Geology 214
Optical Mineralogy, Introductory Petrology and Isotope Geology

1. General Information

Lecturer:	Dr. Jodie Miller,
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Consultation:	In theory I am available anytime but in practice I may be otherwise occupied. My preference would be for you to email me and arrange a time.
Course Description:	Geology 214 is a single semester course carrying 16 credits
Class Timetable:	Mon 4th period 11.00am – 11.50am (L) Wed 3rd period 10.00am – 10.50am (L) Fri 1st period 8.00am – 8.50am (L) Thur practical 2.00pm – 5.00pm

2. Course Overview

The use of the petrographic microscope is essential for geologists as it is the most cost effective way of identifying minerals and thus classifying rocks. This course in optical mineralogy is specifically designed to enable the learner to identify minerals based on their optical properties. This knowledge is immediately applied to identifying minerals present in igneous and metamorphic rocks and to classifying these rocks. Introductory concepts in petrographic interpretation of mineral assemblages and textures are discussed and their use in identifying igneous and metamorphic rocks explored.

Isotope geology is dealt with in an introductory manner, by examining the basics of radiogenic and stable isotope geology and how these tools are applied to tracing geological processes and the dating of geological materials

3. Course Outcomes

Students should have the following skills at the end of the course.

- Practical ability to use mineral optical properties to identify the common rock forming minerals in thin sections.
- Understanding of the petrological classification of igneous and metamorphic rocks from mineral proportion and mineral textural information.

- Competence in practical igneous and metamorphic rock description.
- Understanding of simple igneous systems, including the use of binary and ternary phase diagrams in interpreting igneous rock petrogenesis.
- Understanding of simple metamorphic systems including the use of the phase rule and the concept of equilibrium
- Practical ability to classify rocks using established geochemical classification systems.

These skills will form the fundamental background to advanced petrogenetic and petrographic concepts developed in third year modules.

4. COURSE ASSESSMENT

4.1 Class Mark

The class mark (prestasiepunt) is composed of: (1) continuous assessment of marked practical work, (2) tests during the semester, and (3) two practical exams, one at mid-semester and one at the end of the year.

The marked practical work is composed of 10 practical assignments. One of these is a take home assignment. The practicals are worth 40% of the class mark (i.e. each practical is worth 4%). Due dates for practicals are clearly indicated on the practical when it is handed out in class.

Four 40 minute tests will be held during the semester. The dates are given below. An optional fifth test will be scheduled according to students timetables. The four best marks are combined to give a single test mark out of 20 (i.e. each test is worth 5%).

The two practical examinations will each be 2 hours in duration and will require microscope identification of minerals and hand specimen examination. Each practical test is worth 20% of the class mark.

Therefore the class mark (prestasiepunt) is calculated as follows:

Practical work	40%
Test mark (best of 4)	20%
Practical exam one	20%
Practical exam two	20%

4.2 Final Exam

The final exam in June is a 3 hour theory exam covering all aspects of the course material.
Entrance to the final examination in June requires a class mark (prestasiepunt) of at least 40%. Note that as a result of changes to the examination procedure there is no second option exam available. All students sitting the G214 course **must** sit the first exam in June. Students who for medical reasons are unable to sit the first exam, will be allowed to sit the second exam which follows directly after the first in late June. A medical certificate must be provided. In addition the student will be required to complete an official declaration on a specified form to declare that he/she had indeed been ill.

The first exam period in June is from the 23rd of May until the 12th of June. The second Exam period is from the 13th of June until the 27th of June.

	JUNE and NOVEMBER FIRST EXAMINATION		JUNE and NOVEMBER SECOND EXAMINATION	
	Student	**Consequence**	**Student**	**Consequence**
First semester **or** second semester **or** year module (Admission to the examination requires a class mark of at least 40)	1. Writes, obtaining a final mark of 50 or more	Passes the module	-—	-—
	2. Writes, obtaining a final mark of 40 or 45	Allowed to rewrite in second examination (a*utomatic* admission)	Writes, obtaining a final mark of 50 or more	Passes the module
			Writes, obtaining a final mark of less than 50	Fails the module, must repeat it next year
			Absent, for whatever reason(s)	Fails the module, must repeat it next year
	3. Writes, obtaining a final mark of less than 40	Fails the module, must repeat it next year	-—	-—
	4. Absent due to illness, proven by a medical certificate and declaration	Allowed, with permission of the Examinations Office, to write the second examination	Writes, obtaining a final mark of 50 or more	Passes the module
			Writes, obtaining a final mark of less than 50	Fails the module, must repeat it next year
			Absent, for whatever reason(s)	Fails the module, must repeat it next year
	5.Absent	Fails the module, must repeat it next year		

Further guidelines to changes in the examination procedure are available in Part 1 of the University Calendar 2006.

4.3 Compilation of the final semester mark

The final performance mark for the semester is calculated from the exam mark and the class mark in the ratio 60 to 40 respectively. Provided that the examination mark is 50% or more, the performance mark will not be less than 50%. Final marks between 35 and 50 will be allocated in multiples of 5 at the department's discretion and in line with university policy.

If a student obtains a final mark of 45 or 40, he/she will be allowed to sit the second exam which will follow directly after the first in June.

A final mark of less than 50 shall be allocated is a student obtains an exam mark of less than 40. A final mark of less than 40 shall be allocated if a student obtains an examination mark of less than 30.

See the above table for details.

4.4 Exam and Test Dates

Students are advised to take note of the following exam dates:

- 26th April – First Practical Exam
- 18th May – Second Practical Exam
- 10th June – First Theory Examination
- 24th June – Second Theory Examination (as required)

Test dates during the semester are as follows:

- 24th February
- 17th March
- 13th April
- 12th May

The fifth test date will be set in consultation with the students. The best four marks from the above 40 minute tests will be combined into the class mark as described above in section 4.1.

5. Suggested Text and Reference Books

It is recommended that students taking the G214 course purchase a copy of the following reference book.

Introduction to the Rock-Forming Minerals by Deer, Howie and Zussman, Longman Scientific and Technical

This book is a reference book and will be suitable for use through to the end of your degree and further depending on your career path. This book can be ordered through Protea Bookstores and a group order will be placed depending on how many are requested. As of the 1st of February Protea Bookstores had 7 copies in stock at a cost of R275.00 each.

Other reference and text book that will be of use include

Introduction to Mineralogy by William D Nesse, Oxford University Press
Petrology: The study of igneous, metamorphic and sedimentary rocks by Loren A Raymond
An Introduction to Metamorphic Petrology by Bruce W.D. Yardley, Longman Earth Science Series
Principles of Isotope Geology by Gunter Faure, John Wiley and Sons

These books will be available on reserve at the library. It is not necessary for you to buy copies of these books.

6. Practical and Class Conduct

- This course is a practical course that involves the use of the optical microscope and thin-sections. Please make every effort to look after material provided to you in the course.

- Access to the practical room is available to all registered students at any time provided that this does not clash with other classes. After hours access can be arranged through Stefan Kruger (Rm 1036).
- Continued after hours access to the practical room is subject to satisfactory behaviour in the practical room.
- Cell phones must be switched off during lectures.
- Students should bring to the attention of the lecturer, any reason whether illness or otherwise, why they were unable to attend classes or complete set work. In the event of illness, a medical certificate must be provided giving satisfactory information as to why the absence was necessary.

7. PROBLEMS

- Students should feel free to discuss any problem concerning their progress in the course or their progress mark with the lecturer.
- Problems concerning the class as a whole should first be directed to the class representative who will discuss the issue on behalf of the class with the lecturer.
- If agreement cannot be reached the lecturer will ask another staff member to adjudicate.

8. ADVICE ON PRACTICAL ASSIGNMENTS

- Altyd read through your answer
- Make sure you answer the question being asked
- Label your diagrams carefully, including a scale
- Use different shades of grey or patterns to indicate different minerals
- Pay particular attention to grain boundary relationships as these can tell you a lot about processes.

9. WEB-BASED RESOURCES

The following websites have useful compilations on optical mineralogy

***** http://www.uwgb.edu/dutchs/petrolgy/thinsect.htm
This whole site is very good!

These sites are also useful and have similar information but just on optical mineralogy
http://www.brocku.ca/earthsciences/people/gfinn/optical/222lect.htm
http://webmineral.com/
http://www.gly.bris.ac.uk/www/teach/opmin/mins.html

8. LECTURE AND PRACTICAL TIMETABLE

WEEK	DATE	DAY	PROGRAM
FEBRUARY			
1	6th	Mon	Lecture 1 - Introduction
	8th	Wed	Lecture 2 – Introduction to Light 1
	9th	Thur	*Practical 1 – Introduction to the Petrographic Microscope*
	10th	Fri	Lecture 3 – Introduction to Light 2
2	13th	Mon	Lecture 4 – Refractometry and Relief
	15th	Wed	Lecture 5 – Birefringence and Retardation
	16th	Thur	*Practical 2 – Introduction to Optical Identification of Minerals*
	17th	Fri	Lecture 6 – Interference Colors
3	20th	Mon	Lecture 7 – Pleochroism and Extinction Angle
	22nd	Wed	Lecture 8 – Extinction Angle
	23rd	Thur	*Practical 3 – Introduction to Optical Identification of Minerals*
	24th	Fri	**Test 1**
4	27th	Mon	Lecture 9 – The Optical Indicatrix
MARCH			
	1st	Wed	Lecture 10 – Interference Figures
	2nd	Thur	*Practical 4 – Revision of Igneous Petrology and Rock Classification*
	3rd	Fri	Lecture 11 – Revision of Igneous Petrology and Rock Classification
5	6th	Mon	Lecture 12 – Layered Igneous Intrusions
	8th	Wed	Lecture 13 – Introduction to the Bushveld Complex
	9th	Thur	*Practical 5 – Petrography of the Bushveld Complex*
	10th	Fri	Lecture 14 - Textures of Igneous Rocks in Thin-section
6	13th	Mon	Lecture 15 - Ocean Crust and Ophiolites
	15th	Wed	Lecture 16 – Alteration of Ocean Crust
	16th	Thur	*Practical 6 – Petrography of the Ocean Crust and Ophiolites*
	17th	Fri	**Test 2**
7	20th	Mon	Lecture 17 – Volcanoes and Volcanic Rocks
	22nd	Wed	Lecture 18 - Volcanoes and Volcanic Rocks
	23rd	Thur	*Practical 7 – Mineralogy and Texture of Volcanic Lava Types*
	24th	Fri	Lecture 19 – Introduction to Metamorphism
8	27th	Mon	Lecture 20 – Metamorphic Textures
	29th	Wed	Lecture 21 – Progressive Metamorphism of Pelites

	30th	Thur	*Practical 8 – Mineralogy of Pelitic Rocks*
	31st	Fri	Lecture 22 –Metamorphic Grade, Mineralogy and Textures
MID-SEMESTER BREAK 1ST – 9TH APRIL			
APRIL			
9	10th	Mon	Lecture 23 – Carbonate Rocks and Calc-Silicates
	12th	Wed	Lecture 24 – Subduction zone metamorphism
	13th	Thur	*Practical 9 – Mineralogy of High-Grade Metamorphic Rocks* **Test 3** (last 40 minutes of practical session)
	14th	Fri	Public Holiday
10	17th	Mon	Public Holiday
	19th	Wed	*Monday Timetable* Lecture 25 – Blueschists and Eclogites
	20th	Thur	*Practical 10 – Mineralogy and Textures of Blueschists and Eclogites*
	21st	Fri	Lecture 26 – Introduction to Isotope Geology
Examination Week 24th – 28th April: First Practical Exam 26th April			
MAY			
11	1st	Mon	Public Holiday
	3rd	Wed	Lecture 27 – Stable Isotope Geology
	4th	Thur	*Practical 11 – Stable isotope geology*
	5th	Fri	Lecture 28 – Stable Isotopes in the Hydrosphere
12	8th	Mon	Lecture 29 – Introduction to Radiogenic Isotope Geology
	10th	Wed	Lecture 30 – Decay Systems and Initial Values
	11th	Thur	*Practical 12 – Radiogenic Isotope Geology*
	12th	Fri	**Test 4**
13	15th	Mon	Lecture 31 – Applications of Isotope Geology and the Link to Mineralogy
	17th	Wed	Lecture 32 – Revision
	18th	Thur	Second Practical Exam – Braai in quad afterwards
	19th	Fri	Last day of semester – No lecture

9. LECTURE SUMMARIES

Summaries for each lecture will be provided at the beginning of each lecture. Copies of the powerpoint lecture notes will be available on WebCT Vista after the lecture.

10. PRACTICAL SUMMARY

It is required that all practical work be submitted for marking. Each practical is due at the **beginning** of the subsequent practical. Penalties will be applied for late submission of work in the following manner.

- Failure to submit before 2.10pm – 5%
- Failure to submit before 5.00pm – 10%
- Failure to submit before 9.00am subsequent day – 20%
- Failure to submit before the end of subsequent day – 100%

Any student who will be unable to submit required work on time should consult with the lecturer as soon as possible so that alternate arrangements can be made.

Practical Sessions

Practical One – Introduction to the Petrographic Microscope

- Introduction to using the petrographic microscope
- Care and identification of different parts of the microscope

Practical Two – Introduction to the Optical Identification of Minerals

- Learn how to identify minerals in thin section
- Understand the difference between birefringence, pleochroism, extinction angle, color and relief.
- Construct a table summarizing the main features of different rock-forming minerals to use as a tool for thin-section work.

Practical Three – Introduction to the Optical Identification of Minerals

- Carry on from practical two

Practical Four - Revision of Igneous Petrology and Rock Classification

- Understand how the IUGS classification system works
- Understand the difference between classifications based on mineral mode and chemical composition
- Identify different igneous rocks based on their mineral mode
- Understand the difference in chemistry of different igneous rocks based on mineral mode

Practical Five - Petrography of the Bushveld Complex

- Investigate the mineralogy and texture of the different magma compositions making up the Bushveld Layered Igneous Complex
- Understand the processes leading to the formation of layered igneous intrusions

Practical Six – Petrography of the Ocean Crust and Ophiolites

- Look at the impact of alteration processes on the mineralogy and texture of oceanic basalt lavas
- Understand the processes responsible for these changes
- Understand the environmental conditions under which these processes occur

Practical Seven – Mineralogy and Texture of Volcanic Lava Types

- Investigate the mineralogy and texture of different lava compositions
- Compare the characteristics of different lava types

- Examine the changes that occur in thin-section in response to low temperature alteration of basalts

Practical Eight – Mineralogy of Pelitic Rocks

- Investigate the progressive changes in mineralogy and texture in a series of pelitic rocks of increasing metamorphic grade
- Understand the concept of equilibrium and the application of the phase rule for simple systems

Practical Nine – Mineralogy of High-Grade Metamorphic Rocks

- Compare and contrast the textures of high-grade rocks and low-grade rocks
- Compare and contrast the mineralogy of high-grade rocks and low-grade rocks
- Understand in a general way the processes responsible for any differences.

Practical Ten – Mineralogy and Texture of Blueschists and Eclogites

- Understand the concept of equilibration and the metastable character of many blueschists and eclogites
- Identify the mineralogy of blueschists and eclogites and understand how this differs from rocks formed in different environments
- Understand the geodynamic significance of subduction zones for the mineralogical development in subducted oceanic and sedimentary material

Practical Eleven – Stable Isotope Geology

- Understand the application of stable isotopes to simple geological problems

Practical Twelve – Radiogenic Isotope Geology

- Understand the application of radiogenic isotopes to simple geological problems