CIPW Norm / MELTS lab

Modified from James Brophy, rev. July 2011

Objective

The objective of this lab is to expand our knowledge of what impacts the crystallization sequence within a magma. For this lab, you will learn how to calculate a CIPW Norm and use the program MELTS.

Pre-lab

Complete this portion prior to the start of lab:

1. Using the basalt compositions handed out, calculate the CIPW for all five compositions by hand (directions in the back of your textbook).
2. Reflection questions:
    a. Compare & contrast the norm calculated for composition #1 with the minerals that we chose to crystallize out for the M&M lab.
    b. Compare & contrast the norms calculated for composition #2-5 and try to come up with several general statements about why the normative minerals are different for each composition.
    c. Using your book and the internet, what are the four constraints on the CIPW norm?
3. Please bring a computer to lab if you possibly can

Lab

1. Compare your results for the prelab with your classmates and discuss the reflection questions.
2. Go to the MELTS applet page: http://melts.ofm-research.org/Applet/applet_download.html. Launch the MELTS applet and answer the following questions:
    a. What is log fO2? (use your book)
    b. What is the difference between HM, QFM, NNO, and IW?
    c. Explore what the various buttons will do ("Assimilant" doesn't work)
3. For the each of the basalt compositions on the handout, do the following:
    a. What is the liquidus temperature at 1 kbar and QFM? (set T to 1500 C, push "Find Liquidus" to get the T and then "Equilibrate" to get the first crystal)
        i. What crystallizes first?
        ii. How is the resultant composition of the melt different from the original composition you entered? (If you click on the "liquid" line in the stable phases box, the composition will show up on the right side of the window)
    b. Hold the pressure at 1 kbar, but vary the log fO2.
        i. What is the affect on the liquidus temperature?
        ii. First phase crystallized?
    c. Keep the log fO2 at QFM, and vary the pressure by 5 kbar increments up to 20 kbar.
        i. What affect does it have on the liquidus temperature?

   ii. What is the affect on what phase crystallizes first?
   d. Return the P = 1kbar and log fO2 to QFM. Add water into the starting composition, beginning with 0.25 and increasing to 1 wt% by 0.25 increments.
      i. What affect does it have on the liquidus temperature?
      ii. What is the affect on what phase crystallizes first?
4. We're now going to solidify the entire magma. You need to plot each step of the resultant magma composition on a magmatic AFM diagram (p. 146, Fig. 6.10 in Phillips & Ague). Use a different color for each of the five compositions.
   a. Starting at the liquidus temperature at P = 1 kbar, log fO2 = QFM, and H_2O = 0.00, go through increments of 25 C until the magma is fully crystallized [at the end, results won't change much]
   b. At what temperature is the magma fully solidified?
   c. On an AFM diagram, plot the liquid composition at each step.
   d. Is there a pattern that relates the path on the AFM diagram to the starting composition?
   e. What is the sequence of minerals crystallized for the four different magmas?
   f. Does the final product for each composition match up with the CIPW you calculated?
5. Pick a composition from #2-5 (you'll only do this for one composition – try to pick a different composition than your neighbor). Plot your results on a new AFM diagram.
   a. Which composition are you using?
   b. Starting at the liquidus temperature at P = 5 kbar, log fO2 = QFM, and H_2O = 0.00, go through increments of 25 C until the whole magma is crystallized.
      i. Do the same thing but at P = 10 kbar and P = 20 kbar.
      ii. What is the affect of pressure on the order of crystallization?
   c. Starting at the liquidus temperature at P = 1 kbar and H_2O = 0.00, change the log fO2 to NNO and go through increments of 25 C till the whole magma is crystallized
      i. Do the same thing, but at log fO2 = HM and log fO2 = IW.
      ii. What is the affect of log fO2 on the crystallization order?
   d. Starting at the liquidus temperature at P = 1 kbar and log fO2 = QFM, change the H_2O to 0.25, go through increments of 25 C until the whole magma is crystallized.
      i. Do the same things but at 0.50, 0.75, and 1.00 H_2O.
      ii. What is the affect of water on the order of crystallization?

	1	2	3	4	5			
SiO2	46.00	45.50	49.50	49.30	50.88			
TiO2	1.25	3.44	1.50	1.60	0.72			
Al2O3	17.75	15.71	14.60	15.60	18.18			
Fe2O3	0.00	3.61	2.50	3.50	2.10			
FeO	9.50	8.64	9.40	7.80	6.94			
MnO	0.00	0.22	0.22	0.20	0.16			
MgO	10.00	5.37	7.10	6.50	7.20			
CaO	8.25	9.43	10.80	10.30	11.22			
Na2O	5.75	3.47	2.90	2.70	2.36			
K2O	1.50	1.38	0.45	0.50	0.54			
P2O5	0.00	0.29	0.27	0.30	0.01			
1. Basalt from Wirth's M&M lab; use FeO = 8.25 and Fe2O3 = 1.06								
2. Alkali Basalt, St. Helena Island								
3. Continental Flood Basalt, Columbia River Plateau								
4. Contental Flood Basalt, Columbia River Plateau								
5. Hi Alumina Basalt, New Hebrides Arc								