

GL 9508 Analytical Geochemistry

Course Outline - Winter 2022

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Schedule

Seminar: 2 hrs per week, date and time to be determined

Lectures: 2 hrs per week, date and time to be determined

The lectures are normally 1 hour, during the second hour some lab tours will be given where appropriate

There are no lectures or seminars the week of February 21 and March 7 owing to Reading week and PDAC, respectively. On the last seminar date, term papers will be presented by students.

Seminar Date (Wednesdays)	Lecture Date (Thursdays)
January 5 Introduction	January 6 XRF lecture
January 12 XRF seminar	January 13 ICP lecture
January 19 ICP seminar	January 20 LA-ICP-MS lecture
January 26 LA-ICP-MS seminar	January 27 LIBS lecture
February 2 LIBS seminar	February 3 SEM lecture
February 9 SEM seminar	February 10 EMPA lecture
February 16 EMPA seminar	February 17 CL lecture
February 23 no seminar Reading Week	February 24 no class Reading Week
March 2 CL seminar	March 3 IR lecture
March 9 no seminar PDAC	March 10 no seminar PDAC
March 16 IR seminar	March 17 Raman lecture
March 23 Raman seminar	March 24 – no lecture
March 30 Term paper presentations	April 2

Course Description

A variety of laboratory and field portable techniques are used to analyze whole rocks (bulk techniques) including X-ray Fluorescence (XRF), Induced Coupled Plasma-Mass Spectrometry and Atomic Emission Spectroscopy (ICP-MS and ICP-AES), and Laser Induced Breakdown Spectroscopy (LIBS). Analytical techniques that are used to obtain point chemical analyses of

minerals included Scanning Electron Microscopy-Energy Dispersive System (SEM-EDS), Quantitative Evaluation of Minerals by Electron Microprobe Analysis (EMPA), Cathodoluminescence (CL), Laser Ablation ICP-MS (LA-ICP-MS), Infrared Spectroscopy (IR) and Raman Spectroscopy. The basic theory and practice of these techniques will be introduced through lectures and their applications and the interpretation of data will be examined in seminars. Also note that some specific techniques may be dropped or added. Also note that while X-Ray Diffraction and analyses of stable isotopes by mass spectroscopy are both important analytical techniques, these topics are covered by other courses and therefore not repeated in GL-9508.

Prerequisites

None

WHAT ARE THE PRINCIPAL OBJECTIVES OF THIS COURSE?

The interpretation of geochemical data requires an understanding of the theory behind the analysis, the strengths, limitations and errors of the technique and how geochemical data can be applied to testing geological hypotheses. This course introduces a number of analytical techniques that are applied to determining the compositions of rocks and minerals, which are then applied to geological problems.

Course Materials

There is no formal text. **The PowerPoint presentations will be posted on the 9508 OWL website.**

Course Structure

The instructor will present a one-hour lecture per week on an analytical technique. The seminar will consist of students selecting journal papers that show applications of the technique from the preceding lecture and problem solving with that technique, and presenting them to the class. Each student will also write a term paper on an analytical technique not covered in the lecture material and explain the theory and applications of the technique.

Marking

Seminar	40%
Term Paper Oral Presentation	20%
Term Paper	40%

Seminars: One or more students will present a seminar of up to one hour on a journal paper each week. Students will be assigned topics at the beginning of the term. They will select a paper (or papers) that show the application of the analytical technique in question to research in Earth Sciences. The presenting student will send a pdf of the paper to everyone in the class at least two days before to the seminar. Critical evaluation of the paper by the entire class is expected. The seminar mark will consist of 75% is for presentations and 25% participation in the seminars of others.

Term Paper: Each student will select an analytical technique that is not covered in the course. The theory behind the analytical technique should be explained, as well as examples of applications. *The choice of the technique should be emailed to the instructor, rlinnen@uwo.ca by **February 1st***. Note that a specific technique can only be presented by one person, so the first person to contact the instructor will have that topic. One specific application should be covered in more detail. The paper should also include a discussion of advantages-disadvantages, limitations, errors, analytical costs. A brief comparison of at least one other analytical technique that will produce similar results should be included, as well as a discussion as to why the technique that is the focus of the paper is more appropriate for the application being proposed. **This is to be written as a journal paper, approximately 10 to 15 pages double spaced consist of a Title, Abstract and Introduction, followed by the main body of the text (including figures), Conclusions and References. The term paper is due Aprilst.**

Rubric for 9508 Term Paper

The marking rubric for the term paper is Presentation (10%), Abstract (10%), Introduction (10%), Main Body, (40%), Conclusions (10%), Overall Writing (10%), References (10%).

When you are reading journal articles pay attention to how other people write. What do you think makes a good abstract, Introduction etc.

Format: All papers should have a title page with title and the author, student and course numbers. Papers must use **the format of the journal Geochimica et Cosmochimica Acta**. Marks will be deducted if this format is not followed.

Abstract: 150-250 words. Should summarize the key findings, some data can be included and why this data the analytical technique being discussed is important.

Introduction: Provide the background on the analytical technique, e.g., on the history of its development, current and potential uses.

Main Body: Go into more detail on the theory of the technique being considered, errors, detection limits, and advantages and disadvantages of the technique compared to others that yield similar information. General and novel uses of the technique should be discussed.

Conclusions: This should summarize the interpretations from the main body of the paper. A minimal amount of data should be repeated here. Conclusions are different from the abstract, the latter summarizes the entire paper, including data, whereas the former only summarizes the interpretations, but can also extend those interpretations to broader implications for other studies.

Potential Geochemical Technique Topics

Analyses of halides (Cl, F, Br, I)

Atom probe

Auger Spectroscopy

Chromatography

EELS (Electron energy loss spectroscopy)

EBSD (Electron BackScatter Diffraction)

Hydride Generation-Atomic Fluorescence Spectrometry (used for metalloids, Te, As, Bi, Se)

INAA (Instrumental Neutron Activation Analysis)

Isotope dilution mass spectrometry

micro-CT (Micro-computed tomography)

Mossbauer Spectroscopy

PIXE-PIGE (Particle-induced X-ray emission)-(Particle-induced gamma emission)

SIMS (Secondary-ion mass spectrometry)

TIMS (Thermal Ionization Mass Spectrometry)

TOF-ICP-MS or TOF-SIMS (time-of-flight ICP or SIMS)

UV-NIR (ultraviolet-near infrared spectroscopy)

XANES-XAFS (X-ray Absorption Near Edge Structure)-(X-ray Absorption Fine Structure)

X-Ray tomography

XPS (X-ray photoelectron spectroscopy)

Term Paper Oral Presentation: Each student will make a 20 minute oral (PowerPoint) presentation to the class + 5 minutes for questions on **March 30th**.

Attendance: Students must participate in all lectures and seminars. A maximum of one seminar can be missed if a valid reason is given and the rest of the seminar mark will be pro-rated. Valid reasons for missing a seminar include medical, compassionate, religious holidays, personal (family or work) obligations. The instructor and student will agree upon what is valid, but in the case where there is no consensus advice from the Dean's office will be sought.

General Information

University of Western Ontario policies are listed at http://www.uwo.ca/univsec/academic_policies/. Scholastic offences are taken seriously and graduate students are directed to read the policy, specifically, the definition of what constitutes a Scholastic Offence, at the following Web site:

www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_grad.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 Dean's Office) for visits to Student Health Services. The form can be found here:

https://studentservices.uwo.ca/secure/medical_document.pdf

Accommodation for Illness

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 Dean's Office) for visits to Student Health Services. The form can be found here:

http://www.uwo.ca/univsec/pdf/academic_policies/appeals/accommodation_illness.pdf

Mental Wellbeing

Students who are in emotional/mental distress should refer to Mental Health@Western <http://www.uwo.ca/uwocom/mentalhealth/> for options about how to obtain help.

Accessibility Statement

Please contact the course instructor if you require material 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. Students are not required to sit for more than one hour at a time. For additional information please see

www.uwo.ca/univsec/pdf/academic_policies/appeals/accommodation_disabilities.pdf