**Korjinski (activity/activity) Diagram Exercise Template**

1) Choose your inert component, which in this case is Al2O3

2) Calculate the mole ratios of the mobile components to the inert component for all the minerals which appear on the triangular diagram:

|  |  |  |
| --- | --- | --- |
| **Mineral** | K2O / Al2O3 | SiO2 / Al2O3 |
|  |  |  |
| Quartz |  |  |
| Microcline |  |  |
| Kaliophilite |  |  |
| Muscovite |  |  |
| Kaolinite |  |  |
| Gibbsite |  |  |
| KOH |  |  |

3) Plot the minerals on the oxide ratio diagram.

4) Draw in all stable tie-lines from your triangular diagram.

5) Draw a line perpendicular to each tie-line

a) These perpendiculars represent the orientations of

the mineral phase boundaries with will appear on your

final activity diagram.

6) Transfer these perpendiculars to the qualitative activity diagram with the following axes:

aK+

log -----

aH+

---------------

log a H4SiO4

7) Now use free energy data to quantify the diagram by writing balanced equations representing conversion of one mineral to another using K+, H+ and H4SiO4 to balance your equation. Remember to conserve Al2O3. It's usually easiest to start with the equations which involve only one variable.

**ΔGR  = = -5.709 log K (in kjoules/mol)**

Gibbsite -- Kaolinite boundary

Al(OH)3 (s) = Al2Si2O5(OH)4 (s)

Gro = -58.8 kJ/mol therefore, log K = 10.30

K = ----------------------

log K = 10.30 =

log =

Kaliophilite -- Microcline boundary

KAlSiO4(s) + 2 H4SiO4(aq) = KAlSi3O8 (s) + 4 H2O (l)

Gro = -69.8 kJ/mol, therefore,

log K = 12.23 = - 2 log a H4SiO4 and

log a H4SiO4 = -6.11

Kaliophilite -- Muscovite boundary

KAlSiO4 (s) + = KAl3Si3O10(OH)2 (s) +

Gro = -157.5 kJ/mol, therefore,

log K = 27.6 = ---------

Kaolinite -- Muscovite boundary

3Al2Si2O5(OH)4(s)+2K+(aq)=2KAl3Si3O10(OH)2(s)+2H+(aq)+3H2O

Gro = 36.0 kJ/mol, therefore,

(aH+)2 (aH+)

log K = -6.3 = log -------- = 2 log -------

(aK+)2 (aK+)

aK+

log ----- = 3.2

aH+

**Reactions involving both variables**:

Gibbsite -- Kaliophilite boundary

Al(OH)3(s) = KAlSiO4 (s)

Gro = 29.1 kJ/mol, therefore,

log K = -5.1 = log

**Two more mineral/mineral phase boundaries to do:**

**3Al(OH)3(s)+ K+(aq)+ 3H4SiO4(aq)= KAl3Si3O10(OH)2(s) + H+(aq)+9H2O**

Gro = -70.0 kJ/mol, therefore, log K = 12.26 and

aK+

log ----- = -3 log a H4SiO4 -12.3

aH+

**KAl3Si3O10(OH)2(s)+ 2K+(aq)+ 6H4SiO4(aq)= 3** **KAlSi3O8 (s)+ 2H+(aq)+12H2O**

aK+

log ----- = -3 log a H4SiO4 – 4.51

aH+

Now choose some values of aK+

log ----- and log a H4SiO4

aH+

and plot up the line.

**Finally**:

To simplify this problem set, I eliminated amorphous silica as a potential phase so instead calculate the quartz saturation line. This is the same reaction you used when we studied the impact of pH on quartz solubility.

Then calculate the KOH solubility line.

KOH (s) + H+ (aq) = K+ (aq) + H2O (l)

**KEY-**

**Korjinski (activity/activity) Diagram Laboratory (10/22/12)**

1) Choose your inert component, which in this case is Al2O3

2) Calculate the mole ratios of the mobile components to the inert component for all the minerals which appear on the triangular diagram:

|  |  |  |
| --- | --- | --- |
| **Mineral** | K2O / Al2O3 | SiO2 / Al2O3 |
|  |  |  |
| Quartz | **0** | **∞** |
| Microcline | **1** | **6** |
| Kaliophilite | **1** | **2** |
| Muscovite | **0.333** | **2** |
| Kaolinite | **0** | **2** |
| Gibbsite | **0** | **0** |
| KOH | **∞** | **0** |

3) Plot the minerals on the oxide ratio diagram.

4) Draw in all stable tie-lines from your triangular diagram.

5) Draw a line perpendicular to each tie-line

a) These perpendiculars represent the orientations of

the mineral phase boundaries with will appear on your

final activity diagram.

6) Transfer these perpendiculars to the qualitative activity diagram with the following axes:

aK+

log -----

aH+

---------------

log a H4SiO4

7) Now use free energy data to quantify the diagram by writing balanced equations representing conversion of one mineral to another using K+, H+ and H4SiO4 to balance your equation. Remember to conserve Al2O3. It's usually easiest to start with the equations which involve only one variable.

**ΔGR  = = -5.709 log K (in kjoules/mol)**

Gibbsite -- Kaolinite boundary

**2Al(OH)3 (s) + 2 H4SiO4 (aq) = Al2Si2O5(OH)4 (s) + 5 H2O (l)**

Gro = -58.8 kJ/mol therefore, log K = 10.30

**1**

**K = -------------**

**(a H4SiO4)2**

**log K = 10.30 = - 2 log a H4SiO4**

**log a H4SiO4 = -5.15**

Kaliophilite -- Microcline boundary

KAlSiO4(s) + 2 H4SiO4(aq) = KAlSi3O8 (s) + 4 H2O (l)

Gro = -69.8 kJ/mol, therefore,

log K = 12.23 = - 2 log a H4SiO4 and

**log a H4SiO4 = -6.11**

Kaliophilite -- Muscovite boundary

3 KAlSiO4 (s) + 2 H+(aq) = KAl3Si3O10(OH)2 (s) + 2 K+(aq)

Gro = -157.5 kJ/mol, therefore,

**(a K + )2**

**log K = 27.6 = log ---------**

**(a H + )2**

**(a K + )**

**log K = 13.8 = log ---------**

**(a H + )**

Kaolinite -- Muscovite boundary

**3Al2Si2O5(OH)4(s)+2K+(aq)=2KAl3Si3O10(OH)2(s)+2H+(aq)+3H2O**

**Gro = 36.0 kJ/mol, therefore,**

**(aH+)2 (aH+)**

**log K = -6.3 = log -------- = 2 log -------**

**(aK+)2 (aK+)**

**aK+**

**log ----- = 3.2**

**aH+**

**Reactions involving both variables**:

Gibbsite -- Kaliophilite boundary

**Al(OH)3(s) + K+(aq) + H4SiO4(aq) = KAlSiO4(s)+ H+(aq)+ 3H2O**

**Gro = 29.1 kJ/mol, therefore,**

**(a H+)**

**log K = -5.1 = log ---------------------**

**(a K+)(a H4SiO4)**

**aK+**

**log ----- = 5.1 - log a H4SiO4**

**aH+**

**Two more mineral/mineral phase boundaries to do:**

Gibbsite - Muscovite

**3Al(OH)3(s)+ K+(aq)+ 3H4SiO4(aq)= KAl3Si3O10(OH)2(s) + H+(aq)+9H2O**

**Gro = -70.0 kJ/mol, therefore, log K = 12.26 and**

**aK+**

**log ----- = -3 log a H4SiO4 -12.3**

**aH+**

Muscovite – Microcline

**KAl3Si3O10(OH)2(s)+ 2K+(aq)+ 6H4SiO4(aq)= 3** **KAlSi3O8 (s)+ 2H+(aq)+12H2O**

**Gro = -51.5 kJ/mol, therefore, log K = 9.02 and**

**aK+**

**log ----- = -3 log a H4SiO4 – 4.51**

**aH+**

**Finally**:

To simplify this problem set, I eliminated amorphous silica as a potential phase so instead calculate the quartz saturation line as on pp. 125-127 of your textbook. Then calculate the KOH solubility line as was done for gibbsite Al(OH)3 (s), in equation (1) in Table 12.4 on p. 192 of your textbook.

KOH (s) + H+ (aq) = K+ (aq) + H2O (l)

**Gro = -140.5 kJ/mol, therefore,**

**log K = 24.6 and**

**aK+**

**log ----- = 24.6**

**aH+**

Now choose some values of aK+

log ----- and log a H4SiO4

aH+

and plot up the lines.