

# **UNDERGRADUATE HANDBOOK**

**Department of Geology  
University of Toronto**



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## PREFACE

**This handbook is not intended as a substitute for the calendar, but as a supplement to it. The calendar can be found online at <http://www.artsandscience.utoronto.ca/ofr/calendar/>.** The handbook provides information on some of the programs available to a student interested in studying the Earth Sciences at the University of Toronto. We will be happy to give you further information about this department or put you in contact with the other departments, faculties and colleges.

If you are still in high school, you may wish to visit us. You may be able to arrange this through your guidance teacher. Alternatively you may call us directly for an appointment.

If you are already on campus, call in at the Geology Office (Room # 1066) in the Earth Sciences Centre and arrange to speak to a staff member.

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## **PART A**

### **GENERAL INFORMATION ON THE EARTH SCIENCES**

#### **So You Might Be Interested in The Earth Sciences**

The University of Toronto is the largest university in Canada and offers a wide range of instruction in the earth sciences, with opportunities to specialize in various aspects of geology, geophysics, and geological engineering.

If you are in high school or just starting at the University of Toronto, you may be confused by the array of courses, programs and degrees available. This booklet has been written to augment the official university calendars with some additional information and guidance. It does not replace the calendars which remain the final authority on all University programs, rules, and regulations.

#### **Arts and Science Degree or Engineering Degree?**

The decision to pursue a B.Sc. or an engineering degree (B.A.Sc) depends primarily on your interests; both degrees are acceptable as professional qualifications for a Geoscientist. The basic sciences and geology courses are similar in both faculties, but the engineering programs contain both a fundamental engineering basis and a number of courses designed particularly for the mining and petroleum geologist or engineer.

The B.Sc. program offers the opportunity for a more intensive chemical, physical, biological, or mathematical training, and the opportunity to combine geology with a variety of other subjects. This line of study is best for students whose scientific curiosity prompts the question 'Why?'

The B.A.Sc. (engineering) program is tightly structured with some latitude allowed through the system of technical and non-technical elective courses and can lead to the further qualification of (Professional Engineer). This is the degree for the practical student who asks 'How?'

This booklet deals principally with courses and programs offered at the St. George campus.

#### **Geology and Geophysics**

Geology and Geophysics are closely related disciplines but at the University of Toronto they are taught in two separate departments. It is possible to pursue a program in geophysics alone, or combine it with geology. Most geology students must complete some geophysics courses for their undergraduate degree, whether in the Faculty of Arts and Science or the Faculty of Applied Science and Engineering. Further information and booklets on Geophysics may be obtained from the Department of Physics at (416) 978-7057.

#### **Necessary High School Subjects**

Successful study of earth sciences requires a solid foundation in the basic sciences chemistry, physics, biology and mathematics. Whether you wish to pursue a professional career in the earth sciences or simply wish to learn more about the history of the earth (perhaps as an ancillary to your major interest in another department) you should be aware of certain prerequisites.

If you wish to pursue a professional career in geology, it is essential that you have senior high school credits (grade 12U courses) in Chemistry, Physics, Advanced Functions, and Calculus and Vectors. In addition, a high school Biology credit is useful, and as for all entrance requirements, English is also a prerequisite. If you are seriously interested in a career in geology but lack a prerequisite, talk to a faculty member to see if an alternative is possible.

If you intend to study selected aspects of geology for only a year or two, you will find several courses available with less rigorous prerequisites (or even none at all).

### **St. George, Mississauga (UTM) and Scarborough (UTSC) Campuses**

It is possible to take introductory courses in geology on any of the three campuses as prerequisites to specialist programs in the Faculty of Arts and Science. Programs in Mineral Engineering are offered only on the St. George campus through the Lassonde Program in the Faculty of Applied Science and Engineering.

A four-year Arts and Science Program in Environmental Sciences is available at UTSC. Details of the program can be found at [www.utsc.utoronto.ca](http://www.utsc.utoronto.ca).

UTM offers two programs in the Earth Science Department: (1) Earth Science and (2) Geology. Specialist, Major, and Minor programs in **Environmental Earth Science** are sponsored by the Geology group there. It is also possible to follow a Specialist program in Geology, for those students interested in a traditional geology education. In addition, programs in **Environmental Science**, which are, in effect, joint Geography, Biology and Earth Science programs, contain a significant component of Earth Science courses. Students wishing to obtain a Specialist degree in **Geology** must follow the program descriptions in the St. George Calendar and take third- and fourth-year GLG courses on the St. George Campus. These students may also be required to make up some second-year GLG courses, and should consult Faculty advisors.

Four-year programs in Geology, Environmental Geoscience, Geology and Physics, and Mineral Engineering are available on the St. George campus.

The full details of the Lassonde Program in Mineral Engineering are available from the Faculty of Applied Science and Engineering, (416) 978-6554.

## **PART B**

### **COURSES, PROGRAMS AND DEGREES**

#### **First Year Courses**

##### **Distribution**

The Department offers several introductory courses that are suitable for students with little or no background in sciences or who wish to take only a basic level of Geology. These popular courses include:

GLG 103 Geology in Public Issues  
GLG 105 Evolution of the Earth  
GLG 110 Introductory Geology  
GLG 130 Exploration of the Solar System  
GLG 205 Confronting Global Change

Intended primarily to provide breadth to non-science students, all of these may be used as science Distribution Requirement courses by students in the Humanities and Social Sciences. Exceptional achievement in one of these courses together with any other required make-up courses may prompt a student to consider application for entry into the Geology Program. Consult the Undergraduate Coordinator for more information.

##### **Science**

The Department also offers a more challenging first year Science course, GLG 102F Earth Science, which provides an introduction to a number of aspects of the physics and chemistry of important processes in the planet Earth. This course is open to any Science student and is highly recommended to students considering studying Geology at the second year level.

##### **B.Sc. Programs in Geology (Faculty of Arts and Science)**

A number of four year specialist programs are available for the student who wishes to pursue a career in the broad field of Earth sciences. These programs are designed to provide the necessary preparation in the basic sciences and mathematics, along with fundamental courses, called core courses, which are essential for specialist training. Optional courses are also available, both within programs and outside. Every student must take two full courses outside of his or her particular discipline. These are called "Distribution Requirements", and are designed to broaden the student's education and afford some relief from the rigors of the formal programs. These are described in detail in the main Arts and Science calendar (<http://www.artsandscience.utoronto.ca/ofr/calendar/>).

##### **Program Requirements**

Course requirements for various programs (with the exception of Chemistry and Geology) are shown in tables on the following pages. All four specialist programs require first year chemistry, physics, and mathematics with some also requiring Biology. These core requirements arise because upper year courses in Geology build on a broad training in basic science.

##### **Specialist Programs**

The Specialist program in **GEOLOGY** is intended for students who intend to become professional geologists. It is normally part of a 20 course, honours B.Sc. degree. The program provides a core of instruction in the main subdisciplines of geology. In the third and fourth years it allows the student some flexibility in choice of geology courses and is the normal preparation for graduate studies in geology. Two field courses are required, GLG 340F and GLG 445F, and it is strongly recommended that they be taken during the summers after the second and third years of study, respectively.

The Specialist Program in **ENVIRONMENTAL GEOSCIENCES** was introduced in response to widely voiced societal needs for expertise in this area. Courses required in this program concentrate on geological phenomena on and near the Earth's surface. The program is designed to provide greater rigor in mathematics and chemistry than the Geology Specialist program, to suit the needs of professionals who deal with issues relating to the migration and remediation of groundwaters. Two field courses are also required, GLG 340F, taken in August-September preceding third year and GLG 448F taken in August-September preceding fourth year.

The Specialist Program in **GEOLOGY AND PHYSICS** requires a blend of courses from Geology and Physics that give concentrated training suitable for practising geophysicists. Note that more mathematically demanding courses and programs in geophysics are offered in the Department of Physics.

### **Major and Minor Programs**

Major and minor programs can be part of the B.Sc. degree. These programs can be taken in various combinations to suit individual student interests. For example, the major program in Geology can be taken together with the major in Environmental Geosciences but must include 12 different courses to qualify for the B.Sc.

The variety of third and fourth year courses offered by the Department of Geology, together with earth science related courses in cognate departments such as Geography, Chemistry, Physics, the Division of the Environment and the Faculty of Applied Science and Engineering, gives the student a wide range of topics from which she/he can select courses. Careful planning of courses is very important because most 400 series courses have lower level prerequisites that may not be part of a minimum program requirement.

**NOTES: For an explanation of F, S, H, Y, I please refer to:**

**<http://www.artsandscience.utoronto.ca/ofr/calendar/>**

**Generally, F = fall, S = second, or winter term. H = half a credit. Y = full credit (full year)**

### **Specialist program:**

(14 full courses or their equivalent)

First Year:

required: CHM 151YI/(138HI, 139HI); MAT 135YI/137YI; PHY 138YI/140YI;

recommended: BIO 150YI and GLG102HI

Second Year:

GLG 202HI; GLG204HI; GLG 206HI, GLG207HI, GLG216HI, GLG217HI; MAT 223HI

Third Year:

GLG 318HI, 340HI, 345HI, 351HI, 360HI; ENV 315HI

Fourth Year

1. GLG 445HI, GLG470YI
2. 3.0 full 400-series GLG or JGP courses

**Major program:**

(8 full courses or their equivalent)

First Year:

required: CHM 151YI/(138HI, 139HI); MAT 135YI/137YI; PHY 138YI/140YI

recommended: BIO 150YI and GLG102HI

Second Year:

GLG 206HI, 207HI, 216HI, 217HI

Higher Years:

1. GLG 340HI
2. 2.5 courses from 300/400-series GLG courses/ENV 315HI/JGP 438HI

**Minor program:**

(4 full courses or their equivalent)

Four full course equivalents of which one full course or equivalent is at the 300/400-level

First and Second Years:

Two full course equivalents from 100-series or 200-series GLG courses including no more than one full course equivalent at the 100 level; GLG102 is recommended; one full course equivalent of 100-series CHM, BIO, or PHY courses

Third Year:

One full course equivalent from 300/400-series GLG courses/ENV 315HI/JGP 438HI

**NOTE:**

Some GLG courses have CHM/MAT/PHY prerequisites

**Environmental Geosciences**

**Specialist program:**

(16 full courses or their equivalent which includes fulfillment of the Faculty's Distribution requirement ; must include at least four 300+-series courses, one of which must be at the 400-level)

This is a Type 3 program requiring a minimum CGPA of 2.3. The student must complete four courses from the First Year list before enrolling in the program. Information on application and acceptance timelines is available in the Registration Handbook and Timetable. For more information, please refer to

<http://www.environment.utoronto.ca/UndergraduatePrograms/ApplicationProcedures/ApplicationProcedures>

First Year:

Students must complete BIO 150Y1; CHM (138H1/139H1)/151Y1; MAT 135Y1/137Y1; PHY 138Y1/140Y1

Second Year:

GLG 202H1, 206H1, 207H1, 216H1, (ENV 234Y1/GLG217H1, EEB214H1); MAT 235Y1/(MAT 223H1, GLG 204H1), STA220H1

Third and Fourth Years:

1. GLG 345H, 351H1, 360H1, 436H1, 448H1, 450H1; JGE221Y1/JIE222Y1, ENV 235Y1, 315H1, 321Y1

2. ENV 410H1/JIE401H1; ENV 421H1/GLG471H1

Note: GLG 340H1 is recommended but not required for this specialist program.

**Major program:**

(8.5 full courses or their equivalent; must include at least two full-course equivalents at the 300+ level)

First Year:

CHM (138H1, 139H1)/151Y1; MAT 135Y1/137Y1; PHY 138Y1/140Y1

Second Year:

ENV 235Y1; GLG 202H1, 206H1, 207H1, 216H1, 217H1

Third and Fourth Years:

ENV 315H1; GLG, 351H1, 436H1, 448H1

**Minor program:**

(4 full courses or their equivalent; must include at least one full-course equivalent at the 300+-level)

1. ENV 235Y1

2. GLG 202H1, GLG 206H1, 207H1, 216H1, 351H1; ENV 315H1

**Geology and Physics (Science program)**

Consult Departments of Geology and Physics

**Specialist program:**

(14 full courses or their equivalent with at least one course at the 400-level)

First Year:

CHM 151YI; MAT 137YI; PHY 140YI; GLG102HI is strongly recommended

Second Year:

GLG 206HI, 207HI, 216HI, 217HI; MAT 237YI, 244HI; PHY 251HI, 255HI

Third Year:

APM 346HI; GLG 345HI; PHY 225HI, 308HI, 351HI, 352HI

Fourth Year:

1. GLG 340HI

2. 1.5 300/400-series GLG courses

3. 1.5 300/400-series PHY courses

**Note:**

1. Students are encouraged to select courses on the basis of a coherent theme such as Exploration Geology and Geophysics, Global Tectonics, or Environmental Geodynamics.

2. Students are required to register with the Departments and have their programs approved.

### **B.Sc. Geology and Physics (Faculty of Arts and Science)**

The most obvious route is to follow the Specialist program in Geology and Physics. This builds a strong foundation in Mathematics and Physics but provides a basic geological education and brings in fundamental Geophysics and Exploration Geophysics. A more intensely mathematical and physical approach is through the Specialist Program in Physics with election of a number of Geology courses and emphasis on Geophysics in the final year. Students who follow this program will be well prepared for geophysics graduate research or for positions in the geophysical and interpretation aspects of the petroleum and mining industries. Other combinations are possible by combining Geology, Physics and Mathematics outside of the Specialist Program, and should be discussed with advisors in the Geology and Physics Department.



**PART C**

## **GENERAL INFORMATION FOR UNDERGRADUATES**

### **Professional Status**

Geologists, Geological Engineers and Geophysicists are often called upon to prepare geological reports on their work for submission to the various provincial regulatory and security commissions. Practicing professionals in Ontario are governed by provincial legislation. The Association of Professional Geologists of Ontario (APGO) is the licensing authority under the Professional Geoscientists Act of 2000. Any person who practises Geoscience in Ontario must be registered with APGO as a Practising Geoscientist or a Geoscientist in Training. The practice of “professional geoscience” is defined in the *Professional Geoscientists Act, 2000* as follows:

“An individual practises professional geoscience when he or she performs an activity that requires the knowledge, understanding and application of the principles of geoscience and that concerns the

safeguarding of the welfare of the public or the safeguarding of life, health or property including the natural environment.”

To become a certified member of APGO you must complete a program of study approximately equivalent to a Geology Specialist program or a P.Eng., and must have four years of Geoscience work experience. Further information regarding professional status for Geoscientists is available at <http://www.apgo.net/>



### **Field Instruction**

Field instruction is absolutely vital in the education of geological and geophysical scientists. Field instruction is achieved through courses actually taught in the field, or field excursions that are an adjunct of regular courses, and also by summer employment with industry and government. It must be emphasised that summer employment is particularly valuable in providing the experience necessary to plan operations in a variety of terrains, geographical regions and weather. In short, this is when you acquire the plain, down-to-earth common sense that cannot be inculcated in the lecture room. Geological and geophysical employment is often available for the summer months. Most students take the opportunity both to earn a good wage and broaden their experience. In respect of variety of experience, interesting localities and colleagues, and generous remuneration, students of geology have an advantage over those in other disciplines seeking summer employment.

### **Field Courses and Field Trips**

The Department offers three field courses that are held outside the standard weeks of fall and spring terms and are an essential part of some courses. Additional fees are required for the field courses to cover part of the cost of transportation and meals and there may be minor charges for field trips held during the term. The field courses, GLG 340H1, GLG 445H1 and GLG 448H1 each carry a half course credit. GLG445H1 is normally taken in May following the third year of study. It is a summer session course and students must register with their college *before* leaving for the field course. GLG340H1 and GLG 448H1 are held in August just before the beginning of classes and students should register for them at the same time as for other courses.

Details of all arrangements will be available in the Department several months in advance of each field course. **It is essential to register with the department for each of these courses in addition to your formal registration in your college.**

Students are expected to supply field clothing, geological hammers and hand lenses.

## **Undergraduate Involvement in Research**

There are at least four ways to become involved in research:

1. SCI 299Y and 399Y Research Opportunities Program are courses available only to second year and third year students, respectively. Students earn a full course credit while carrying out research under the direction of a faculty member. Only a limited number of research projects are available under this program and descriptive brochures of projects are available through the college registrars.
2. The GLG 371H and GLG 372Y Directed Studies courses are individual study programs chose by students with the advice of, and under the supervision of, a staff member. Such work may involve obtaining data in the field or lab and analysing it, an interdisciplinary research project, and supervised readings.
3. Students in Specialist programs are required to do GLG 470Y or GLG 471S research projects leading to the writing and presentation of an undergraduate thesis. This work can be supervised by any member of the teaching staff and may either be on a topic suggested by the professor, or on a problem introduced by the students themselves for research.

It is best to make arrangements during your third year so as to avoid delays in September. At that time everyone is busy, and facilities such as thin sectioning are always overloaded. The onus is on you to find a supervisor who is interested in what you propose to do or in whose research you are interested and wish to become involved. You must register your research project with the Undergraduate Office. Part of this process involves providing a title and brief description of the project, as well as a mutually-agreed upon marking scheme. Note that 70% of the final mark is based on the students performance during the thesis, which can involve some combination of milestone delivery, vigilance in work progress, in addition to the final written account of the project. Although results vary, typical written accounts range in length from 30-50 pages inclusive (double-spaced, reasonable margins). The format of the written account, in terms of scope and topics to be covered, is to be determined by the supervisor, and clearly conveyed to the student. Students are required to present a 20 minute talk to an assembly of faculty and student peers following the end of classes in April. This presentation is marked by the attending faculty and the average will constitute the additional 30% of the final mark.

4. Many faculty members are prepared to involve you in research projects at any undergraduate level if you are serious about it. There is no degree credit for this and you must be very careful not to allow your formal course work to suffer. For a serious student it can, however, be a rewarding experience that may well lead to more extensive involvement at the graduate level. If you are interested, talk to your instructors and find out what involvement they might be prepared to offer you. Some faculty members hire students to assist with research in the summer, and there are government awards (see NSERC Summer Research Studentships below) specifically designed to provide salaries for promising summer students.

## **Scholarships, Awards, and Financial Assistance**

Regulations governing the student aid program change from year to year, and it is wise to keep in touch with college registrars or the Student Awards Office for current information. Many scholarships are available in the university and you should check your eligibility before submitting applications for any of them. A complete list is available at the student awards office in the Koffier Centre. Scholarships and awards available specifically to students in the earth sciences are listed below. Note that in many cases, these are administered and awarded by the university to the best eligible student. Thus, students do not apply for these.

**NSERC SUMMER RESEARCH STUDENTSHIPS** are available to some second year students and above, for selected undergraduate research projects. These provide salary for four months. Applications (through a faculty member involved in the project) are due in mid to late December. They require a minimum of an upper "B" standing in grade point average and are an excellent introduction to research investigations.

**BURGE-CONNELL SCHOLARSHIP (\$1,000)** Open to students entering second year geology, or physics and geology. Must be in top 25% of first year class or have grade point average of 2.7 and show financial need.

**THE FREDERICK R. BURTON SCHOLARSHIP IN GEOLOGY (APPROX \$900)** To be awarded, on the recommendation of the geological staff at UTM, to the Year III student specializing in Geology who obtains the highest standing in the courses required for the specialist program, and who has an otherwise satisfactory standing.

Enrolment in the Geology specialist program in Year IV is a requirement of this award and the winner's Year IV program must contain five full courses, or their equivalent.

**THE CHEVRON STANDARD LTD. SCHOLARSHIP IN GEOLOGY (\$750)** Awarded to an outstanding third year student with a first class average in a program that includes those courses common to the Geology and Lassonde Mineral Engineering programs.

**THE COLEMAN GOLD MEDAL** Awarded to the fourth year student in one of the Geology Specialist programs graduating with the highest standing. The winner of this medal will also receive the Wesley Tate Scholarship.

**THE COMINCO SCHOLARSHIP (TWO SCHOLARSHIPS OF \$800 EACH)** Awarded to an outstanding student specializing in Geology who has a first class average in second year. Renewable after the third year if marks are satisfactory. Shared with Engineering students.

**THE R.E. DEANE AWARD (APPROX. \$250)** Awarded to the student showing the best performance at the GLG 445H1 field course.

**THE H.V. ELLSWORTH SCHOLARSHIP IN MINERALOGY (APPROX. \$3,000)** Awarded to an outstanding student at the beginning of the fourth year on the basis of excellence in mineralogy. Financial need is also considered.

**THE FIRST, SECOND AND THIRD ALEXANDER T. FULTON SCHOLARSHIPS IN SCIENCE (1st - \$50; 2nd - \$40; 3rd - \$30)** Awarded to an outstanding first year student with an A

average who has taken at least one course in three of the following subjects: Biology, Chemistry, Geology, Mathematics, Physics.

**THE GORDON GILCHRIST SCHOLARSHIP IN TERRAIN AND ENVIRONMENT EARTH SCIENCES (\$500)** Awarded to the student in the former TEES program at Scarborough who has the highest aggregate standing at the end of the third year of study in the required courses of the program.

**J. EDGAR MACALLISTER FOUNDATION UNDERGRADUATE AWARDS (\$1,000)** Students in the Lassonde Program in Mineral Engineering students are eligible. Details in the Engineering Calendar.

**THE ALEXANDER MACLEAN AWARD (\$150)** Awarded to an outstanding student having a first class average in a program in either Arts and Science or Lassonde Mineral Engineering that includes GLG 318H1, 319H1, 332H1.

**GARNET W. MCKEE-LACHLAN GILCHRIST SCHOLARSHIPS (GEOPHYSICS) (\$200)** These scholarships are awarded as follows: (1) to the student in the second year of Geophysics with the highest standing in the first and second year; (2) to the student in second year of Engineering Physics who has the highest standing in the first and second years of those students who intend to proceed to the third year in the Geophysics option; (3) to a student in the third year of Geology and Physics, of the fourth year if no third year student is eligible.

**THE CHARLES LESTER MILLS SCHOLARSHIP IN SCIENCE (APPROX. \$285)** Awarded to an outstanding student who has taken at least one course in Mathematics and at least one course in two of Astronomy, Botany, Chemistry, Geology, Physics and Zoology.

**THE MINERALOGICAL ASSOCIATION OF CANADA AWARD** The MAC offers a prize to the student who excels in the 2nd year mineralogy course GLG 206H1.

**THE NON-FERROUS CASTINGS LIMITED BURSARY (\$300)** To be awarded to a Year III student in Geology who requires financial assistance.

**PETRO-CANADA SCHOLARSHIP IN GEOLOGY AND GEOPHYSICS (\$800)** Academic Requirements: Second year, A average

- (i) *Applied Science and Engineering* - An outstanding student of Lassonde Mineral Engineering who has pre-registered for the Concentration 2 of the Lassonde Program in Third year.
- (ii) *Arts and Science* - An outstanding student in a Specialist program in Geology, or Chemistry and Geology, or Geology and Physics or Physics (with concentration in Geophysics).

The candidate must be a Canadian citizen, must continue in the selected program and option, and may not hold other awards of \$400.00 or more.

**THE DON SALT MEMORIAL SCHOLARSHIPS (\$750)** Two awards, one to a third year student and one to a fourth year student, in any of the following courses. The emphasis is placed on a motivation for a career in Mineral Exploration and oriented toward geophysics. The award is not based solely on high marks.

- a) Lassonde Program in Mineral Engineering

- b) Geology and Physics
- c) Geology
- d) Physics, including advanced courses in geophysics.

**THE FREDERICK W. SCHUMACHER SCHOLARSHIP (\$690)** Awarded to a student of first class standing in the second, third or fourth year to the Geology specialist program or the Lassonde Program in Mineral Engineering.

**THE WESLEY TATE PRIZE (\$335)** Awarded to an outstanding fourth year geology student. The winner of this prize also receives the Coleman Gold Medal.

**EDITH TYRELL MEMORIAL BURSARY (\$600)** Awarded to a student entering third or fourth year of Metallurgy and Materials Science or Lassonde Program Mineral Engineering. Application to be made within one month of the opening of the academic year. Further details in the Engineering Calendar.

**THE DANIEL WILSON SCHOLARSHIPS IN SCIENCE (token value)** Awarded to an outstanding student with a first class average in third year in Geography or Geology.

**THE ISABEL AND TUZO WILSON SCHOLARSHIP (APPROX. \$1000)** On the recommendation of the Geological faculty at UTM, to be awarded to an outstanding full-time student who is taking courses in Earth Science and who is entering either second or third year with priority given to the second year. Registration in the following winter session is a requirement of this award.

**THE EDWARD BLAKE SCHOLARSHIP IN EARTH SCIENCES (APPROX \$77)** Awarded to an outstanding student with an A average in second year in a program which includes three courses in Geography and/or Geology and/or Geological Sciences.

## Libraries

Information on U of T. libraries and catalogues may be obtained on the Internet via <http://main.library.utoronto.ca/>. Electronic versions of most periodicals of interest to Geology students are available online through the University Library website to members of the University community.

One of the three Main Libraries of the University of Toronto, the Sigmund Samuel Library is the Undergraduate Library of the University, carrying multiple copies of required reading and much recommended reading.

The Earth Sciences Library of Geology, Botany and Forestry, situated in the Earth Sciences Centre, is a research library serving many of the needs of the Department of Geology. Computer terminals are available for searching library catalogues and specialised data bases. The Science and Medicine Library also has a great number of monographs and serials on geology.



The John P. Robarts Research Library, seat of the central library administration, houses the Map Library which has a large collection of geological, aeromagnetic and topographic maps together with maps of a highly specialized nature.

The Physics Library, second floor of the Burton Tower, carries many geophysical publications.

At University of Toronto at Mississauga (UTM), the library contains several of the major journals and a large selection of books, in addition to the "Bibliography and Index of Geology" and other similar indices. Material desired but not found at UTM can be obtained very rapidly through the book delivery service.

At University of Toronto at Scarborough (UTS), good literature resources pertinent to the Environmental Earth Sciences program are available from the Bladen Library and access to libraries on the St. George Campus is facilitated through a book delivery service.

### **University of Toronto Career Counselling**

The Career Counselling and Placement Centre, located in the Koffler Student Centre at 214 College Street offers an opportunity for companies to advertise part-time, summer and permanent positions. If you are a graduating student or looking for summer work in the field of geology, the on-campus recruitment program will be of interest to you. Employers visit the campus during the March to October period to interview students for summer or permanent positions. Many jobs in geology, exploration and resource exploitation are obtained in this way. Information about job opportunities and specific on-campus recruitment programs is posted as early as September, so it is important to check early. Branch offices of the CCPC are located on both the UTM and UTS campuses.

### **Undergraduate Geological Association (UGA)**

The undergraduate lounge, room 2117 on the second floor of the Earth Sciences Centre, is open to all Geology undergraduates. The UGA sponsors guest speakers, organizes social events and in general, provides a means to develop a working relationship among staff, graduates, and undergraduates which benefits all concerned. The Engineering Club also arranges a number of informal events during the year to which Arts and Science students are welcome.

### **Other Activities and Information**

#### **RockFest**

The graduate students hold a regular Friday afternoon RockFest with two short talks and refreshments. Graduate students, staff and occasional guests speak about their current research. Undergraduates are welcome and many find it a convenient and enjoyable way of keeping abreast of the range of activities in the Department and meeting people whose paths they might otherwise not cross.

#### **FRED (Fossils, Rocks, Environment and Dirt at the University of Toronto)**

FRED is a weekly newsletter listing news, happenings, jobs, conferences etc. of the Department of Geology for the St. George, UTM and UTS campuses plus the Royal Ontario Museum. Please check the department website.

#### **Jobs**

Job opportunities are regularly announced in FRED and in general email distribution.

#### **Computing Facilities**

Computing facilities for undergraduates are located in room 4107. Undergraduate computing in the Department of Geology is served by a dedicated computer laboratory with an assortment of PC and printing facilities.

Current versions of many common word processing, spreadsheet and graphics software packages are available. In addition, several software packages dedicated to geological and mineralogical problems are in use.

#### **Departmental Seminars**

The department arranges a series of seminars during term in which distinguished speakers from other universities, industry, and government participate. All students are encouraged to attend and should watch the announcements on the notice boards by the elevator in the Department of Geology. Announcements are also made via email notification.

### **Undergraduate Memberships in Societies and Subscription to Journals**

#### **Geological Association of Canada (GAC)/Mineralogical Association of Canada (MAC)**

These two national associations offer reduced rate memberships to students. Students intending to become professional geologists are strongly encouraged to join these societies; see the Undergraduate Coordinator for more information.

A number of professional societies offer student membership at reduced rates to undergraduate students, and some journals offer reduced-rate subscriptions. Any of the teaching staff will be glad to sign your application form. MAC offers a complimentary membership to the student who performs best in second year mineralogy GLG206F.

#### **The University of Toronto Student Chapter of the Society of Economic Geologists**

The aims of the Student Chapter are to encourage interest in ore deposits of all types, and to improve communication between the university and the mining industry. Activities include a regular series of talks, production of a student chapter newsletter, as well as yearly field trips and symposia. All undergraduates are welcome to join the Student Chapter and participate in the activities.

#### **Prospectors and Developers Convention**

The Prospectors and Developers Convention (P and D), held each Spring at the Royal York Hotel, and Toronto Convention Centre, draws as many of 9000 participants in all aspects of the mining industry from all parts of the world for a week of meetings, technical sessions, exhibits, and socializing. Students are offered a reduced admission rate and are encouraged to attend. The convention presents an opportunity for many students to meet prospective employers, both for summer employment and more permanent employment.

#### **Canadian Institute of Mining and Metallurgy**

The Canadian Institute of Mining and Metallurgy (CIM) is an organization with a Toronto Branch that takes an active interest in the students at U. of T. They offer a student membership and subscription to their publication, organize a “smoker” (an event with a talk, followed by beer and pizza for all), and several times yearly invite students to their meetings as luncheon guests.

## PART D

### RESEARCH SPECIALTIES OF FACULTY MEMBERS (UTSC = U of Toronto, Scarborough; UTM = U of Toronto, Mississauga, ROM = Royal Ontario Museum)

BAILEY, R.C., B.Sc., Ph.D. (Geophysics) 978-3231  
[bailey@geology.utoronto.ca](mailto:bailey@geology.utoronto.ca)

Physical processes and geodynamics of the deep crust; Electromagnetic sounding of the Earth's crust and mantle; Inverse theory in Geophysics.

BERGQUIST, B., B.S., Ph.D. (Biogeochemistry) 978-3709  
[bergquist@geology.utoronto.ca](mailto:bergquist@geology.utoronto.ca)

Biogeochemical cycles that are important for life on Earth and how these cycles have evolved over time through the use of trace metal and stable isotope geochemistry.

BOLLMANN, J.: B.Sc., Ph.D. (Paleo-oceanography) 978-2061  
[bollmann@geology.utoronto.ca](mailto:bollmann@geology.utoronto.ca)

The relationship between the geosphere and biosphere and their variability during the history of our planet. Main research interests are global climate change, paleo-oceanography, microplankton ecology and evolution, especially calcareous marine algae.

BRENAN, J.M., B.Sc., Ph.D.: (Igneous Petrology/Geochemistry) 978-0281  
[brenan@zircon.geology.utoronto.ca](mailto:brenan@zircon.geology.utoronto.ca)

Experimental trace element geochemistry; origin of island arc magmas; geochemistry of rhenium and the platinum group elements; kinetics of high temperature processes.

CARON, J.-B., Ph.D. (Paleontology) 586-5593 ext. #1  
[jcaron@rom.on.ca](mailto:jcaron@rom.on.ca)

Systematic paleontology, quantitative community analysis and paleoecology of the “Cambrian Explosion.”

CRUDEN, A.R., B.Sc., Ph.D.: (Tectonics & Remote Sensing) 828-3971  
[cruden@geology.utoronto.ca](mailto:cruden@geology.utoronto.ca)

Tectonics of Precambrian terrain boundaries (Baltic and Canadian Shields). The study of granitic magma ascent and emplacement mechanisms using a quantitative structural geological and fluid mechanics approach. Tectonic applications of remote sensing.

DAVIS, D., B.Sc., M.Sc., Ph.D.: (Geochronology) 946-0365  
[dond@geology.utoronto.ca](mailto:dond@geology.utoronto.ca)

Geochronology and radiogenic isotope geochemistry; growth and evolution of the Earth's crust.

EYLES, N., M.Sc., Ph.D., D.Sc.: (UTSC) (Glacial Sedimentology) 287-7231  
[eyes@lake.scar.utoronto.ca](mailto:eyes@lake.scar.utoronto.ca)

Sedimentology of Early Proterozoic to Pleistocene glaciated basins based on studies at modern ice margins. Application of depositional models to geotechnical engineering, drift exploration and hydrocarbon exploration. Urban geology and waste management.

- FERRIS, F.G., B.Sc., Ph.D.: (Biogeochemistry) 978-0526  
[ferris@quartz.geology.utoronto.ca](mailto:ferris@quartz.geology.utoronto.ca)  
 Laboratory and field studies in environmental biogeochemistry focusing on the precipitation and dissolution of minerals by microorganisms. Impact of epilithic microbial biofilms on the interfacial chemistry of rock surfaces (rock-fluid-biofilm interactions). Immobilization and mineralization of dissolved mineral forming elements by microorganisms in natural and contaminated environments.
- GHENT, R., Ph.D.: (Planetary remote sensing, geodynamics) 978-0597  
[ghentr@geology.utoronto.ca](mailto:ghentr@geology.utoronto.ca)  
 Use of remotely sensed data to investigate the geological and geodynamical evolution of planetary surfaces, including those of Venus, Mars, the Moon, and Earth.
- GORTON, M.P., M.Sc., Ph.D.: (Geochemistry) 978-5420  
[gorton@zircon.geology.utoronto.ca](mailto:gorton@zircon.geology.utoronto.ca)  
 Geochemistry, especially of rare earths and other trace elements. Application to igneous rocks and to trace element mobility associated with alteration.
- HALFAR, JOCHEN, Ph.D. (UTM) (Paleoclimates) (905) 828-5419  
[jochen.halfar@utoronto.ca](mailto:jochen.halfar@utoronto.ca)  
 Deciphering paleoclimates on different time scales ranging from the past centuries to the Neogene using geochemical, sedimentological, and oceanographic approaches
- HALLS, H.C., M.Sc., Ph.D.: (UTM) (Geophysics) (905) 828-5363  
[hhalls@credit.erin.utoronto.ca](mailto:hhalls@credit.erin.utoronto.ca)  
 Geology and geophysics of late Precambrian rocks with emphasis on the Keweenaw rift system of central North America. Global distribution, nature and tectonic significance of Precambrian diabase dike swarms. Paleomagnetic and geological studies of meteorite impact sites. The analysis of multicomponent paleomagnetic data.
- HAMILTON, M., Ph.D. (Geochronology) 946-7424  
[mahamilton@geology.utoronto.ca](mailto:mahamilton@geology.utoronto.ca)  
 Geochronology and radiogenic isotope geochemistry; growth and evolution of the Earth's crust.
- HENDERSON, G.S., B.Sc., M.Sc., Ph.D.: (Mineral Chemistry/Mineralogy) 978-6041  
[henders@geology.utoronto.ca](mailto:henders@geology.utoronto.ca)  
 Mineral chemistry/mineralogy. Scanning tunnelling microscopy and spectroscopic studies of minerals and melts i.e., Raman/IR, X-ray scattering studies EXAFS, NMR. Atmospheric chemistry: Hydrocarbons and Ozone in the Troposphere/Stratosphere, Arctic/Antarctic Ozone and Br chemistry.
- HOWARD, K.W.F., M.Sc., Ph.D.: (UTSC) (Hydrogeology) 287-7233  
[gwater@lake.scar.utoronto.ca](mailto:gwater@lake.scar.utoronto.ca)  
 Hydrogeology. Major ion, minor ion, and environmental isotope characteristics of groundwater. Fluid and geophysical well logging. Groundwater. Fluid and geophysical well logging. Groundwater resource assessment. Simulation of aquifer and pumping test behaviour using numerical finite difference techniques.

- MIALL, A.D., B.Sc., Ph.D., D.Sc.: (Stratigraphy & Sedimentology) 978-8841  
[andrew@quartz.geology.utoronto.ca](mailto:andrew@quartz.geology.utoronto.ca)  
 Stratigraphy and sedimentology of clastic rocks, fluvial and deltaic sedimentary processes, sequence stratigraphy, regional basin analysis, and their application to studies of petroleum, coal and stratabound ore deposits, plate tectonic analysis of sedimentary basin.
- MUNGALL, J.E., B.Sc., M.Sc., Ph. D.: (Igneous Petrology and Ore Deposits) 978-2975  
[mungall@geology.utoronto.ca](mailto:mungall@geology.utoronto.ca)  
 Petrogenesis of magmatic ore deposits; field, theoretical and experimental investigations of the chemical and physical controls on large magmatic systems. Geology of the Sudbury impact structure.
- PYSKLYWEC, R., B.Sc. (Eng.), M.Sc., Ph.D.: (Tectonophysics) 978-4852  
[russ@geology.utoronto.ca](mailto:russ@geology.utoronto.ca)  
 Tectonophysics and Earth system evolution; numerical modeling of large-scale crust-mantle processes and integration with geophysical/geological/geodetic observation; dynamics of plate collision, orogenesis, continental subsidence; mantle convection.
- ROBIN, P.-Y.F., M.Sc., Ph.D.: (UTM) (Thermodynamics & Structural Geology) 828-5419  
[py.robin@utoronto.ca](mailto:py.robin@utoronto.ca)  
 Thermodynamics and kinetics of reaction and phase transformations in the solid state: interface migration, change of order, exsolution and diffusion and their applications to geothermometry; physical properties and natural deformation mechanisms of rocks and minerals; numerical methods in structural geology and fabric analysis; structural petrology.
- RUDKIN, D, Ph.D. (ROM) (Paleontology) 586-5592  
[davidru@rom.on.ca](mailto:davidru@rom.on.ca)  
 Palaeobiology, systematics, and taphonomy of fossil Arthropoda, particularly Trilobita; Trilobite trace fossils and palaeoethology; Palaeozoic palaeobiology and biostratigraphy of the Hudson Bay and James Bay lowlands in Ontario , Manitoba , Quebec , and southern Nunavut.
- SCHULZE D.J., B.A., M.Sc., Ph.D.: (UTM) (Igneous & Metamorphic Petrology) (905) 828-3970  
[dschulze@credit.erin.utoronto.ca](mailto:dschulze@credit.erin.utoronto.ca)  
 Igneous and metamorphic petrology; kimberlites, lamprophyres, and related alkalic rocks; mantle-derived ultramafic xenoliths and their bearing on the composition and evolution of the upper mantle; tectonic evolution of the lithosphere.
- SHERWOOD LOLLAR, B., B.A., Ph.D.: (Stable Isotope Geochemistry) 978-0770  
[bsl@geology.utoronto.ca](mailto:bsl@geology.utoronto.ca)  
 Stable isotope geochemistry applied to natural gas and groundwater systems. Emphasis on the use of stable isotopes as environmental tracers, i.e. to identify the origin and trace the evolution of geochemical components; and to investigate processes of transport, mixing and gas-water-rock interaction in hydro geological environments.

SPOONER, E.T.C., B.A., M.A., Ph.D.: (Mineral Deposits) 978-3280  
[etcs@quartz.geology.utoronto.ca](mailto:etcs@quartz.geology.utoronto.ca)

Researching characteristics, structural relationships and origin of Archean Au-quartz vein /shear-zone systems as integral aspects of the evolution of Archean terranes in the Superior and Slave Provinces, in the Barberton greenstone belt, South Africa, and in the Ghana, West Africa; laboratory research is concentrated on the development of methods for fluid-inclusion gas, cation/anion and light stable isotope analysis by methods such as gas chromatography, ion chromatography and mass spectrometry.

SRINIVASAN, G. Ph.D. (Cosmochemistry and meteoritics) 978-0278  
[srini@geology.utoronto.ca](mailto:srini@geology.utoronto.ca)

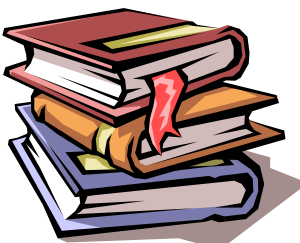
Origin and evolution of planetary bodies and solar system; petrographical, chemical and isotopic composition of meteorites.

WORTMANN, U.G., Dipl. Geol. Dr. rer.nat.: (Geobiology) 978-7084  
[uli.wortmann@utoronto.ca](mailto:uli.wortmann@utoronto.ca)

Investigation of deep biosphere communities using geochemistry and reaction-transport modeling.

## PART E

### UNDERGRADUATE COURSES IN GEOLOGY St. George Campus (Department of Geology)



Unless noted, there are no prerequisites.

#### **SCI199Y1 First Year Seminar 52S**

Undergraduate seminar that focuses on specific ideas, questions, phenomena or controversies, taught by a regular Faculty member deeply engaged in the discipline. Open only to newly admitted first year students. It may serve as a distribution requirement course; see page 40.

#### **GLG102H1 Earth Science 26L, 39P**

Introduction to the functioning of the Earth as a chemical and physical system. Topics include formation of the Earth from the solar nebula, radioactive decay and age dating, meteorite impacts, melting and crystallization of rocks, erosion and sedimentation, the carbon cycle and its effects on climate, and the transport and remediation of pollutants in the environment.

Prerequisites: Grade 12 Chemistry SCH4U, Physics SPH4U, Functions MCB4U.

#### **GLG103H1 Geology in Public Issues 26L**

Geologic hazards: earthquakes, volcanoes, landslides, tsunamis. The distribution and politics of natural resources, including petroleum and ore deposits. Nuclear power and nuclear waste disposal. Global change: the geologic record of hot and cold climates, and how the earth survives.

GLG103H1 is primarily intended as a science Distribution Requirement course for Humanities and Social Science.

**GLG105H1 Evolution of the Earth: 26L**

**Controversy over the Last 2300 Years**

The evolution of ideas about the origin and development of the earth from the Athenians to the 20th Century. With attention on whether the earth has an infinite or a finite life; on the evolution and disappearance of species; on the origin of oceans, continents and mountains; on the forces that have shaped the earth's surface; and on the courage of scientists in confronting the religious and political views of their time.

GLG105H1 is primarily intended as a science Distribution Requirement course for Humanities and Social Science students.

**GLG110H1 Introductory Geology 26L**

The nature and evolution of the Earth; plate tectonics; rocks and minerals; volcanism; geological time; fossils; geology of Ontario; environmental issues.

Exclusion: JGG150Y1

GLG110H1 is primarily intended as a science Distribution Requirement course for Humanities and Social Science students

**GLG130H1 Exploration of the Solar System 26L**

Scientific findings of the solar system exploration program and their application to the origin of the earth and solar system; space resources; search for life on other planets.

Prerequisite: Grade 12 U Chemistry or Physics

**GLG202H1 Introductory Geochemistry 26L, 39P**

An introduction to thermodynamics, phase diagrams and solution chemistry, with application to geological and environmental processes.

Prerequisite: CHM151Y1/(138H1, 139H1); MAT 135Y1/137Y1

**GLG204H1 Quantitative Methods in Geology 26L, 39P**

An introduction to quantitative approaches to geological problems: use of scalars, vectors and tensors in stress and strain analysis, statistical treatment of geological datasets, heat and mass transfer in earth materials.

Prerequisite: MAT135Y1/137Y1; MAT223H1; PHY138Y1/140Y1

**GLG205H1 Confronting Global Change 26L, 8T**

The emergence of society as a major geological force is considered in terms of the evolving debate about the consequences of human activity for the habitability of our planet. Major issues such as climate change, environmental pollution, and depletion of natural resources are examined.

GLG205H1 is primarily intended as a science Distribution Requirement course for Humanities and Social Science students

**GLG206H1 Materials of the Earth 26L, 39P**

An overview of the structural, chemical and optical properties of minerals. Laboratories on the identification of minerals in hand specimen and thin section. A mandatory 2 day field trip in late September.

Prerequisite: CHM (138H1, 139H1)/151Y1

**GLG207H1 Rock-forming Processes 26L, 39P**

Origin and classification of igneous, sedimentary and metamorphic rocks and their associated ore deposits. Emphasis is placed on formation of rock types in the context of plate tectonic theory, and the practical aspects of rock identification in hand sample and thin section.

Prerequisite: GLG206H1



**GLG216H1 Dynamic Geology**

**26L, 39P**

A survey of principal physical, biological and chemical processes shaping the Earth. Laboratories will explore these processes in more detail through a series of problem sets.

Prerequisite: CHM (138H1/139H1)/151Y1

**GLG217H1 Earth Evolution**

**26L, 39P**

An introduction to the evolution of the biosphere from the earliest stabilization of the Earth's crust. Patterns of evolution and extinction are related to physico-chemical and biologically-mediated changes at the Earth's surface. Laboratories cover major groups of invertebrate fossils, microfossils, their classification and living analogues.

Prerequisite: GLG216H1



**ENV234Y1 Environmental Biology**

See "Centre for Environment"

**GLG299Y1 Research Opportunity Program**

Credit course for supervised participation in faculty research project. See page 43 for details.

**ENV315H1 Chemical Analysis of Environmental Samples**

See "Centre for Environment"

**GLG318H1 Igneous and Metamorphic**

**26L, 39P Processes**

An overview of the nature and origin of igneous and metamorphic rocks, with particular emphasis on the interpretation of textures and mineral assemblages as they reflect conditions of rock formation. Laboratory exercises familiarise students with the most common igneous and metamorphic rock types, and provide practical examples of the theoretical principles discussed in

lectures. This course also has a mandatory weekend field trip (in conjunction with GLG206H1) to view igneous and metamorphic rocks and structures. The venue for the trip alternates yearly between Bancroft and the Montreal area.

Prerequisite: GLG202H1, GLG206H1, 207H1

**GLG319H1 Metamorphic Processes 26L, 39P**

Descriptive petrography and classification of metamorphic rocks; metamorphic processes and evolution of metamorphic rocks; interpretation of metamorphic rocks.

Prerequisite: GLG202H1, GLG318H1, 360H1

**GLG340H1 Field Course I: White Fish Falls Manitoulin Island**

A twelve-day field course in mid-May. Students are introduced to field geology and to basic field measurement, mapping and documentation techniques in the Espanola - Manitoulin Island area, west of Sudbury. Students are responsible for the cost of board and lodging and transport to and from the field area.

This is a summer session course and students must also register with the Department in the preceding term

Prerequisite: GLG207H1, 216H1, 217H1 or permission of instructor

**GLG345H1 Structural Geology 26L, 39P**

The development of geological structures at a variety of scales is examined using the concepts of stress, strain, material behaviour and tectonic setting. Laboratory work focuses on modern methods of structural analysis and their applications in geotechnical engineering and economic geology.

Prerequisite: GLG216H1 or MIN185H1

**GLG351H1 Geochemical and Biological Regulation of Aqueous Systems 39L, 26P**

An introduction to aqueous environmental geochemistry emphasising the importance of chemical equilibria, mass transport, and microbiological activity in regulating the chemical composition of natural and contaminated systems.

Prerequisite: CHM (138H1, 139H1)/151Y1; and any 2nd year science course. GLG202H1 is recommended

**GLG360H1 Sedimentary Geology 26L, 39P**

An introduction to the methods for studying sedimentary rocks in surface and subsurface. Petrographic description and classification of sedimentary rocks are dealt with in lectures and laboratory exercises, followed by a treatment of the principles of stratigraphic documentation and correlation, facies-analysis methods, and a brief description of depositional systems.

Prerequisite: GLG207H1, 216H1/MIN185H1



**GLG371H1/ Directed Studies  
372Y1**

An individual study program chosen by the student with the advice of, and under the supervision of, a staff member. Such work may involve obtaining data in the field or lab and analysing it, an interdisciplinary research project, and supervised readings

Prerequisite: enrolment in a Geology Major or Specialist Program of Study, completion of at least two full course equivalents of 200-series GLG courses.

**GLG398H0/Independent Experiential Study Project  
399Y0**

An instructor-supervised group project in an off-campus setting. See page 43 for details.

**GLG423H1 Mineralogy 39L**

Crystal chemistry of the major rock forming minerals. The course covers the underlying concepts behind the behaviour of minerals as solid-state materials including: Structure and bonding of minerals, chemical substitutions and solid-state transformations, high temperature and pressure behaviour, chemical weathering and kinetics.

Prerequisite: GLG206H1

**GLG430H1 Basin Analysis 39L, 13P**

Architecture and evolution of sedimentary basins in relation to plate-tectonic setting and crustal properties. Sequence stratigraphy: sequence models and sequence forcing mechanisms tectonism, eustasy, climate change. The global-cycle-chart controversy. World-wide review of basins in the context of plate tectonics.

Prerequisite: GLG360H1

**GLG436H1 Paleoecological Assessment of Environmental Change 26L, 39P**

The use of proxy data (terrestrial and aquatic microfossils) to infer past environmental conditions. The nature and extent of Quaternary environmental change is considered in the context of assessing current issues such as acidification, metal pollution, eutrophication and global climate change.

Paleoenvironmental techniques are applied in the laboratory.

Prerequisite: A 200-level course from one of BIO, GGR, GLG

Recommended preparation: BIO468H1/469Y1/GLG217H1

**JGP438H1 Shallow Crust Geophysics 26L, 52P**

An introduction to the geophysical exploration of the subsurface. Topics include gravity, seismic, magnetic, electrical and electromagnetic surveying and their application in prospecting, hydrogeology, and environmental assessments.

Exclusion: PHY496H1

Prerequisite: GLG345H1 or permission of instructor

**GLG440H1 Advanced Petrology 26L, 39P**

Integrated field, experimental and theoretical approaches to understanding the petrological diversity of igneous and metamorphic rocks. Topics include development of thermobarometers for igneous and metamorphic rocks, the importance of oxygen fugacity in petrogenesis, melting/solidification and metamorphism and igneous activity in the context of global tectonics.

Prerequisite: GLG318H1

**GLG441H1 Remote Sensing of Earth and the Terrestrial Planets 26L, 39P**

Remote sensing of Earth and Terrestrial planets; introduces theory and principles of optical and radar remote sensing. Applications to new planetary data, including those from Earth, Mars, and the Moon, are emphasized. Practical components of the course involve GIS applications for the synthesis and analysis of multiple datasets.

Prerequisite: at least two full course equivalents from any 200-series Science courses.

**GLG442H1 Mineral Deposits 26L, 39P**

Geology and geochemistry of magmatically related ore deposits, principally Ni, Cu, Pt group, Cr, including porphyry Cu deposits. Use of S, O and H isotopes and fluid inclusions in mineral deposit geology. Origin and interpretation; systematic ore mineralogy, in hand specimen and reflected light microscopy.

Prerequisite: GLG 318H1

**GLG443H1 Ore Genesis and Exploration 26L, 39P**  
**Geochemistry**

Genesis of ore deposits. The basic tools for studying ore genesis such as stable isotopes, fluid inclusions and sulfide mineralogy and their applications to selected types of ores.

Prerequisite: GLG 442H1

**GLG445H1 Field Course II: Benny Belt TBA**

Advanced geological mapping project in a challenging field environment. Students learn to compile existing geoscience data, create a geological map and prepare a professional final report on their activities and findings. Students are responsible for the costs of board, lodging and transportation. This is a summer session course and students must also register with the Department during the preceding term.

Prerequisite: GLG207H1, 340H1/MIN240F, GLG345H1 or permission of instructor

**GLG448H1 Field Course III: Chalk River TBA**

A two-week course in late summer designed to familiarize students in a variety of hydrogeological and biogeochemical field techniques; based at Atomic Energy Canada Laboratories, Chalk River,



and includes a mixture of lecture, laboratory and field exercises. Students are responsible for the cost of board and lodging and transport to and from the field area.

This is a summer session course and students must also register with the Department during the preceding term.

Prerequisite: GLG351H1 or permission of instructor

**GLG450H1 Contaminant Fate and Transport in Subsurface Environments 26L, 39P**

Drawing primarily on examples from hydrogeology, this course explores physical, chemical and isotopic constraints on contaminant source transport and attenuation

Prerequisite: GLG351H1 or permission of instructor

**GLG465H1 Geodynamics 26L, 39P**

Exploration of physical Earth processes and their relationship to large-scale geological phenomena. Mantle convection as plate tectonic engine; intraplate/plate boundary lithospheric deformation including orogenesis and crustal subsidence. Focus on reconciling geodynamic theory/modelling with geological/geophysical observations.

Prerequisite: GLG345H1 or permission of instructor

**GLG470Y1 Research Project TBA**

Laboratory research emphasizing methods and experimental techniques applicable to geology. Students must obtain the consent of an instructor and register with the Undergraduate Coordinator before enrolling and are urged to do so toward the end of their Third Year. Students are required to give an oral presentation of research results to an open meeting of the Department.

Exclusion: GLG471H1

Prerequisite: Completion of the required 300-level courses in a specialist program involving Geology and permission of the Department

**GLG471H1 Research Project TBA**

Laboratory research emphasizing methods and experimental techniques applicable to geology. Students must obtain the consent of an instructor and register with the Undergraduate Coordinator before enrolling and are urged to do so toward the end of their Third Year. Students are required to give an oral presentation of research results to an open meeting of the Department.

Exclusion: GLG470Y1

Prerequisite: Completion of the required 300-level courses in a specialist program involving Geology and permission of the Department