

National University of Ireland, Galway
OLLSCOIL NA hÉIREANN, GAILLIMH

AUTUMN EXAMINATIONS 1999

**3rd SCIENCE
GEOLOGY [GE 311]**

PAPER ONE

Prof. B.P.J. Williams
Prof. P.D. Ryan
Dr. M. Feely
Ms. S. Baxter

Time allowed: Three hours

Answer four questions: at least **one** from Section A, at least **one** from Section B, and only one from Section C.

Please use separate Answer Books for each section.

Illustrate your answers with neat sketches and diagrams where appropriate.

SECTION A

1. Show how the quartz wedge may be used to highlight the relationship ($r = n_1 - n_2$)d. (r = retardation; n_1 and n_2 = refractive indices; d = thickness of thin section).
2. Define extinction. Illustrate the relationships that exist between the crystallographic axes and the principle optical directions in Augite and Hypersthene crystals. How is inclined extinction used in the estimation of the composition of some pyroxenes?
3. Write short notes on the following:
 - (a) Optic axial plane
 - (b) Obtuse bisectrix
 - (c) Compensation
 - (d) Pleochroism

4. What diagnostic optical properties help you to distinguish in thin section between the following mineral pairs:
- (a) Muscovite and Hornblende
 - (b) Quartz and Calcite
 - (c) Glaucophane and Biotite
 - (d) Chialstolite and Staurolite
 - (e) Wollastonite and Tremolite

SECTION B

5. (Note: Short answers only are required for each section of this question).
- (a) In the context of phase relations of silicates and silicate melts, define:
 - (i) System (2)
 - (ii) Phase (2)
 - (iii) Component (2)
 - (iv) Equilibrium (2)
 - (b) State Gibb's Phase Rule (Use a diagram to explain your answer if you so wish). (4)
 - (c) Diagram 1 shows the phase relations in the system Albite-Anorthite.
 - (i) What does the liquidus curve define? (2)
 - (ii) What does the solidus curve define? (2)

At temperature 't' (assuming equilibrium), what will the ratio of crystals to melt be for a magma of composition X? (3)

What will the composition of the melt be? (2)

What composition will the crystals have? (2)

What features might you see in a thin section which would indicate that in fact equilibrium was NOT reached in this system as cooling progressed? (2)
6. Using *diagrams* and *examples* to illustrate your answer, discuss the various forms that mafic intrusions take.

7. Write about the occurrence, associations and possible origins of andesites.

8. *"We can classify rocks, for petrological purposes, exactly, definitely, and strictly only by creating arbitrary divisions, cutting them up by sharp planes and putting them into man-devised pigeon holes. Such a classification is a pis-aller, a makeshift, a classification of convenience; it may or may not correspond to the evolution of igneous rocks as it really is".*

Henry S. Washington (1992) *Bull. Geol. Soc. Am.* 33 p801.

Discuss the above statement with reference to both the chemical and mineralogical classification of igneous rocks.

SECTION C

9. Define, giving examples, the different types of data that a field geologist can record. Discuss the type of descriptive statistical plots and the measurements of central tendency that are appropriate for each data type.
10. Write an essay on the importance of statistics in the analysis of field geological data.