

Faculty of Science
Dept of Earth and Planetary Sciences
Unit GEOS337 Geochemical Analysis and Techniques
2011 Semester 1

Unit convenor:

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Students in this unit should read this unit outline carefully at the start of semester. It contains important information about the unit. If anything in it is unclear, please consult the unit convenor.

About this unit

Duration and mode of delivery: 6 on-campus sessions – lectures, tutorials, practicals

Location: Lectures and tutorials will be held in Room 829 Building E7A

Number of credit points: 3

Contact hours: 36 (6 days, 6 hours per day)

Pre-requisites: GEOS207(P) or GEOS206(P) or CHEM324 or CHEM325

Co-requisites: GEOS314 or GEOS343

This is an introduction to the various analytical techniques used in inorganic geochemistry to determine the major element, trace element and isotopic composition of rocks and their constituent minerals.

Advances in instrumentation and the development of new techniques have led to the acquisition of more complete data from individual samples and the more rapid processing of samples has resulted in the generation of large datasets. An understanding of these analytical techniques is necessary to remove the 'black box' aura and to create a greater appreciation of the quality of the results. This is critical to the interpretation of geochemical data and the significance attached when propagated in petrogenetic models.

The unit is run in a short-course format over 6 days (36 hours), with 6 on-campus sessions. The form of the unit is to provide theory in the lectures and then to extend this into practical applications during the tutorials and practicals. The class will be divided into groups to undertake the practical sessions on the electron microprobe and ICP-MS. Although basic instruction will be given in instrument operation the main aim in the practicals is for you as a group to develop an analytical strategy to solve the problems presented to you.

Attendance at lectures/practical/tutorial sessions is compulsory.

Teaching Staff

Convenor: Dr Norman J. Pearson

Contact hours

Norman Pearson: 9:00 am – 5:30 pm daily. Come to my office (E5B 205) or GAU Laboratories Level 1 E5B (room 107 or 123). It is best to e-mail (norman.pearson@mq.edu.au) or phone (9850 8361) to make an appointment.

Classes

Unit of study timetable 2011

Day 1: 4 March 2011: 10:00 – 5:00 Geochemical Analysis – Basics

Lecture 1	Introduction <ul style="list-style-type: none">• Overview of analytical methods, instruments and laboratories• Analytical procedure
Tutorial 1	Planning an analytical program
Practical 1	Instrument calibration and standardisation

Day 2: 18 March 2011: 10:00 – 5:00 Data Quality

Lecture 2	Geochemical data <ul style="list-style-type: none">• Reporting geochemical data• Accuracy and precision• Basic statistics and uncertainty
Tutorial 2	Quality assurance – how good are your analytical data? “Analytical Methods” in your thesis or manuscript Communicating your results

Day 3: 1 April 2011: 10:00 – 5:00 X-ray Analytical Techniques I

Lecture 3	X-ray spectrometry <ul style="list-style-type: none">• X-ray generation• Interaction of X-rays with matter• Detection and counting of X-rays
Tutorial 3	Basic quantitative X-ray analysis
Lecture 4	Whole-rock analysis I <ul style="list-style-type: none">• X-ray Fluorescence Spectrometry for major and trace elements
Tutorial 4	Whole-rock data quality – XRF

Day 4: 8 April 2011: 10:00 – 5:00 X-ray Analytical Techniques II

Lecture 5	Mineral analysis I – major elements <ul style="list-style-type: none">• Electron Microprobe (EMP) Instrumentation• Quantitative mineral analysis
Tutorial 5	Mineral chemistry – data reduction and quality
Practical 2	Electron microprobe analysis

Day 5: 29 April 2011: 10:00 – 5:00 Mass Spectrometry I

Lecture 6	Whole-rock analysis II <ul style="list-style-type: none">• Introduction to mass spectrometry• Trace element analysis by ICP-MS
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Tutorial 6	ICP-MS data reduction and quality
Lecture 7	Isotope geochemistry – Multi-collector ICP-MS • Radiogenic and stable isotope systems
Tutorial 7	Isotope ratio measurement – data reduction and quality

Day 6: 13 May 2011: 10:00 – 5:00 Mass Spectrometry II

Lecture 8	Mineral analysis II – trace elements and isotope ratios • Laser Ablation ICP-MS – in-situ trace element analysis • In-situ geochronology
Tutorial 8	LAM-ICPMS – data reduction and quality
Seminars	“Analytical Methods” in your thesis or manuscript Communicating your results

Day 6: 27 May 2011: 10:00 – 12:00 Assessment Test

Attendance at lectures/practical/tutorial sessions is compulsory.

Required and Recommended Texts

There are no prescribed textbooks for this course. A hardcopy of Powerpoint lecture presentations will be provided. The following books are recommended for additional reading.

Potts, P.: A Handbook of Silicate Rock Analysis. Blackie (on reserve)

Rollinson, H.: Using Geochemical Data. Longman

Unit Web Page

There is no web page for this unit.

Learning Outcomes

Unit aims

- to familiarise students with the various analytical techniques used in geochemical analysis, concentrating on the facilities available in the Geochemical Analysis Unit: (X-Ray fluorescence spectrometry (XRF), electron microprobe analysis (EMP), inductively coupled plasma mass spectrometry (ICP-MS), including quadrupole and multi-collector instruments, and solution and laser ablation sample introduction.
- to provide a basic understanding of how each instrument works and how this is applied to quantitative analysis
- to develop the skills to evaluate data quality by determining the accuracy and precision of the data
- to develop the skills to analyse and present geochemical data
- to understand the importance of data quality in the application and interpretation of geochemical data to solve petrological problems
- to integrate the different skill sets into the planning of a geochemical analysis program

Learning outcomes

Upon completion of the course, you will be able to:

- explain the basic principles of how the XRF, EMP and ICP-MS operate;
- select an appropriate analytical technique for the geochemical analysis of major and trace elements in geological materials;
- devise an analytical program using the appropriate techniques to solve basic petrological problems using geochemistry;
- use the skills acquired in the unit to assess the quality of data obtained using different analytical methods;
- organise and present geochemical data in table and graphical format suitable for a report, thesis or publication.

Generic skills

Generic skills targeted in the course include problem solving, project management, numeracy, data synthesis, teamwork and communication skills.

Relationship Between Assessment and Learning Outcome

Assessment

There is no final exam in this unit and assessment is primarily based on performance in the assignments with additional components made up of a seminar presentation and a class mark.

Assignment 1	Basic analytical techniques and data handling	10%
Assignment 2	X-ray Fluorescence and Electron Microprobe Analysis	15%
Assignment 3	Mass spectrometry analysis	15%
Assignment 4	EMP Practical Project	20%
Seminar	'Analytical Methods' for thesis or manuscript	10%
Class mark		10%
Test		20%

Assignments 1, 2 and 3 will be based on the concepts and skills covered in the lectures in days 1 and 2, days 3 and 4, and day 5 respectively. The exercises undertaken in the tutorials in these sessions will provide a framework for self-assessment of your progress and in the preparation of the assignments. The practical project (Assignment 4) will involve EMP instrument usage and the data generated during the practical will be used in the assignment. During the time on the EMP the class will be divided into groups and each group will be

required to produce a plan for the analytical session and the data collection. Although the practical work will be done as a group, each student will be required to submit an individual assignment in the form of a written report. The emphasis of the report is to provide a description of the analytical method and to demonstrate the skills acquired in the testing of data quality and data presentation. The length of the report should be no more than 500 words, excluding data tables and figures.

Marks in the assignments will be awarded for presentation, clear and concise language usage, and the correctness of answers. It is important that you follow scientific methodology and include all steps in the derivation of your answers to questions involving numerical calculations. Marks may be deducted if the assignments are submitted past the due date. Extensions will be considered if you contact the unit convenor prior to the assignment deadline and provide a reasonable explanation why the extra time is required.

The topic of the seminar is "Preparing an Analytical Methods Section for your thesis (or manuscript)". The topic will form the basis of a class discussion in Tutorial 2 (Day 2). At that time the class will be divided into groups and each group will choose one of the instrument techniques covered in the course. Your brief will be to prepare a description of your chosen analytical method as you would provide for your thesis or manuscript. Each group will be required to produce a PowerPoint presentation of your description and give this as a short seminar on Day 6. A group mark will be awarded and it will be based on content and presentation.

The class mark will be awarded on the basis of attendance, frequency of participation in class discussions, quality of participation and teamwork skills in the group exercises.

Due Dates:

Assignment 1	28 March 2011
Assignment 2	27 April 2011
Assignment 3	9 May 2011
Seminar	13 May 2011
Assignment 4	27 May 2011
Test	27 May 2011

Assignments can be submitted as e-mail attachments in PDF format. A reply e-mail will be sent to you to acknowledge receipt of the assignment. Also remember to keep a back-up copy in case there are any problems.

Feedback will be provided in the form of written comments on the assignments and in class discussions. Assignments 1, 2 and 3 will be returned at on-campus days 3, 5 and 6 respectively.

In addition to the formal assessment associated with the assignments there will be a number of exercises to supplement the tutorial questions that will allow you to evaluate your own progress. Completion of these exercises is optional but you are encouraged to use them to help you improve your skills and to establish a set of criteria to check before you submit your assignments.

Plagiarism

The University defines plagiarism in its rules: "Plagiarism involves using the work of another person and presenting it as one's own." Plagiarism is a serious breach of the University's rules and carries significant penalties. You must read the University's practices and procedures on plagiarism. These can be found in the Handbook of Undergraduate Studies or on the web at: <http://www.student.mq.edu.au/plagiarism/>

The policies and procedures explain what plagiarism is, how to avoid it, the procedures that will be taken in cases of suspected plagiarism, and the penalties if you are found guilty. Penalties may include a deduction of marks, failure in the unit, and/or referral to the University Discipline Committee.

To maintain good academic practice, so that you may be given credit for your own efforts, and so that your own contribution can be properly appreciated and evaluated, you should acknowledge your sources and you should ALWAYS:

1. State clearly in the appropriate form where you found the material on which you have based your work.
2. Acknowledge the people whose concepts, experiments, or results you have extracted, developed, or summarised, even if you put these ideas into your own words.
3. Avoid excessive copying of passages by another author, even where the source is acknowledged. Find another form of words to show that you have thought about the material and understood it, but remember to state clearly where you found the ideas.

YOU WILL BE GUILTY OF PLAGIARISM if you do any of the following in an assignment, or in any piece of work which is to be assessed, without clearly acknowledging your source(s) for each quotation or piece of borrowed material:

1. Copy out part(s) of any document or audio-visual material, including computer-based material.
2. Use or extract someone else's concepts or experimental results or conclusions, even if you put them in your own words.
3. Copy out or take ideas from the work of another student, even if you put the borrowed material in your own words.
4. Submit substantially the same final version of any material as a fellow student. On occasions, you may be encouraged to prepare your work with someone else, but the final form of the assignment you hand in must be your own independent endeavour.