ESS103A
Igneous Petrology, Spring 2006

Name__________________________
Due: May 8, 2006

Homework 3
PHASE DIAGRAMS AND MAGMA DIFFERENTIATION

The purpose of this assignment is to further practice using phase diagrams to derive useful information about igneous systems.

A. The Ab-Or diagrams.

Diagram A1 has point "**Y**" on it. Diagram A2 has point "**X**" on it. Please note: the compositional axis is *switched* from the way it is in your textbook!

1. a) Label the fields in both diagrams. Check your book for help.
b) On diagram A1, the system at point **Y** cools until it begins to crystallize. At what temperature does crystallization begin?
c) Assume the system of composition **Y** undergoes equilibrium crystallization. At 875°C, what is the composition of the melt? Of the solid?
d) What percent melt remains at 875°C? What percent of the system is solid?
e) Check your answers to **c)** and **d)** by writing a mass balance equation and solving it.
f) How many phases are present at composition **Y**, 750°C?
g) How many phases are present at composition **Y**, 600°C?
h) Draw a sketch of what you expect this system to look like in thin section at 600°C.

2. On diagram A2, start at composition **X** and 800°C.
a) Upon equilibrium cooling to just above 705°C, what is the composition and percentage of the solid phase?
b) What reaction occurs at 705°C?
c) Draw a sketch of what you expect this system to look like in thin section at 600°C.
d) Compare the sketch in 2c) to that in 1h). Use the appropriate textural terms.

B. The Fo-En-Qtz diagram

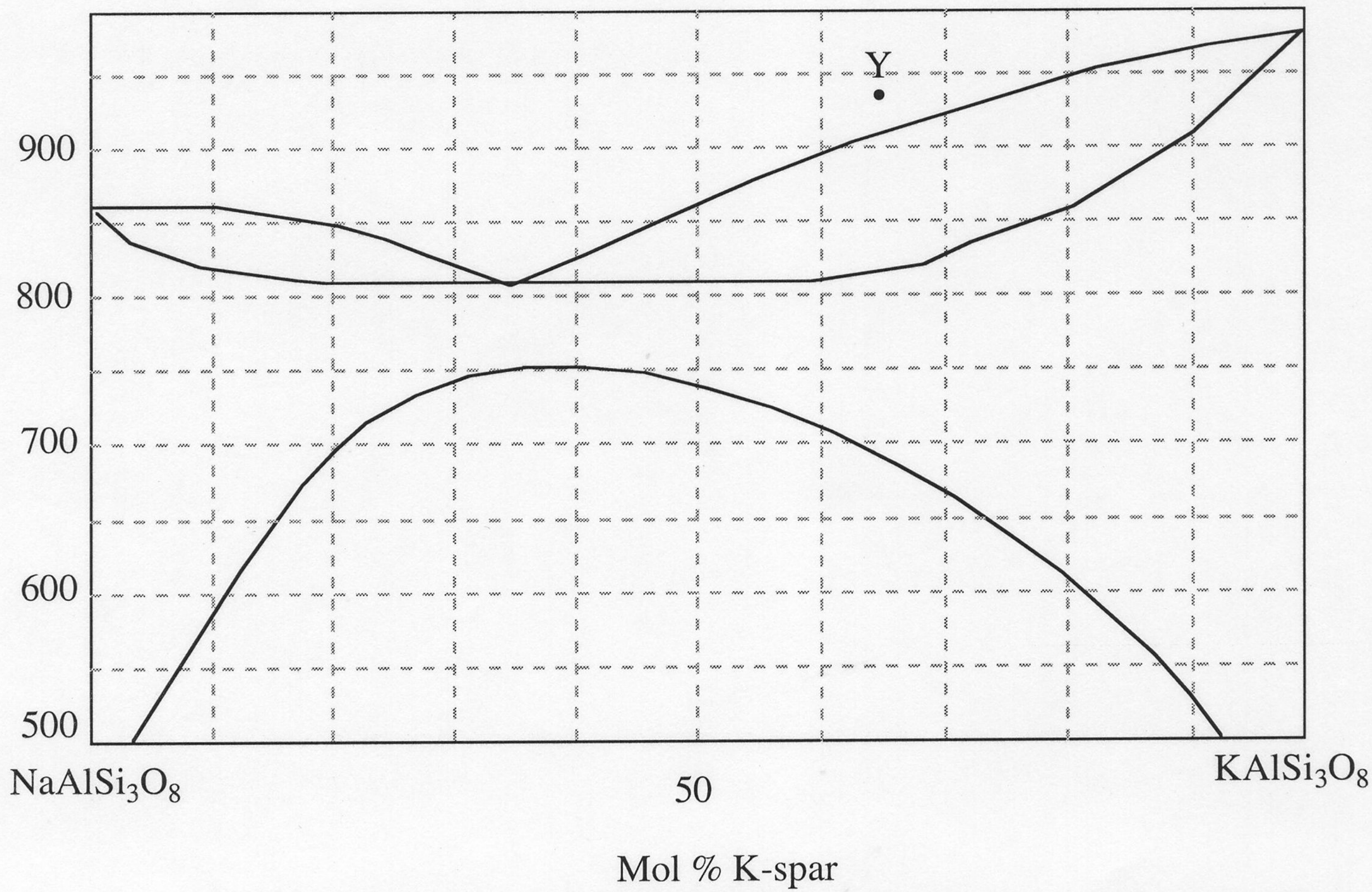
3. Assume a system with a bulk composition of 10 wt% SiO_2 (**composition A**) is at 1500°C.
a) What phases are present at this temperature?
b) What intrusive rocks did we see on the Peninsular Ranges field trip that contained these phases, or similar phases (think of hornblende as a proxy for pyroxene in our rocks, and understand that the rock may contain *other* phases in addition to the ones on this diagram…)
c) How many components are necessary to describe this diagram?

4. Assume system **A** is now heated.
a) At what temperature does the system begin to melt?
b) How many degrees of freedom F are there at this point? What is this point called?
c) What is the composition of the melt? Call this **composition B**.

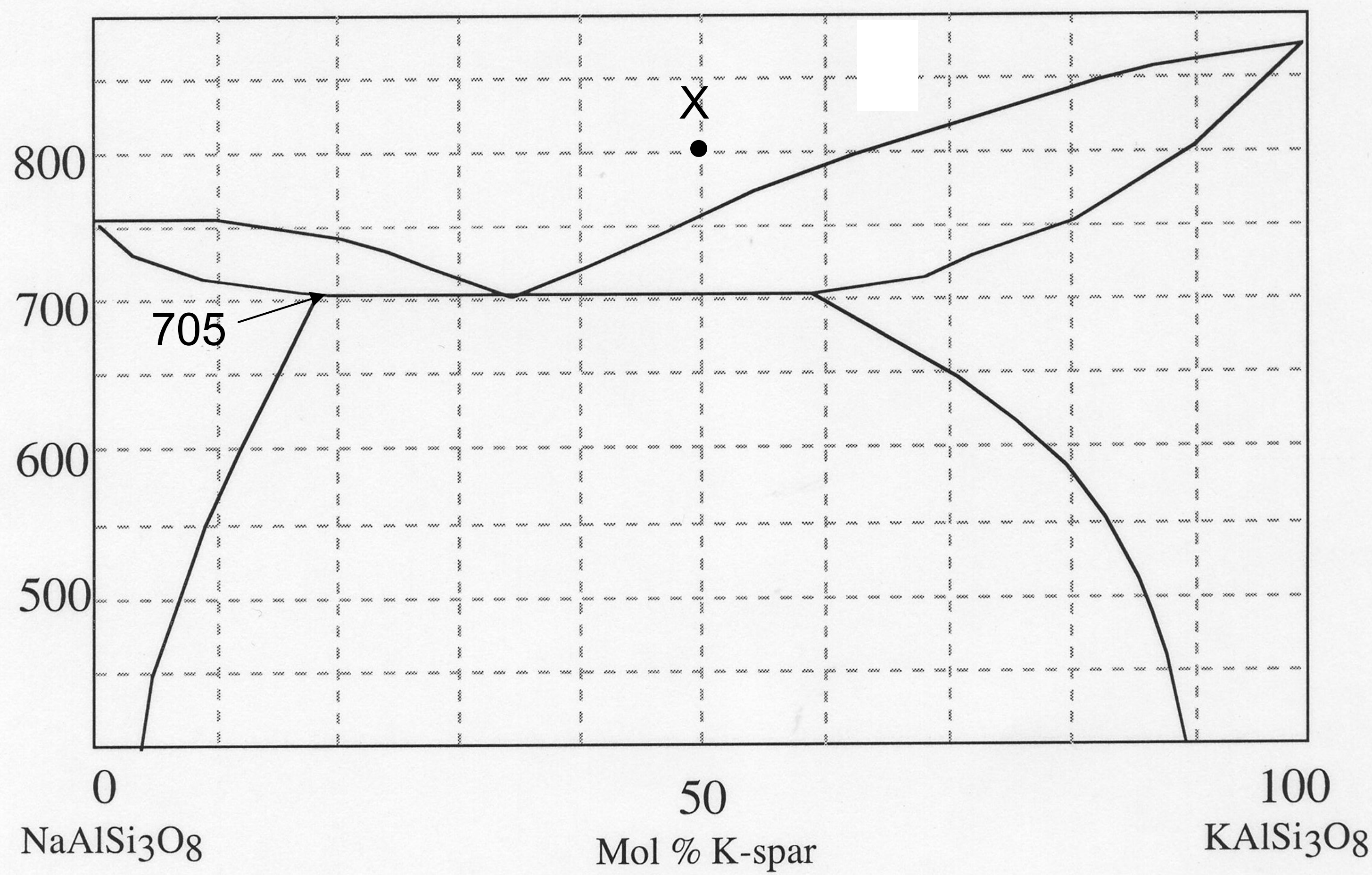
d) What percent of the system **A** can melt before the melt composition begins to change from its initial composition?

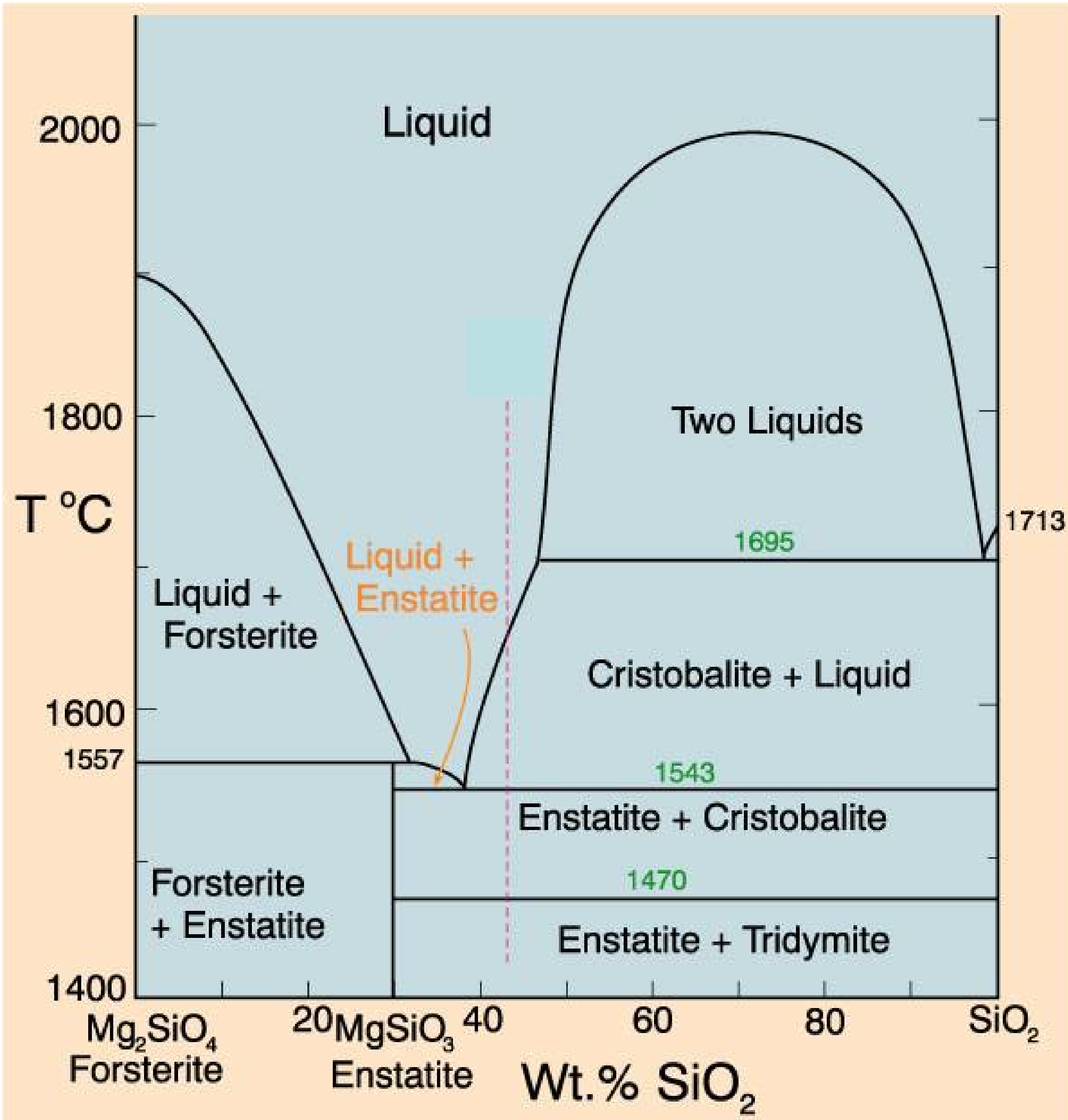
5. Assume 20% of system **A** melts. The melt then migrates from the source material, and forms a new intrusive body. The melt then undergoes equilibrium crystallization.
a) At what temperature is the melt completely crystallized?
b) What is the composition of this crystallized material?
c) What phases are present in this new intrusion?
d) What intrusive rocks did we see on the Peninsular Ranges field trip that contained these phases (again, think of hornblende as a proxy for pyroxene in our rocks, and understand that the rock may contain *other* phases in addition to the ones on this diagram…)
e) Think about your answers to questions 3b and 5d. In a couple of sentences, describe the implications for genesis of evolved melts.
f) If this new intrusion was reheated to produce a few percent fractional melt, what would the composition of this melt be? Call this **composition D**.
g) If the melt of **composition D** was reheated, could you produce a melt of a different bulk composition either by fractional melting or by equilibrium melting? What is a geologic implication of this observation?

A1



A2




Liquid
Two Liquids
2000
1800
T °C
1600
1557
1400
1713
1695
Liquid +
Enstatite
Liquid +
Forsterite
Cristobalite + Liquid
1543
Enstatite + Cristobalite
1470
Forsterite
+ Enstatite
Enstatite + Tridymite
Mg2SiO4
Forsterite
20
MgSiO3
Enstatite
40
60
80
SiO2
Wt.% SiO2