

Petrology 2006
Basalts and Phase Diagram Exam

1. An attached phase diagram shows a single reaction, one involving the formation of wollastonite from calcite and quartz. In case you forgot, wollastonite has formula CaSiO_3 .

a. Write and balance the reaction involving calcite, quartz, wollastonite and carbon dioxide.

b. Which assemblage (calcite + quartz or wollastonite + CO_2) has greatest (molar) entropy?

c. Which assemblage (calcite + quartz or wollastonite + CO_2) has greatest (molar) volume?

d. Note that the reaction line curves on this P-T diagram. Most of the example reactions we have seen before make straight lines. So, what's going on this time? Why does the reaction line curve?

e. If you extended this diagram all the way left to absolute zero temperature (0 K), you would find that the reaction line is asymptotic with the temperature axis. It never intersects the axis. This is true for any reaction that involves water or CO_2 . Why? We did not talk about this but I bet you can figure it out!

f. In what type of rock might this reaction occur?

2. An attached phase diagram shows some reactions in the $\text{Al}_2\text{O}_3\text{-SiO}_2\text{-H}_2\text{O}$ system.

a. How many components are necessary to describe the minerals involved in the reactions?

b. Where on the diagram are there 2 degrees of freedom? How many minerals coexist there?

c. Where on the diagram is there only 1 degree of freedom? How many minerals coexist there?

d. Where on the diagram is there zero degrees of freedom? How many minerals coexist there?

e. Where (use the letters on the diagram to answer this question) are each of the following assemblages stable?

i. quartz (Q)

ii. diaspore (Di)

iii. kyanite - quartz (Ky-Q)

iv. corundum - kyanite - vapor (Co-Ky-V)

v. pyrophyllite-kyanite-andalusite-diaspore (Py-Ky-And-Di)

vi. pyrophyllite-kyanite-andalusite-quartz-vapor (Py-Ky-And-Q-V)

vii. kaolinite-pyrophyllite-kyanite-andalusite-quartz-vapor (Ka-Py-Ky-And-Q-V)

3. What are the major minerals that make up a basalt? That is, if a rock is termed a basalt, what minerals must it contain? And, what other minerals are present in some basalts?

4. What kind of rocks are found in Earth's upper mantle? Since we have never been to the mantle, what several different kinds of evidence do we use to determine the kind of rocks that are found there?

5. Basalt is the most common kind of volcanic rock at Earth's surface. Where do the basaltic magmas originate, and what process (or processes) is (are) involved in the formation of the magmas?

6. What are the three major kinds of basalt? How do their compositions differ? What mineralogical difference may they have?

7. An attached figure shows a Harker diagram for some basaltic rocks. Dots are chemical data for about half a dozen individual samples. Curves have been drawn showing that there is a smooth relationship among all the samples.

a. Explain this relationship. What is the relationship between these magmas? What do the diagrams tell you about their origin?

b. Describe the process that began with eruption of the first magma and how things changed as subsequent magmas erupted.

c. Can you determine which of the compositions was the first basalt to form, and which was the last? If so, tell me which is which. If not, why not?

d. What would it mean if the data was scattered – if no smooth lines could be drawn through the points?