National University of Ireland, Galway
OLLSCOIL NA hÉIREANN, GAILLIMH

SUMMER EXAMINATIONS 1999

3rd SCIENCE
GEOLOGY [GE 311]

PAPER ONE

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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
   (a) to estimate the order of an interference colour and
   (b) to determine the optic sign of a centred optic axis uniaxial interference figure showing isochromatic curves.

2. Define extinction. Illustrate the relationships that exist in general, between the crystallographic axes and the principle optical directions in the Orthorhombic and Monoclinic crystals. Comment on how inclined extinction can be useful in the estimation of the composition of some silicate minerals.

3. Show how the relationship $r=(n_1-n_2)d$ is of fundamental importance in determinative optical mineralogy.
   (r=retardation; n_1 and n_2 =refractive indices; d=thickness of thin section)

4. Write short notes on the following:
   (a) Positive and negative relief.

(b) Acute bisectrix

(c) Quarter-wave plate

(d) Pleochroism

SECTION B

5. *(Note: short answers only are required for each section of this question)*

(a) Figure 1a illustrates the effect of changing P_{H20} on the Di-An binary system. Briefly describe what would happen as a melt of composition X cools from 1500°C to 900°C at::

(i) P_{H20} = 1 bar

(ii) P_{H20} = 10 kbar

Based on your answers, what effects to different P_{H20} have on:

(i) the appearance of the rock crystallised under these conditions

(ii) the production of a melt from a rock consisting of Di + An?

(b) Figure 1b illustrates the SiO_2-Mg_2SiO_4 system. Briefly describe the processes involved in cooling a melt of composition m_1 from 1620°C to 1530°C.

What features might you see in thin section, which would indicate crystallisation of a mineral in this system?

(c) Figure 1c illustrates the Or-Ab system. What would tend to happen to a crystal of composition f_h at 700°C as it cools to 600°C?

Again, how may this process be recognised in the laboratory?

6. Using examples and diagrams to illustrate your answer, discuss the different proposed modes of granite emplacement.

7. Define:

(a) silica saturation

(b) silica oversaturation

(c) silica undersaturation

Discuss the occurrence and possible origins of undersaturated igneous rocks.

8.(a) Can the Bowen Reaction Series explain the features seen in a layered gabbroic intrusion? Illustrate your answer with an example.

8.(b) Below are the MgO and TiO_2 compositions of a glass (G), an olivine (Ol) and a clinopyroxene (CPx), along with those of a basaltic suite (LT1 - LT6) believed to have been formed through fractionation of a magma now represented by glass G.

	G	Ol	CPx	LT1	LT2	LT3	LT4	LT5	LT6
TiO_2	1.7	0.0	0.0	2.25	2.6	3.0	3.3	3.5	4.0
MgO	19.1	41.9	14.4	15.5	14.9	11.6	8.4	7.6	6.75

On graph paper, plot % $Ti0_2$ (y-axis) against % MgO (x-axis) for glass G, Ol and CPx.

Mark clearly on the graph, the direction a melt of composition G will move as:

(i) Ol only crystallises from the melt
(ii) CPx only crystallises from the melt
(iii) Ol and CPx in a 1:2 ratio crystallise from the melt

What phase(s), and in what quantities, could crystallise from G to generate

(i) the most primitive rock in the suite?
(ii) the most evolved rock in the suite?

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. Give an example of how a numerical model can be used to simulate a geological or palaeontological system. Discuss the strengths and weaknesses of this model.

11. Outline the field procedures and data reduction methods required to produce, either a magnetic anomaly map, or a gravity anomaly map of an area of the size of Connemara.
Gravity and magnetic anomaly map interpretation is strongly affected by the problem of non-uniqueness. Explain this problem, and indicate how it can be dealt with during interpretation.