GEO 306/546 – Min-Pet I **Name:_____**

Petrology Homework Assignment #2 – Calculating the CIPW Norm

Due Monday, April 28, 2003

The purpose of this exercise is to acquaint you with how the norm is calculated from a bulk rock composition, and how it is used to classify volcanic rocks. Volcanic rocks are found in a variety of tectonic settings, and petrologists need to be able to focus on subtle differences in composition to distinguish between these environments. Calculation of the norm enhances these differences and allows a clearer view of the differences between rocks, and allows for a more precise classification. The following table gives a set of compositional data for a bulk rock in wt. % oxides. You are to use the recipe found below to calculate the norm for this rock, as well as answer the questions found at the end of this assignment. You are to enter your final calculated values into the table at the end of this assignment, but be sure to include extra sheets showing all of your work!

Oxide	Wt. %
SiO_2	50.80
TiO_2	1.93
Al_2O_3	15.25
Fe_2O_3	2.91
FeO	7.23
MnO	0.16
MgO	8.27
CaO	9.83
Na_2O	2.15
K_2O	0.28
H_2O	1.07
P_2O_5	0.25
Total	100.56

1. Determine the molecular number for each oxide by dividing each wt. % oxide by its molecular weight, and multiplying the resulting numbers by 1000 to get rid of any decimals. Set any molecular number less than 2 to 0, except for K_2O and P_2O_5.

2. Add the MnO molecular number to the FeO molecular number if the MnO molecular number is less than or equal to 2.

You are now ready to begin calculating the norm. Remember, every time you use some amount of an oxide, you must subtract it from the total amount to get the amount remaining!

3. Apatite (ap) – The amount of ap is equal to the amount of P_2O_5. Subtract all P_2O_5 from the original P_2O_5 column, and 3.33 times the amount of P_2O_5 from the CaO column to give the amount of CaO left to form other normative phases.

4. Magnetite (mt) – The amount of mt is equal to the amount of Fe_2O_3. Subtract all Fe_2O_3 from the original Fe_2O_3 column, as well as an equal amount of FeO from the FeO column.

5. Ilmenite (il) – The amount of il is equal to the amount of TiO_2. Subtract all TiO_2 as well as an equal amount of FeO from the FeO column.

6. Orthoclase (or) – The amount of Orthoclase is equal to twice the amount of K_2O. Subtract all K_2O, as well as an equal amount of Al_2O_3, and 6 times this amount of SiO_2.

7. Albite (ab) – The amount of ab is equal to twice the amount of Na_2O. Subtract all Na_2O, as well as an equal amount of Al_2O_3, and 6 times this amount of SiO_2.

8. Anorthite (an) – The amount of an is equal to the remaining amount of Al_2O_3. Subtract all remaining Al_2O_3, an equal amount of CaO, and 2 times this amount of SiO_2.

9. You now need to calculate two additional numbers in order to proceed. They are M and X_{Mg}.
   M = MgO + FeO and **XMg = MgO/M**

10. Diopside (di) – The amount of di is equal to the remaining amount of CaO. Subtract all remaining CaO, and equal amount of M, and twice this amount of SiO_2.

11. Hypersthene (hy) – The amount of hy is equal to the remaining amount of M. Subtract all remaining M, and an equal amount of SiO_2.

12. Quartz (qz) – The amount of qz is equal to the remaining amount of SiO_2. Subtract all remaining SiO_2.

13. You must break di and hy into their constituent parts in the following manner:

di:	wo = di en = di x X_{Mg} fs = di x (1- X_{Mg})	hy:	en = hy x X_{Mg} fs = hy x (1- X_{Mg})

14. Convert the amounts of all of these normative constituents back into wt. % by multiplying each one by its molecular weight and divide by 1000.

Now, you can use the norm data you just calculated to give a more precise classification to you bulk rock using the classification scheme below.

Quartz Tholeiite – Normative qz, hy

Tholeiite – Normative hy

Olivine Tholeiite – Normative hy (<3 wt. %), ol

Alkali Olivine Basalt – Normative ol, ne (ne = Nepheline; ne<5 wt. %)

Basanite – Normative ol, ne, ab (ne>5 wt. %; ab>2 wt. %)

Olivine Nephelinite – Normative ol, ne (ab<2 wt. %)

Olivine Melilite Nephelinite – Normative ol, ne, lc (Leucite), la (Lawsonite)

Now, take all of this information, and complete the data table on the next page. Be sure to answer the associated questions as well!

NOTE: When filling in the Table below, the M and X_{Mg} values it asks for are the INITIAL calculated values for these numbers.

Oxide	Molecular #	Norm. Phase	Amount	Wt. %
SiO_2		ap		
TiO_2		mt		
Al_2O_3		il		
Fe_2O_3		or		
FeO		ab		
MnO		an		
MgO		di		
CaO		*wo*		
Na_2O		*en*		
K_2O		*fs*		
H_2O		hy		
P_2O_5		*en*		
M		*fs*		
X_{Mg}		qz		

1. According to Table 3-4 in your text, without knowing its normative constituents, what would you name this rock, based on its bulk composition alone?

2. According to the classification scheme given above, what would you call this rock based on its normative constituents?

Don't forget to include extra sheets showing all of your work! It is worth half of the points for this assignment, and it is important so that we can tell where you made any mistakes!!!