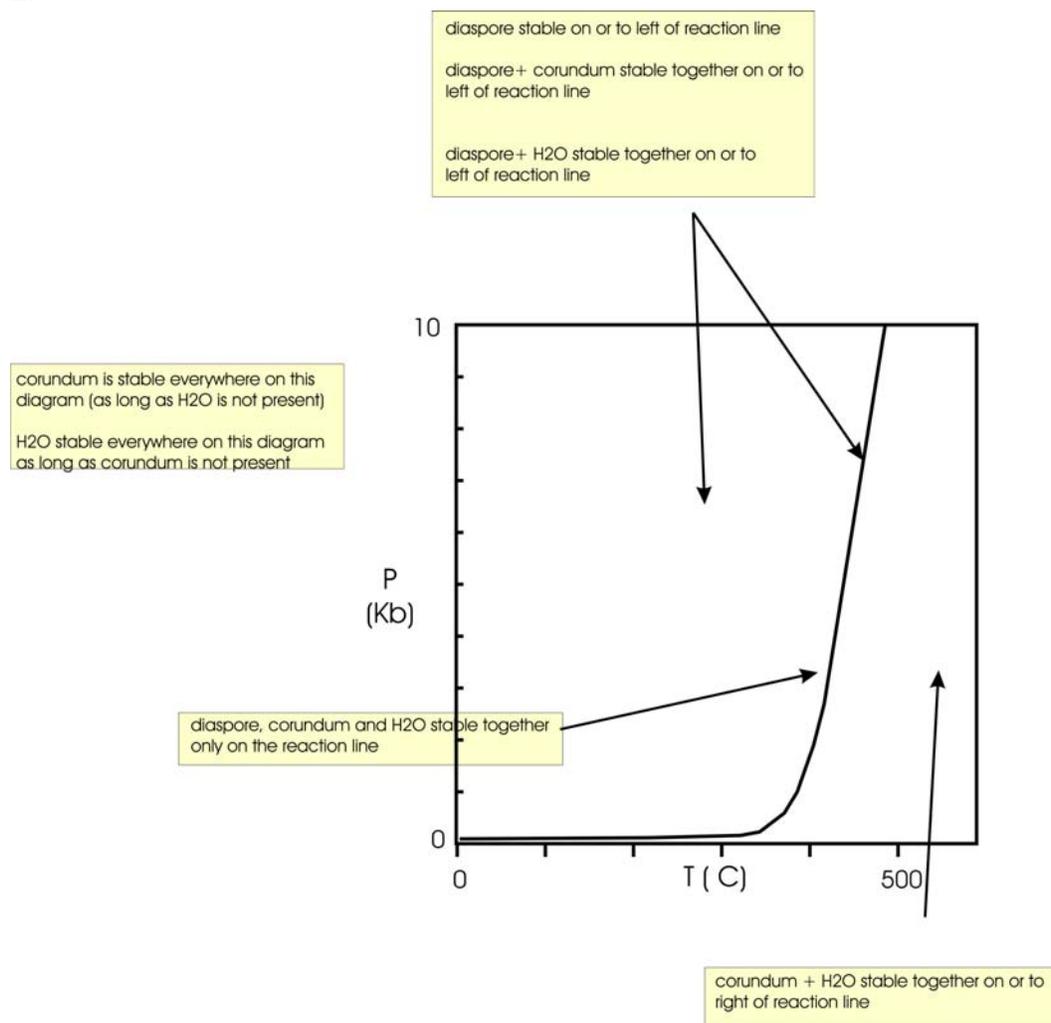
Phase Diagrams

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Question Answers

1. A tough question. The answer is that if minerals always reacted to equilibrium, there should be no diamond or sillimanite for us to look at. But, some minerals persist even if they are thermodynamically unstable. We term such minerals metastable.

2.



3. Most of the possible assemblages are stable except that any assemblage that contains sillimanite cannot also contain Py + Di.

4. To answer this correctly, you must consider the reaction coefficients. (They are all 1

except for the 3Q in reaction 1.)

Assemblage #	Minerals (and amounts) in Field A	Minerals (and amounts) in Field B	Minerals (and amounts) in Field C
1	3 moles of pyrophyllite	3Ky, 9Q, 3H ₂ O	3Ky, 9Q, 3H ₂ O
2	2 moles of pyrophyllite 3 moles of quartz	2Ky, 9Q, 2H ₂ O	2Ky, 9Q, 2H ₂ O
3	1 mole of pyrophyllite 1 mole of muscovite	1Ky, 3Q, 1H ₂ O, 1Ms	2Ky, 2Q, 2H ₂ O, 1Ksp
4	1 mole of pyrophyllite 3 moles of muscovite	1Ky, 3Q, 1H ₂ O, 3Ms	4Ky, 4H ₂ O, 3Ksp
5	1 mole of pyrophyllite 5 moles of muscovite	1Ky, 3Q, 1H ₂ O, 5Ms	4Ky, 4H ₂ O, 2Ms, 3Ksp

5. There are 5 phases total, each reaction is missing 1.

missing	included	reaction
(Ka)	Py, Q, H ₂ O, Ky	$Py = Ky + 3Q + H_2O$
(Ky)	Py, Q, H ₂ O, Ka	$Ka + 2Q = Py + H_2O$
(H ₂ O)	Py, Q, Ka, Ky	$2Py = Ka + 5Q + Ky$
(Q)	Py, H ₂ O, Ka, Ky	$3Ka = Py + 2KY + 5H_2O$
(Py)	Q, H ₂ O, Ka, Ky	$Ka = Ky + Q + 2H_2O$

6. 5. There are 5 phases total, each reaction is missing 1.

missing	reaction
(Gr)	$An = Ky + Wo$
(Q)	$An = Ky + Wo$
(An)	$Gr + Q = Ky + 3Wo$
(Wo)	$3An = Gr + 2Ky + Q$
(Ky)	$Gr + Q = An + 2Wo$

Two of the reactions are the same. The one missing (gr) is also missing (Q). This is called a degenerate situation. It arises because the three minerals (An, Ky, Wo) can be described using a 2-component system (Al_2SiO_5 - CaSiO_3). There is no need for a third component so a reaction can be balanced with only three phases.

7.

Co: everywhere
 Zo: A through D
 Ge: everywhere
 Zo-An: A through D
 An-Ge: F and G
 Zo-An-Ge: nowhere
 Gr-An- H_2O : C, D, E, F
 An-Wo-Q: D, E, F, G
 Gr-Co-An-Ge: line 5
 Gr-An-Co- H_2O : E
 An-Ge-Wo-Zo: nowhere
 Zo-Ky-Co-Gr- H_2O : A
 Gr-An-Zo-Q- H_2O : line 2
 An-Co-Gr-Ge- H_2O : line 5
 An-Co-Gr-Q- H_2O : nowhere

