

Name _____

EPS 303 - Igneous homework #1

Part I. You receive a package in the mail from one of your colleagues who has just collected a suite of volcanic rocks that she wants to have chemically analyzed. However, in order not to bias the results, she won't tell you where the samples are from. So, you crush and analyze the rocks and come up with the compositions listed in the attached table. Your assistant calculates the CIPW norms for 5 of the rocks, but forgets to finish the job and leaves one blank.

(a) Give each of the six analyses a general rock name, e.g., basalt, andesite, dacite, rhyolite:

1:

2:

3:

4:

5:

6:

(b) Look at the chemical analysis of sample 6; is this rock likely to have **nepheline** in the norm? What about **quartz** and/or **olivine**? What oxides in the analysis give you clues about each normative mineral? Note: you do **not** need to do a norm calculation to answer this question!

ne:

qz:

ol:

(c) Based on the normative analyses, give each basalt from part (a) a more explicit name, e.g., tholeiite, olivine tholeiite, or alkali basalt. Also, give a likely tectonic setting for each.

rock #:

name:

tectonic setting:

Part II. The binary phase diagram for the system $\text{KAlSiO}_4\text{-SiO}_2$ (attached) is shown for a constant pressure of 1 bar.

(a) List all of the components in this system:

(b) List all of the phases in this system:

(c) Label the eutectic(s), peritectic(s), solidus, and liquidus on the phase diagram.

- (d) Track the equilibrium crystallization history of a melt with a composition of **40 wt% SiO₂** by determining the assemblage present and estimating abundances (relative percent) of each phase for each of the following temperatures. Calculate the thermodynamic variance at each temperature.

Temp., °C	Liquid	Ks	Lc	Sa	Cr	Tr	variance
1700							
1600							
1500							
1400							
1300							
1200							
1100							
1000							
900							

- (e) Describe the behavior of the melt when it reaches a temperature of 1150°C. Write out the chemical reaction that occurs at this temperature and state which phase is consumed.

Part III. (a) The same melt as in Part IIa cools to a temperature of 1300°C, at which point the melt separates from the already-formed leucite crystals, rises into the crust, and undergoes final crystallization. Track the crystallization history of this melt in terms of the phase abundances at each of the following temperatures, and calculate the thermodynamic variance at each T.

Temp., °C	L	Ks	Lc	Sa	Cr	Tr	variance
1200							
1100							
990							
900							

- (b) Describe the behavior of this melt when it reaches a temperature of 1150°C. Write out the chemical reaction that occurs at this temperature and state which phase is consumed.

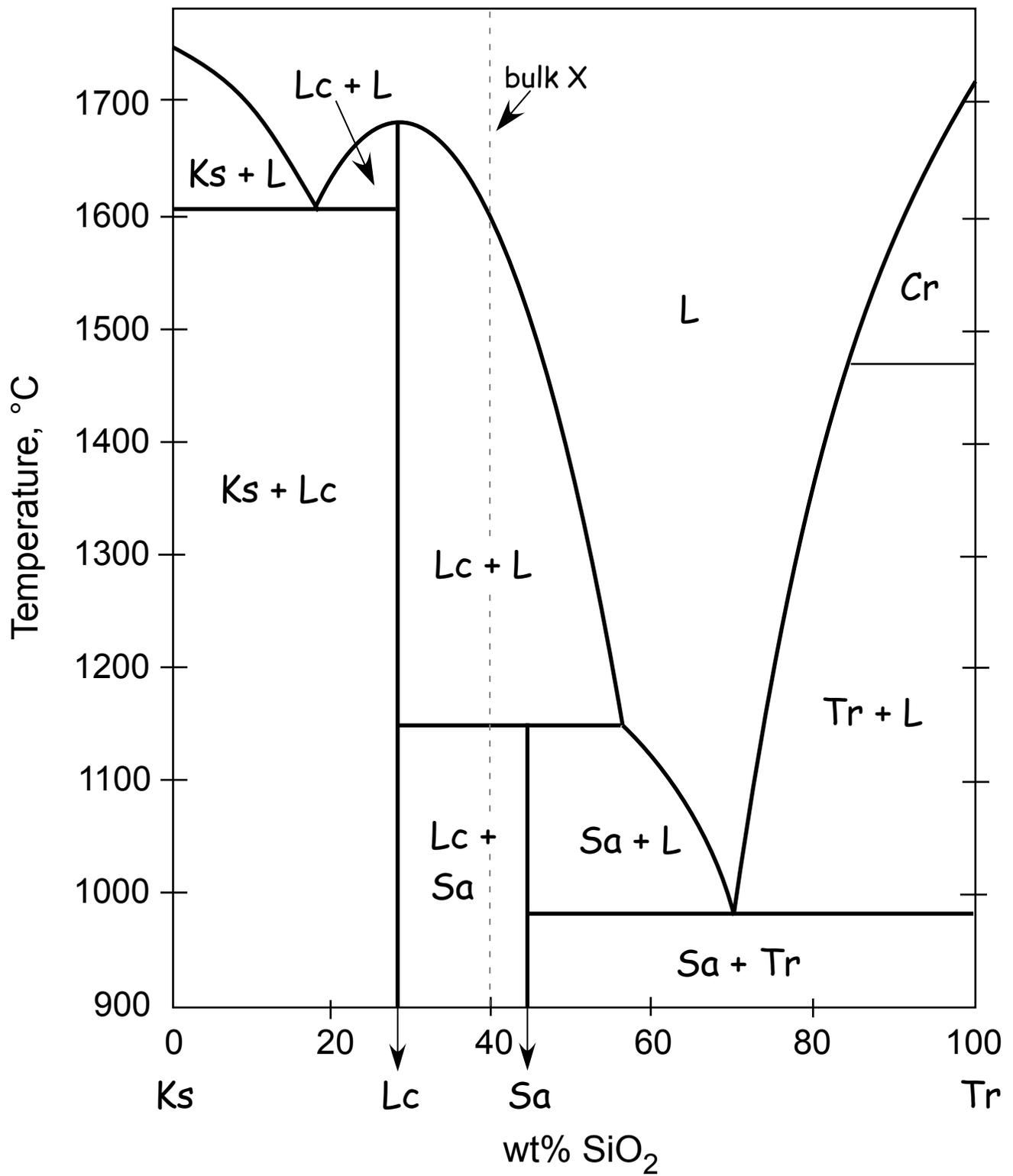
(c) How did the fractionation history affect the silica content of the final rock relative to the rock in Part II?

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Rock analyses for Part I.

	1	2	3	4	5	6
SiO ₂	67.73	50.83	46.66	76.21	58.57	47.01
TiO ₂	0.50	3.44	2.44	0.07	0.64	3.20
Al ₂ O ₃	15.44	12.67	16.01	12.58	19.87	15.57
Fe ₂ O ₃	0.69	3.10	3.52	0.30	3.20	2.32
FeO	2.40	11.39	8.35	0.73	2.73	11.57
MnO	0.06	0.25	0.20	0.04	0.15	0.20
MgO	1.30	4.19	4.76	0.03	1.74	5.25
CaO	3.35	8.18	8.96	0.61	7.51	9.77
Na ₂ O	3.85	3.24	4.56	4.05	4.25	3.00
K ₂ O	3.25	0.87	1.86	4.72	0.74	0.31
P ₂ O ₅	0.15	0.75	0.74	0.01	0.10	0.32
LOI*	1.15	0.94	2.41	0.52	0.63	1.64
Total	99.87	99.85	100.47	99.87	100.13	100.16
CIPW norm:						
qz	22.98	4.44	0.00	33.06	12.67	?
or	18.90	5.56	11.00	27.80	4.37	?
ab	32.49	27.25	25.76	34.06	35.96	?
an	15.29	17.51	17.72	2.50	32.96	?
ne	0.00	0.00	6.95	0.00	0.00	?
di	0.00	15.75	14.40	0.30	2.93	?
en (hy)	6.82	16.04	0.00	0.92	4.52	?
ol	0.00	0.00	9.92	0.00	0.00	?
mt	0.93	4.41	5.10	0.46	4.64	?
il	0.91	6.54	4.63	0.15	1.21	?
ap	0.34	1.68	1.62	0.00	0.24	?

*LOI = loss on ignition (generally H₂O + CO₂).



Ks: kalsilite
 Lc: leucite
 Sa: sanidine
 Tr: tridymite
 Cr: cristobalite
 L: liquid (melt)