

# EARTH SCIENCES 3313A IGNEOUS PETROLOGY

Fall 2015

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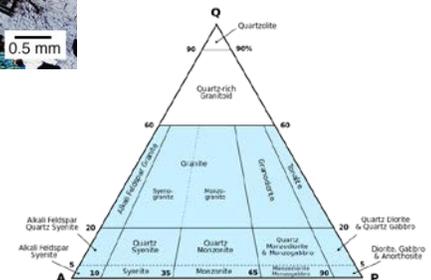
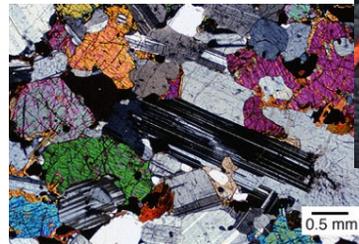
Office hours: Thursdays 3-5pm or by appointment

Teaching assistant:

Kathy Feick ([kfeick@uwo.ca](mailto:kfeick@uwo.ca), office WSc G17)

and Peter Christoffersen ([pchris7@uwo.ca](mailto:pchris7@uwo.ca), office WSc G32)

Pre-requisites: ES 2206A Mineral Systems, Crystallography and Optics



## CALENDAR

**Lectures:** Tuesdays & Thursdays: 12:30-13:20, Room: Physics & Astronomy Building 150

**Labs:** 2 sessions on Wednesdays 2:30-5:30pm and 6.00-9.00pm, Room: B&GS-1065, start on Wednesday, September 23<sup>rd</sup>. Print and fill up your microscope loan form (posted on OWL) and bring your \$20 deposit at the first lab session.

**Fall Study Break October 29-30<sup>th</sup>:** no labs scheduled on Wednesday, October 28<sup>th</sup> and no classes on Thursday 29<sup>th</sup>.

**Tuesday, October 20<sup>th</sup>:** Midterm exam in class

**Wednesday, December 9<sup>th</sup>:** Lab exam in BGS 1065

**Thursday, December 10<sup>th</sup>:** Study Day, no class.

**December 11<sup>th</sup> – 22<sup>nd</sup>:** Examination period. Final exam, date and location TBA.

## WHAT ARE THE PRINCIPLE OBJECTIVES OF THIS COURSE?

To outline the physical and chemical properties of magma, to introduce the techniques that are used to interpret the origin and evolution of different series of magmas and to examine in more detail magma evolution in specific igneous and tectonic environments.

The laboratory is an integral part of the course and students will learn to identify common igneous minerals, rocks and textures in hand specimen and in thin section using a petrographic microscope.

In class, we will discuss:

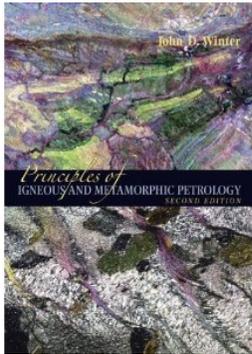
- The origin and conditions for producing melts
- How different compositions and conditions influence the phases present in a rock (phase equilibria)
- The association of different rock types with plate tectonic settings
- The major and trace element behavior in igneous systems which is used to understand the formation and evolution of the crust-mantle system on Earth and other planets

During the labs: you will study of igneous processes using rock hand sample and thin section descriptions (petrography).

## WHY STUDY IGNEOUS PETROLOGY?

Volcanoes are one of the main natural hazards to mankind. It is therefore important to understand the mechanisms and processes controlling volcanic eruptions. It is also clear that the materials which constitute the Earth's atmosphere, oceans, and crust ultimately originated from the Earth's mantle and were brought to the Earth's surface via igneous processes. Consequently igneous petrology is a key component to understanding how the Earth works as a system and how that system has changed over time. Igneous rocks are also the source of metals in many types of ore deposits, thus understanding the behavior of metals in igneous processes is fundamental to mineral exploration.

## LEARNING RESOURCES



The **required textbook** for this course is Igneous and Metamorphic Petrology (2010) 2<sup>nd</sup> Edition, by John Winter, The cost is high for a new textbook, \$140-160, but it is also used in the ES 3315 course – Metamorphic Petrology. You may also be able to purchase it on used book websites (make a web search), or as electronic version.

**You are required to read the book chapters associated with the corresponding lectures prior to class to get familiarized with the contents and technical vocabulary (see schedule below and announcements made during classes).**

**Materials from other sources will be also discussed in class.**

There is a copy on reserve in the library. For additional information and power point copies of the figures, see <http://www.whitman.edu/geology/winter/> (the website also has a list of errata to fix in your book).

There are several other excellent textbooks of Volcanology, Igneous Petrology and related subjects in the library. These include:

Igneous Petrology 2<sup>nd</sup> Ed., Anthony Hall (1996)

Principles of Igneous and Metamorphic Petrology, A.R. Philpotts (1990)

Igneous Petrology, M.G. Best and E.H. Christiansen, 2001

Igneous Petrogenesis, Marjorie Wilson

Igneous Petrology 2<sup>nd</sup> ed., A.R. McBirney

Origins of igneous rocks, Paul C. Hess

Basalts and phase diagrams: An introduction to the quantitative use of phase diagrams in igneous petrology, S.A. Morse

Using Geochemical Data: Evaluation, Presentation, Interpretation, H. Rollinson

## LABORATORIES

An **optical mineralogy text is required**, suggested:

Nesse, 2003, Introduction to Optical Mineralogy. Oxford. 3<sup>rd</sup> Ed. or Deer, Howie and Zussman, 1992,

An Introduction to Rock-Forming Minerals. Longman.

Petrography of igneous and metamorphic rocks, A.R. Philpotts QE461.P56 1989

Atlas of igneous rocks and their textures, W.S. MacKenzie, C.H. Donaldson and C. Guilford QE461.M219 1982

**Other recommended materials:**

-10x or better hand lens (a pencil magnet is also recommended)

-\$20 deposit for your microscope key (a form to print and fill up will be posted on OWL)

## EXAMS & ASSIGNMENTS

- **15%** mid-term exam on **Tuesday October 20<sup>th</sup>** during class time
- **30%** final exam, **date and location TBA (examination period: December 11<sup>th</sup> to 22<sup>nd</sup>)**
- **20%** lab exam: open book and 1-page limited notes (notes or previous lab assignments specific to the studied lab materials will not be accepted), **Wednesday December 9<sup>th</sup> in BGS 1065**

*Note: for both the mid-term and final exams, students should bring a non-programmable calculator (other electronic devices will not be allowed), color pencils, and a ruler.*

- **10%** home assignments: 3 assignments due in class 7 days after being assigned + 1 paper reading assignment (during the second part of the semester, will be posted on OWL) with discussion in class, your answers will be graded. Penalty: 10% off for each late day, 2 days late maximum for credits, due in class. **Assignments are an important part of your preparation for your exams, so I strongly encourage you to turn in your assignments on time.**
- **25%** lab assignments: **due at the end of each lab**, 10% off for each late day, (only exception are if you have special SSD arrangement, or exceptional reason approved by counseling), **3 days late maximum for credits**. Each assignment will be posted on OWL on Monday of each week, you are responsible for printing these and to review the materials and questions prior to the lab session on Wednesday.

**Pop quizzes will be given during some lectures and credited for a bonus point.**

## MARKING SCHEME

Each student is required to complete labs and assignments individually (see academic integrity below). Your presentation (writing and clarity) will be marked for one point. Assignments are normally marked and returned one week after they are due (they are normally due one week after they are handed out). Late assignments are penalized 10% per day for each day they are late and a mark of zero percent is given if the assignment is not submitted within 2 days from the due date (you have thus maximum 9 days to complete it).

Students are responsible for all material that is presented during lectures. Note that, although there is a course text and most of the material comes from this text, materials from other sources is also discussed during lectures. Also note that all additional materials shown in class and labs will be posted on the OWL web site for the course.

### ***PLANNED CLASS SCHEDULE***

*Some topics may not be covered or at a different week.*

Take note in class of announcements which will also be posted on OWL for updates on your reading assignments.

1 - Introduction - Structure of the Earth – Chapter 1

2 - Classification of Igneous Rocks: based on minerals -based on chemistry -based on CIPW norms. Chapters 2 & 3

3 - Magmatic environments and tectonic setting - Physical Properties of Magma: cooling mechanisms of flows -predicting volcanism versus plutonism -viscosity, diffusion -melt structure. Layered Intrusions. –

Chapters 4 & 12

4-5 - Phase Equilibria: binary diagrams, ternary diagrams -fractional/equilibrium crystallization/melting – Chapters 5-6-7

6 - Major Element Geochemistry: characteristic normative minerals -Harker diagrams -Pearce Element Ratios -fractional crystallization -magma series and tectonic settings. – Chapters 8 and 11

8- Basalts -evaluation of source, primary versus evolved, melting of peridotite: effects of H<sub>2</sub>O, degrees of partial melting, P-T, origin of alkaline and tholeiitic basalts. – Chapter 10

9 - Element Partitioning: major and trace element substitution in crystals -partition coefficients -effects of temperature, melt composition, crystal composition -batch melting and fractional crystallization - partitioning of REE's -tectonic applications. – Chapter 9

10 - MORB and OIB – Chapters 13, 14 & 15

- major element, trace element

11 - Arc Magmas – Chapters 16 & 17

- major element, trace element and petrogenesis of continental and island arcs

12 Alkaline magmatism – Granitisation – Chapters 19 & 18

13 - Archean magmatism (not covered in textbook)

- archean magma suites
- geochemical characteristics

December 8: Last class to review materials from the full semester: bring your questions!

## ***General Information***

**Statement on Academic Offences:** "Scholastic offences are taken seriously and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, at the following Web site: <http://www.uwo.ca/univsec/handbook/appeals/scholoff.pdf>

### **Student's responsibilities in the event of a medical issue:**

If you are unable to meet a course requirement due to illness or other serious circumstances, you must provide valid medical or other supporting documentation *first* to the Faculty of Science's Academic Counselling Unit as soon as possible *and* contact your instructor immediately. It is the student's responsibility to make alternative arrangements with their instructor once the accommodation has been approved and the instructor has been informed. In the event of a missed final exam, a "Recommendation of Special Examination" form must be obtained from the Academic Counselling Unit immediately. For further information please see: <http://www.uwo.ca/univsec/handbook/appeals/medical.pdf>

A student requiring academic accommodation due to illness, should use the Student Medical Certificate when visiting an off-campus medical facility or request a Records Release Form (located in the Academic Counselling Unit) for visits to Student Health Services. The form can be found here: [https://studentservices.uwo.ca/secure/medical\\_document.pdf](https://studentservices.uwo.ca/secure/medical_document.pdf)

### **Accessibility Statement**

Please contact the course instructor if you require materials in an alternate format or if you require any other arrangements to make this course more accessible to you. You may also wish to contact Services for Students with Disabilities (SSD) at 661-2111 x.82147 for any specific question regarding an accommodation.