Igneous petrology EOSC 321

Laboratory 3:

Modal and normative compositions of felsic and intermediate rocks

Learning Goals. After this Lab, you should be able:
- Classify igneous rocks based on their normative compositions
- Compare and contrast the modal and normative compositions of igneous rocks and consider why there are differences
- Identify the key rock-forming minerals in felsic rocks
- Name felsic rocks based on their mineral modes using triangle diagrams

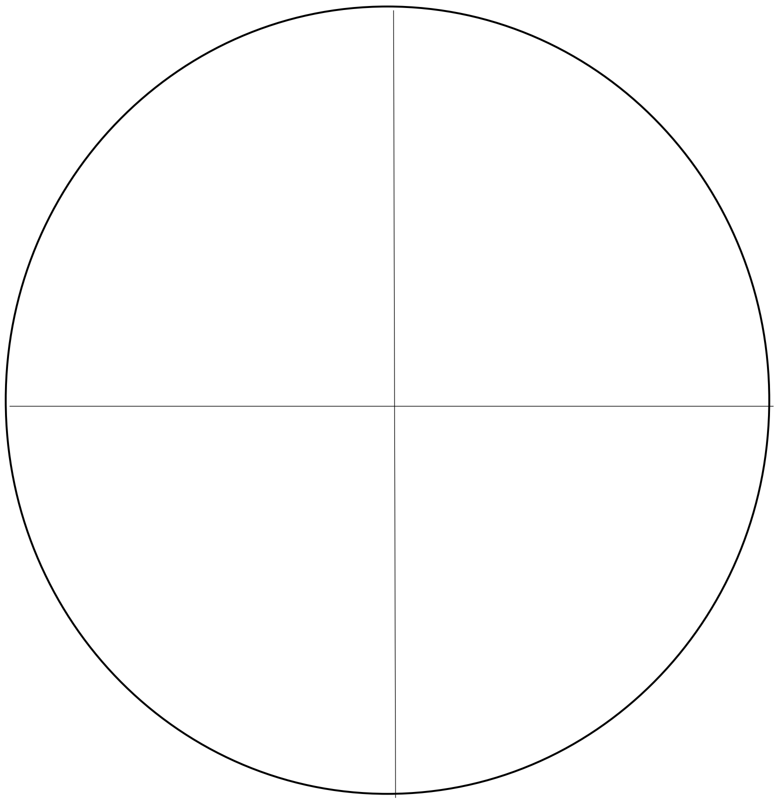
Material Needed: a) Microscope, b) Classification triangles, c) a Manual on Optical Mineralogy (i.e. Minerals in Thin Section by Perkins and Henke), d) Laptop computer, e) Triangular graphing paper included with this handout.

Duration and organization: This lab should be completed by the next week Lab period. The assignment is for **groups of 2 students**.

Test. You will receive a thin section of an unknown mafic or intermediate plutonic rock for your independent 30 minute examination. Draw a sketch of the key features of the rock and write its petrographic description and finally give it a rock name. You may use your previous lab notes, textbooks etc., but NO ELECTRONIC DEVICES! Your petrographic report should be completed and handed to the TA after 45 minutes of your Lab.

TEST 2 Mafic Rocks
45 minutes

Thin section _______________ Your
Name:___________
Magnification______________ Student
ID:____________
Field of view width _________



Texture:

Description[1]:

Rock name:

---

[1] Please determine the plagioclase composition and include it in the description of plagioclase

<u>Activity II.</u> This lab emphasizes the skills of rock classification of macro-specimens based on modal and normative compositions. Ideally, a normative composition, i.e. abundances of imaginary, normative minerals should be used for a more accurate classification of a rock. Rock norm is not always similar to modes of real minerals present in the rock. Learn how to calculate rock norms using the specialized petrological software and compare the norms with mineral modes.

Note that macrospecimens have been stained to make K-feldspar turn yellow. Learn to recognize Ksp in stained and unstained natural samples.

The Lab samples have been collected from the Endako batholith (central Canadian Cordillera), a composite batholith that consists of many intrusive phases. The batholith had a protracted emplacement history, covering approximately 75 m.y., with clear evidence for periods of magmatic quiescence. The oldest magmatic suite of the Endako batholith, the Stern Creek suite, is dated at approximately 220 Ma. Plutons of the Stag Lake suite range in age from 180 Ma to 161 Ma. The Francois Lake suite is divided into two subsuites: the Glenannan subsuite dated at 157 Ma to approximately 155 Ma and the 149 to 145 Ma Endako subsuite that hosts the Endako molybdenite deposit. Intrusion of the Casey phase occurred at 145.1 Ma. Eocene intrusion of the high-level, miarolitic Sam Ross Creek phase happened last. The Endako batholith hosts Jurassic molybdenite deposit, which is the oldest economic Mo deposit in the Cordillera of North America. Pulsed magmatism, evident even within individual magmatic suites, may play a major role in concentrating and ultimately depositing molybdenite in this porphyry system.

Assignment:

1. Examine the hand samples in the Lab found in the tray labeled "Endako batholith". For each sample, estimate modes of mafic minerals, quartz, plagioclase and K-feldspar using the attached reference fields of view. Plot the estimates on the QAP ternary diagram and name each rock using the IUGS classification triangle for felsic and intermediate plutonic rocks (all attached).

2. Trace the evolution of the bulk composition and modal mineralogy of the Endako magma based on the relative ages of the magmatic phases given in the background Info. How would you describe the temporal evolution of the melt?

3. Bulk chemical analyses of all Endako phases are given in the attached Table. Calculate their normative compositions on a CIPW Norm calculator you downloaded from the course website. Remember to normalize the analyses to 100% without volatiles (H_2O, CO_2, Loss on Ignition (LOI)). Sulfur (S) in the analyses is given in ppm, just ignore it. For comparison with mineral modes, you need to calculate VOLUME % of normative minerals.

4. Use the norms for classification of the Endako rocks on the second empty classification triangle. Count Q as % normative quartz, P- as % normative anorthite, A – as % normative Ksp. Plot each rock on the QAP ternary diagram and name the rock accordingly.

5. Compare names and positions of points in the triangles assigned to each rock based on the modes and the norms. Comment on possible discrepancies. Hint: What are mafic minerals present in the rocks and how do they contribute to the discrepancies?

6. At the end of the Lab, hand in for marking 1) The filled table with modal and normative mineralogy; 2) QAP triangle showing modal mineralogy and rock names of all phases of the Endako batholith; 3) QAP triangle showing normative mineralogy and rock names of all phases of the Endako batholith; 4) A paragraph discussing possible discrepancies between modal and normative compositions of the rocks.

Marking Rubric for the assignment

Total lab is marked out of 24 points.

1) The filled table with modal (6 points) and normative (3 points) mineralogy - (9 points total)

- We will only be grading the modal Quartz, Plag, Kfeld, and COMBINED Mafic.
- 1/8th of the point per wrong answer will be taken off for the modal section
- 0.25 point per row that is incorrect for the calculated normative will be taken off. If the normative mineralogy is totally wrong, a maximum of 3 points will be taken off.
- If the normative values are incorrect due to the failure to normalize to 100%, take off 1 point.

2) QAP triangle showing modal mineralogy and rock names of all phases of the Endako batholith (3 points) [0.25 points for correct location and 0.25 for correct name]

3) QAP triangle showing normative mineralogy and rock names of all phases of the Endako batholith; (3 points)

4) The paragraph - 8 points in total.

- 5 points for “possible discrepancies between modal and normative compositions of the rocks”.
- 3 points for “Evolution of the bulk composition and modal mineralogy of the Endako magma based on the relative ages of the magmatic phases”

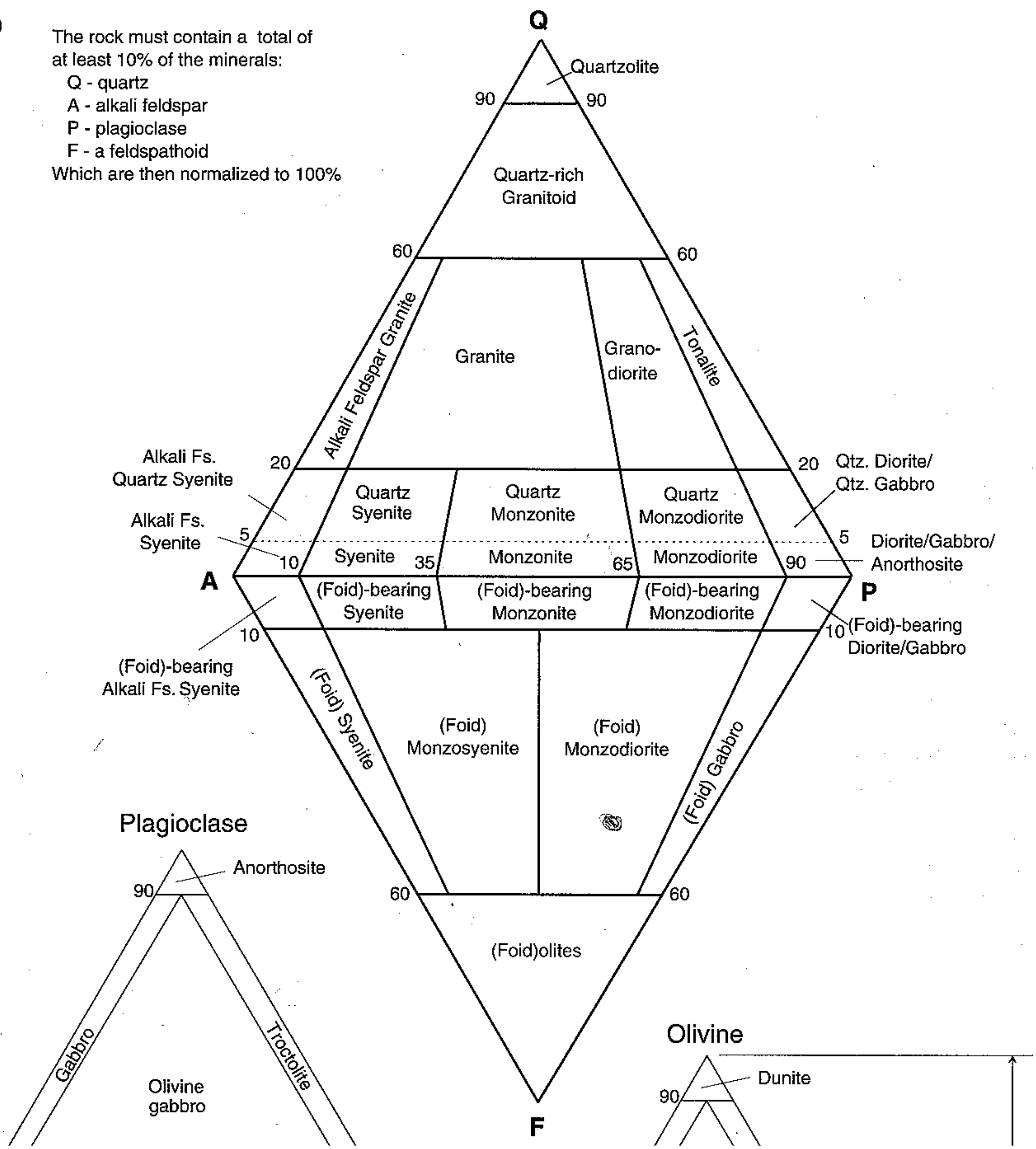
Sample	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	FeO	MnO	MgO	CaO	Na_2O	K_2O	H_2O	CO_2T	P_2O_5	S	LOI
Fraser suite	**66.7**	**0.63**	**15.9**	**1.1**	**2.5**	**0.1**	**0.99**	**2.17**	**4.8**	**3.91**			**0.2**	**60**	**0.7**
Casey phase (type area)	77.0	0.10	12.4	0.1	0.4	0.06	0.15	0.20	3.8	4.58	0.5	0.0	0	0	
Francois sub-phase	**70.2**	**0.39**	**14.8**	**1.2**	**1.0**	**0.1**	**0.70**	**1.66**	**4.4**	**4.20**			**0.2**	**74**	**0.9**
Endako phase	67.0	0.43	14.4	0.9	1.7	0.1	1.23	2.64	3.0	4.28			0.2	638	3.4
Glenannan phase	**72.2**	**0.29**	**13.5**	**1.5**	**0.8**	**0.1**	**0.82**	**1.71**	**3.5**	**3.86**			**0.1**	**29**	**0.6**
Nithi phase	75.0	0.17	13.1	0.3	0.7	0.06	0.29	0.89	3.9	4.09	0.5	0.2	0	0	
Copley Lake phase	**70.6**	**0.30**	**14.9**	**1.1**	**1.2**	**0.06**	**0.66**	**1.93**	**4.0**	**4.22**	**0.6**	**0.3**	**0**	**0**	
Caledonia phase	61.6	0.52	16.5	2.6	2.4	0.19	2.50	2.43	4.4	3.15	2.2	1.1	0	0	
Leg Lake phase	**70.6**	**0.30**	**14.9**	**1.1**	**1.2**	**0.06**	**0.66**	**1.93**	**4.0**	**4.22**	**0.6**	**0.3**	**0.11**	**0**	
Sugarloaf phase	57.20	0.74	17.40	3.0	4.3	0.15	3.07	6.50	3.7	2.30			0.29	199	0.6
Limit Lake intermed. pha	**68.8**	**0.42**	**15.3**	**1.1**	**2.0**	**0.07**	**1.45**	**3.21**	**3.7**	**3.02**	**0.7**	**0.0**	**0**	**0**	
Stag. Lake mafic phase	49.4	1.02	17.4	4.8	5.8	0.19	5.55	10.37	2.7	0.94	1.4	0.0	0	300	
Stern Creek Suite	**63.9**	**0.51**	**16.3**	**1.5**	**2.5**	**0.1**	**2.26**	**4.52**	**4.4**	**1.99**			**0.2**	**49**	**1.2**

Table 1. Modal and norm compositions of Endako Batholith samples

	Modal Mineralogy						Normative Mineralogy																							
	Quartz	Plagioclase	K feldspar	Mafic mineral 1	Mafic mineral 2		Qz	Plag	Ort	Ne	Leucite	Kalsilite	Corundum	Di	Hy	Wo	Ol	Larnite	Acm	K2SiO3	Na2SiO3	Rut	Ilm	Mt	Hem	Ap	Zircon	Per	Chr	Sph
Fraser suite																														
Casey Phase																														
Francois sub-phase																														
Endako phase																														
Glenannan phase																														
Nithi phase																														
Copley Lake phase																														
Caledonia phase																														
Leg lake phase																														
Sugarloaf phase																														
Limit Lake intermediate phase																														
Stag lake mafic phase																														
Stern Creek suite																														

(a)

The rock must contain a total of
at least 10% of the minerals:
Q - quartz
A - alkali feldspar
P - plagioclase
F - a feldspathoid
Which are then normalized to 100%

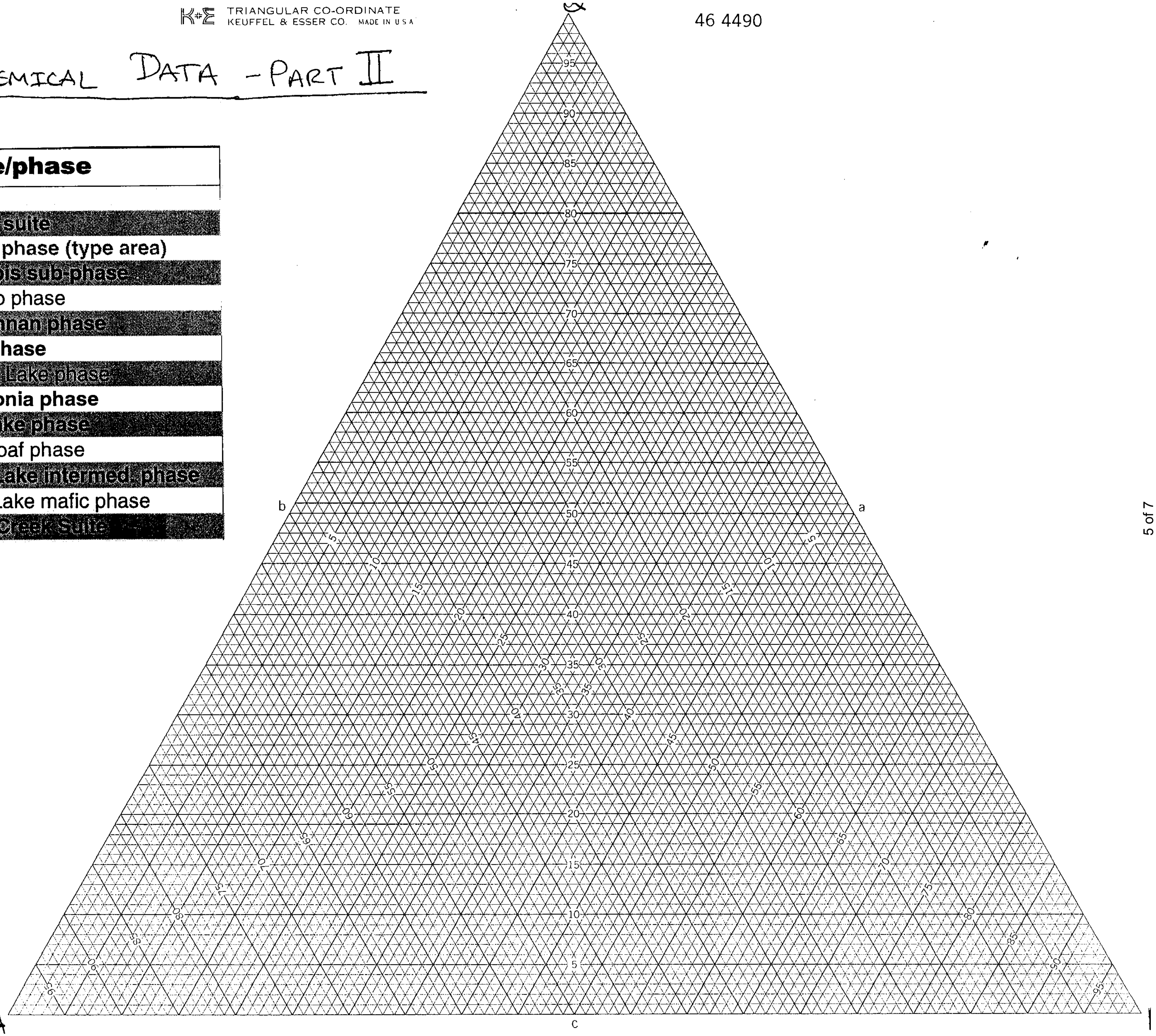


K+E TRIANGULAR CO-ORDINATE
KEUFFEL & ESSER CO. MADE IN U.S.A.

46 4490

GEOCHEMICAL DATA - PART II

	Suite/phase
1.	Fraser suite
2.	Casey phase (type area)
3.	Francois sub-phase
4.	Endako phase
5.	Glenannan phase
6.	Nithi phase
7.	Copley Lake phase
8.	Caledonia phase
9.	Leg Lake phase
10.	Sugarloaf phase
11.	Limit Lake intermed. phase
12.	Stag. Lake mafic phase
13.	Stern Creek Suite

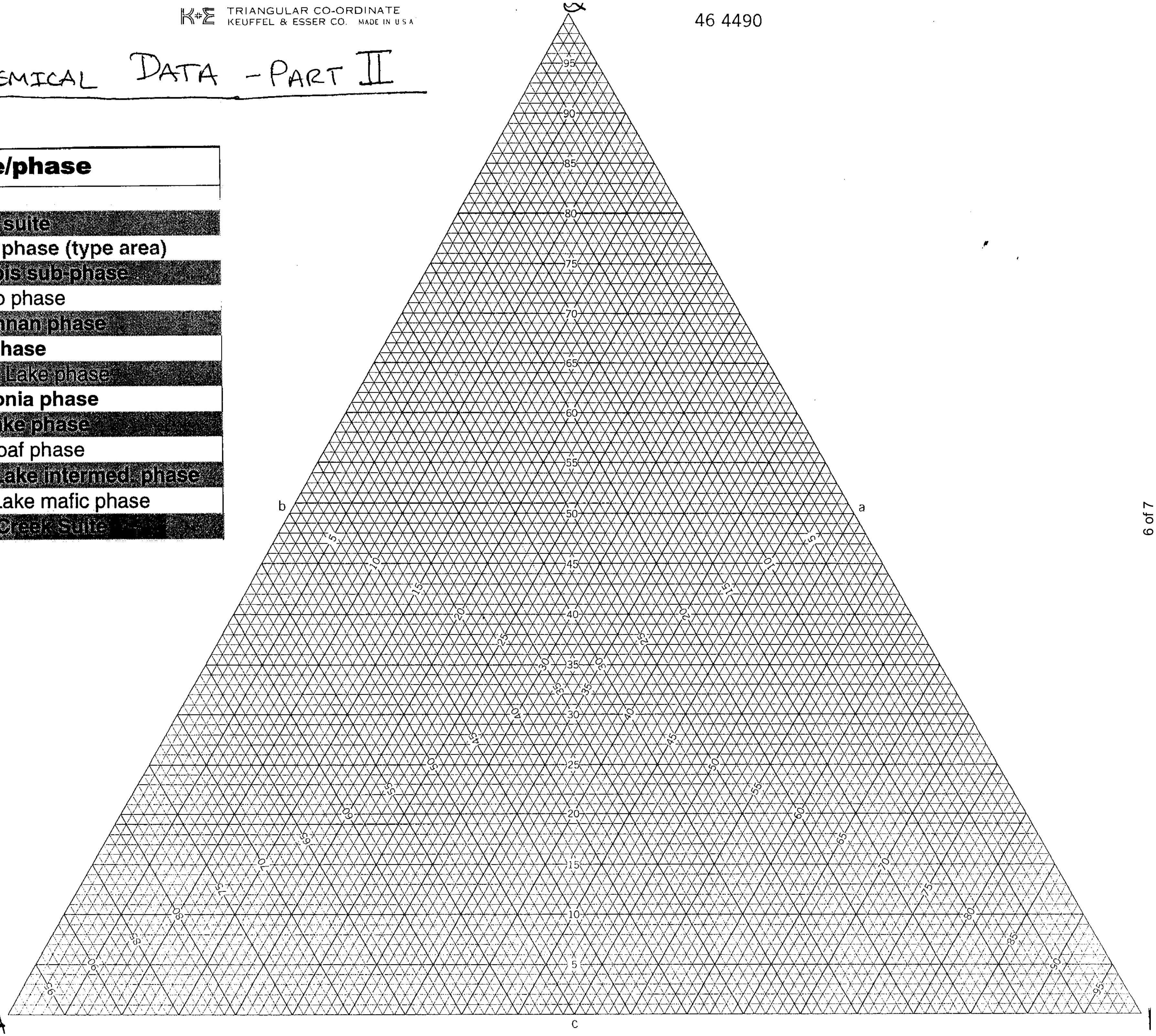


K+E TRIANGULAR CO-ORDINATE
KEUFFEL & ESSER CO. MADE IN U.S.A.

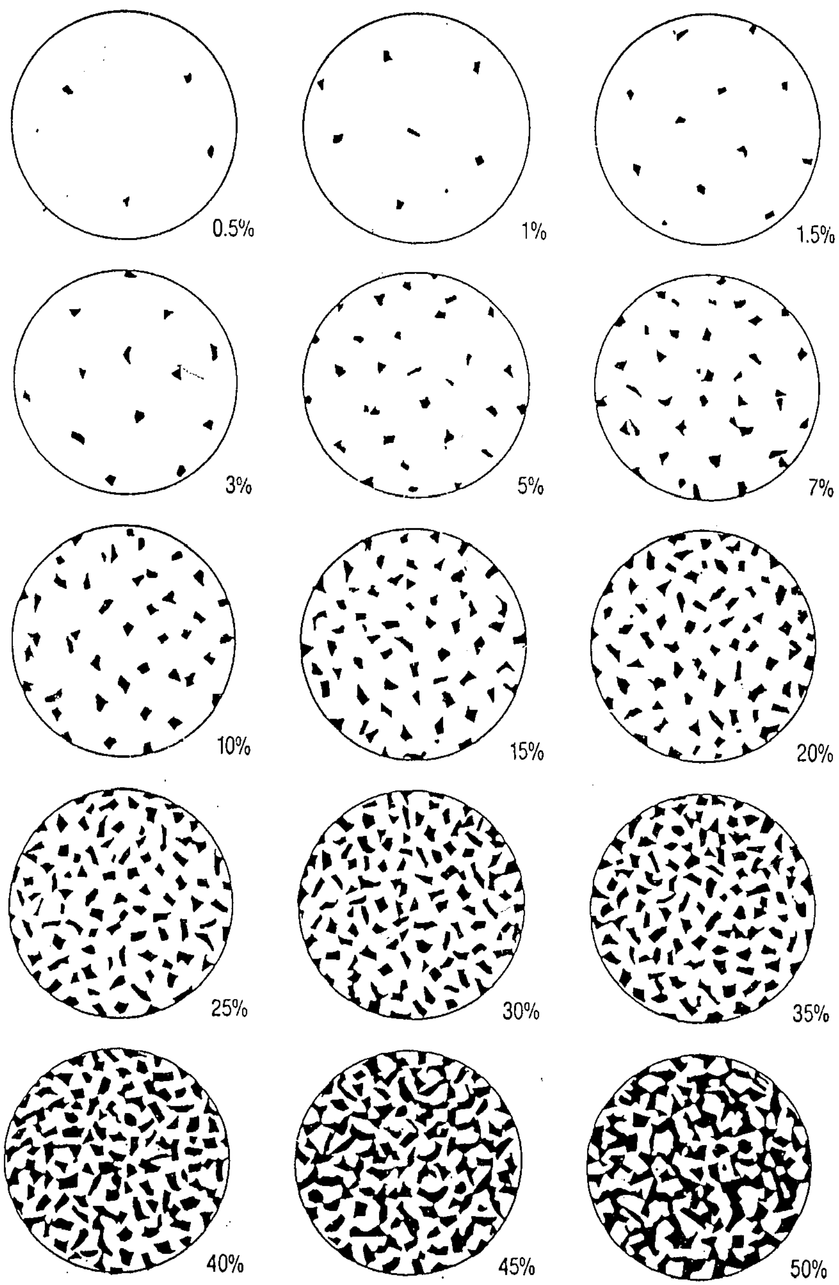
46 4490

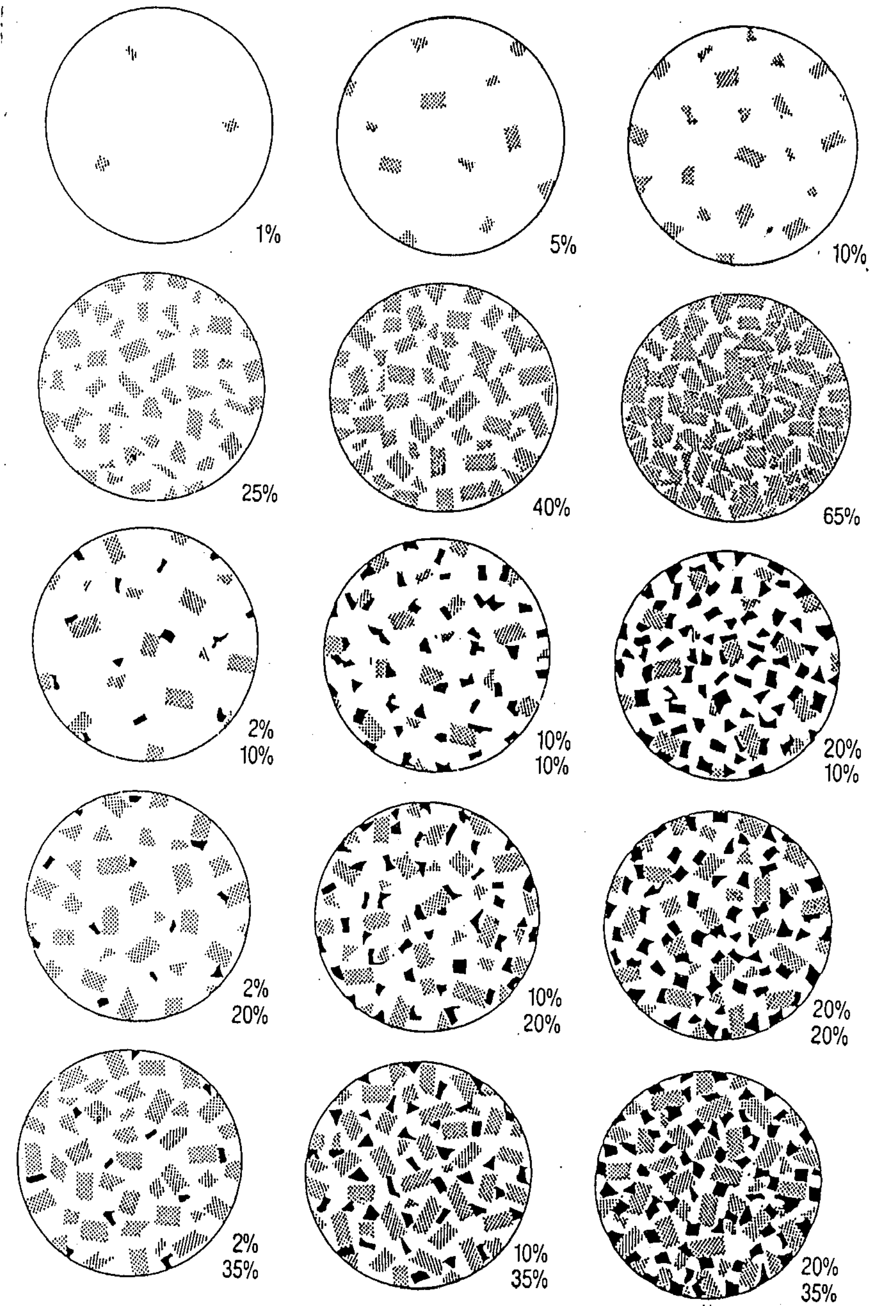
GEOCHEMICAL DATA - PART II

	Suite/phase
1.	Fraser suite
2.	Casey phase (type area)
3.	Francois sub-phase
4.	Endako phase
5.	Glenannan phase
6.	Nithi phase
7.	Copley Lake phase
8.	Caledonia phase
9.	Leg Lake phase
10.	Sugarloaf phase
11.	Limit Lake intermed. phase
12.	Stag. Lake mafic phase
13.	Stern Creek Suite



APPENDIX 3. Percentage Diagrams For Estimating Compositon By Volume*





*To convert the results to weight percentages, multiply each volume percentage by the specific gravity of that mineral and recalculate the resulting numbers so that they sum to 100.