

EARTH SCIENCE (FORMERLY GEOLOGY)

Department Website: <https://www.smu.ca/geology/>

We are directly dependent on our planet for our survival and as we shift toward a greener future, our society requires Earth Scientists. For example, Earth Scientists are crucial for exploration and mining of critical mineral resources to support clean energy infrastructure (e.g., lithium batteries, rare earth elements for wind turbines, indium for solar voltaic panels) and food security (e.g., potash for fertilizers), to develop and practice sustainable solutions for carbon based energies, and for predicting and mitigating erosion of our coastlines and continental interior due to rising sea levels and more frequent and severe weather systems.

Earth Science is the study of Earth, its materials, the processes that affect its surface and interior, the history of change that it has undergone, as well as the interaction between Earth and the environment. Students enrolled in the Bachelor of Science degree program may choose to pursue a Concentration, Major, or Honours in Earth Science. For Majors and Honours in Earth Science, the Department offers three streams: Earth Science, Geology, and Environmental Geoscience.

The **general Earth Science stream** is for students wishing to engage in advanced studies in the geosciences, but whose career trajectory does not require Professional Geoscientist (P.Geo.) registration. This program is of interest for students who are considering career paths such as teaching, science communication, environmental law, resource-related business, working for development organizations, or emergency management.

The **Geology stream** is intended for those who wish to work as a designated P.Geo., including careers in mineral exploration and mining, petroleum geoscience, and/or government geoscience.

Those who pursue our **Environmental Geoscience stream** study the structure of Earth with a direct focus of understanding human interactions with the planet, particularly to predict or anticipate geologic and/or geomorphologic hazards and to provide information to help minimize impacts on the environment. This program will also have the necessary knowledge requirements to register for P.Geo. with career prospects including (but not limited to) mine site reclamation, environmental monitoring, environmental policy, and/or hydrogeology.

Many of our courses may be taken by students majoring in other science subjects as well as those in arts and business. A double major Earth Science/Geography or Earth Science/Environmental Science will emphasize environmental aspects of geology. The Earth Science/Business program emphasizes the economic aspects of the earth. In addition, a number of courses are offered for non-science students, emphasizing global aspects of geology, Earth history, and the interactions between Earth and human society.

Science students interested in Earth Science should take Understanding the Earth (GEOL 1200) and The Dynamic Earth (GEOL 1201). Those planning to pursue the double majors and honours programs should take these courses in their first year. These courses provide a broad survey of the discipline, with practical experience provided through labs and field trips.

Students wishing to enter the Earth Science program after taking other 1000-level Earth Science courses (Planet Earth: Atlantic Canada Perspective (GEOL 1202), Earth History: Atlantic Canada Perspective (GEOL 1203), Global Change (GEOL 1206), Environmental Geology: Atlantic Canada Perspective (GEOL 1208), and Atlantic Ocean: Formation, Fossils, Phenomena (GEOL 1211)), may substitute the course for The Dynamic Earth (GEOL 1201). Therefore, these students can enter the program in the 2nd year by either taking Understanding the Earth (GEOL 1200) concurrently with Mineralogy (GEOL 2301) in the fall semester, or Geology for Engineers (GEOL 1204) in the spring preceding the 2nd year of the program in lieu of Understanding the Earth (GEOL 1200). Likewise, engineering students who, after taking Geology for Engineers (GEOL 1204), wish to continue taking Earth Science courses, may substitute this course for Understanding the Earth (GEOL 1200).

In 2nd year, Mineralogy (GEOL 2301), Optical and Analytical Mineralogy (GEOL 2302), Sedimentation and Stratigraphy (GEOL 2325) and Applied Earth Science Techniques (GEOL 2326) will help establish or further round out student's appreciation and knowledge of how we study the Earth. These courses are also recommended for students in other programs.

Students in the Earth Science Major and Honours programs should seek the advice of the Department Chair as to their elective and supporting courses, and are encouraged to tailor their course selection for P.Geo. registration in one of the two streams available. Year 4 students are encouraged to participate in the research projects being carried out in the Department. Under special circumstances, some prerequisites for 3000 and 4000-level courses may be waived with the permission of the Department.

Programs

The Bachelor of Science (B.Sc.) is a well-established, foundational degree. Its specific requirements are listed below alongside general graduation requirements (<https://smu-ca-public.courseleaf.com/undergraduate/faculties/faculty-science/bachelor-science/>).

***Pending MPHEC Approval Major in Earth Science (general stream)

The requirements for the degree of Bachelor of Science with Major apply as listed in this Academic Calendar under the heading of Faculty of Science, Bachelor of Science – Major (<https://smu-ca-public.courseleaf.com/undergraduate/faculties/faculty-science/bachelor-science---major/>).

The specific list of fifty-four (54) required credit hours (eleven (11) courses) in the Major subject used to satisfy 6(d), as well as six (6) non-geology science courses to satisfy 6(e) is provided below:

| Code | Title | Credit Hours |
|---|-----------------------------------|--------------|
| Mandatory sixty (60) credit hours (twenty (20) courses) in the core program: | | |
| GEOL 1200 | Understanding the Earth | 3 |
| GEOL 1201 | The Dynamic Earth | 3 |
| GEOL 2301 | Mineralogy | 3 |
| GEOL 2302 | Optical and Analytical Mineralogy | 3 |
| GEOL 2325 | Sedimentation and Stratigraphy | 3 |
| GEOL 2373 | Geomorphology | 3 |

| | | |
|---|---|-----------|
| GEOL 2326 | Applied Earth Science Techniques | 3 |
| GEOL 3413 | Structural Geology | 3 |
| <i>At least an additional three (3) credit hours (one (1) course) from the following:</i> | | 3 |
| GEOL 2400 | Field Methods (formerly GEOL 3300) | |
| GEOL 3305 | Geomatics | |
| GEOL 3306 | Geophysics (formerly GEOL 2305) | |
| <i>At least an additional three (3) credit hours (one (1) course) from the following:</i> | | 3 |
| GEOL 3312 | Igneous Petrology | |
| GEOL 3313 | Metamorphic Petrology | |
| GEOL 3326 | Sedimentary Petrology | |
| <i>At least an additional three (3) credit hours (one (1) course), from the following list:</i> | | 3 |
| GEOL 3454 | Analytical and Environmental Geochemistry | |
| GEOL 4441 | Mineral Resources | |
| GEOL 4466 | Petroleum Geology | |
| <i>An additional twenty-one (21) credit hours (seven (7) courses) from any 2000-level or higher GEOL course</i> | | 21 |
| <i>An additional six (6) credit hours (two (2) courses) of non-geology science courses:</i> | | |
| ENVS 1250 | Energy in the Environment | 3 |
| ENVS 2200 | Energy, Resources, and Pollution | 3 |
| Total Credit Hours | | 60 |

The suggested sequence of courses for years 1 and 2 is available online on the Faculty of Science website listings for Program Requirement Tables (<https://www.smu.ca/faculty-of-science/science-program-requirement-tables.html>). Students should consult with a Science Advisor or the Department Chairperson for course selections and the suggested best sequence of courses for years 3 and 4.

Earth Science Major with Geology stream (P.Geo.)

The Geoscience Profession Act was proclaimed in Nova Scotia in March 2003. This Act requires that one be a member in good standing of The Association of Professional Geoscientists of Nova Scotia (or another provincial counterpart) in order to work in geoscience-related fields in this province. The requirements for professional registration are summarized by the Canadian Council of Professional Geoscientists (CCPG) at: geoscientistscanada.ca (<http://geoscientistscanada.ca>)

Earth Science Major students who wish to qualify for professional registration in Geology should complete the following program which combines elements of the Earth Science Major plus those which satisfy the Canadian Council of Professional Geoscientists (CCPG) knowledge requirements.

| Code | Title | Credit Hours |
|--|-----------------------------------|--------------|
| Mandatory forty-five (45) credit hours (fifteen (15) courses) of GEOL courses | | |
| GEOL 1200 | Understanding the Earth | 3 |
| GEOL 1201 | The Dynamic Earth | 3 |
| GEOL 2301 | Mineralogy | 3 |
| GEOL 2302 | Optical and Analytical Mineralogy | 3 |
| GEOL 2325 | Sedimentation and Stratigraphy | 3 |

| | | |
|---|---|-----------|
| GEOL 2326 | Applied Earth Science Techniques | 3 |
| GEOL 2400 | Field Methods (formerly GEOL 3300) | 3 |
| GEOL 3305 | Geomatics | 3 |
| GEOL 3306 | Geophysics (formerly GEOL 2305) | 3 |
| GEOL 3312 | Igneous Petrology | 3 |
| GEOL 3313 | Metamorphic Petrology | 3 |
| GEOL 3326 | Sedimentary Petrology | 3 |
| GEOL 3413 | Structural Geology | 3 |
| GEOL 3453 | Principles of Geochemistry | 3 |
| GEOL 4414 | Tectonics | 3 |
| <i>At least an additional three (3) credit hours (one (1) course) from the following:</i> | | 3 |
| GEOL 4441 | Mineral Resources | |
| GEOL 3454 | Analytical and Environmental Geochemistry | |
| GEOL 4466 | Petroleum Geology | |
| <i>An additional twelve (12) credit hours (four (4) courses) from any 2000-level or higher GEOL course.</i> | | 12 |
| Mandatory Science Foundation Requirements | | |
| MATH 1250 | Calculus for Life Sciences I | 3 |
| or MATH 1210 Introductory Calculus I | | |
| CHEM 1210 | General Chemistry I | 3 |
| PHYS 1210 | University Physics I | 3 |
| <i>Select an additional eighteen (18) credit hours (six (6) credits) of foundational science courses in the following subject areas: MATH, PHYS, CHEM, CSCI, BIOL; with no more than six (6) credit hours in any one subject area, and at least three (3) credit hours in MATH or CSCI.</i> | | 18 |
| Total Credit Hours | | 87 |

The suggested sequence of courses for years 1 and 2 is available online on the Faculty of Science website listings for Program Requirement Tables (<https://www.smu.ca/faculty-of-science/science-program-requirement-tables.html>). Students should consult with a Science Advisor or the Department Chairperson for course selections and the suggested best sequence of courses for years 3 and 4.

Earth Science Major with Environmental Geoscience stream (P.Geo.)

Earth Science Major students who wish to qualify for professional registration in Geology should complete the following program which combines elements of the Earth Science Major plus Environmental Science to satisfy the Canadian Council of Professional Geoscientists (CCPG) knowledge requirements.

| Code | Title | Credit Hours |
|---|------------------------------------|--------------|
| Mandatory forty-eight (48) credit hours (sixteen (16) courses) in GEOL courses | | |
| GEOL 1200 | Understanding the Earth | 3 |
| GEOL 1201 | The Dynamic Earth | 3 |
| GEOL 2301 | Mineralogy | 3 |
| GEOL 2302 | Optical and Analytical Mineralogy | 3 |
| GEOL 2325 | Sedimentation and Stratigraphy | 3 |
| GEOL 2326 | Applied Earth Science Techniques | 3 |
| GEOL 2400 | Field Methods (formerly GEOL 3300) | 3 |
| GEOL 3306 | Geophysics (formerly GEOL 2305) | 3 |

| | | |
|---|---|----|
| GEOL 3413 | Structural Geology | 3 |
| GEOL 3453 | Principles of Geochemistry | 3 |
| GEOL 3340 | Principles of Hydrogeology | 3 |
| <i>at least six (6) credit hours (two (2) courses) of the following:</i> | | 6 |
| GEOL 2373 | Geomorphology | |
| GEOL 3305 | Geomatics | |
| GEOL 4475 | Glaciers and Glaciation | |
| <i>Additional nine (9) credit hours (three (3) courses) from any 2000-level or higher GEOL course</i> | | 9 |
| Mandatory fifteen (15) credit hours (five (5) course) from Environmental Science: | | |
| ENVS 1250 | Energy in the Environment | 3 |
| ENVS 2400 | Applications in Environmental Science | 3 |
| <i>At least an additional nine (9) credit hours (three (3) courses) from the following:</i> | | 6 |
| ENVS 2100 | Green Chemistry | |
| ENVS 2200 | Energy, Resources, and Pollution | |
| ENVS 3410 | Environmental Impact Assessment | |
| ENVS 3450 | Aquatic Environments | |
| ENVS 3473 | Environmental Chemistry I | |
| ENVS 4431 | Environmental Information Management (formerly ENVS 3430) | |
| ENVS 4432 | Data Science in the Environment | |
| ENVS 4450 | Natural Resource Management | |
| ENVS 4470 | Environmental Remediation and Restoration | |
| ENVS 4480 | Environmental Contaminants | |
| ENVS 4490 | Climate Change: Evidence and Uncertainty | |
| ENVS 4460 | Environmental Pattern Analysis | |
| Mandatory Foundation Science Courses | | |
| MATH 1250 | Calculus for Life Sciences I | 3 |
| or MATH 1210 Introductory Calculus I | | |
| PHYS 1210 | University Physics I | 3 |
| CHEM 1210 | General Chemistry I | 3 |
| <i>Select an additional eighteen (18) credit hours (six (6) credits) of foundational science courses in the following subject areas: MATH, PHYS, CHEM, CSCI, BIOL; with no more than six (6) credit hours in any one subject area, and at least three (3) credit hours in MATH or CSCI.</i> | | 18 |

Total Credit Hours 87

Honours in Earth Science

The requirements for the degree of Bachelor of Science with honours apply as listed in this *Academic Calendar* under the heading of Faculty of Science, Bachelor of Science – Honours (<https://smu-ca-public.courseleaf.com/undergraduate/faculties/faculty-science/bachelor-science--honours-double-honours/>). The specific list of required credit hours used to satisfy 11(a) include:

- Mandatory core courses for the Major;
- Honours Project GEOL (GEOL 4550) (Students must secure a supervisor for the honours project before applying to the honours program);
- Research Methods in Geology (GEOL 4650)
- Sufficient GEOL courses for a minimum of sixty (60) credit hours, of which only six (6) credit hours may be at the 1000-level and towards

which Honours Project GEOL (GEOL 4550) and Research Methods in Geology (GEOL 4650) count as nine (9) credit hours.

Double Major in Earth Science

The requirements for the Bachelor of Science degree with Double Major are listed in **Section Three (3)** of this Academic Calendar. Students who wish to pursue a Double Major in Geology and another science subject are required to take Understanding the Earth (GEOL 1200), The Dynamic Earth (GEOL 1201) and at least an additional thirty (30) credit hours (ten (10) courses) in Geology from the 2000-level or higher.

Double Honours in Earth Science

The requirements for the Bachelor of Science degree with Double Honours are listed in **Section Three (3)** of this Academic Calendar. Students who wish to pursue a Double Honours in Geology and another science subject need to meet the requirements of the Double Major in Geology and another science subject. If the thesis subject is in Geology, students are additionally required to take the Honours Project GEOL (GEOL 4550) and Research Methods in Geology (GEOL 4650) courses.

Cooperative Education in Earth Science

This program, which is available at both the major and Honours level, integrates on-the-job experience and academic studies. Upon completion of one of the Cooperative Education programs, the student receives the Bachelor of Science degree in geology, at the major or Honours level, with the added qualification of “Cooperative Education”.

Further details and regulations on the Cooperative Education program (<https://smu-ca-public.courseleaf.com/undergraduate/faculties/faculty-science/cooperative-education-programs-major-honours/>) are found in the Faculty of Science listing in this Calendar.

Concentration in Earth Science

Students may choose to obtain a B.Sc. General with a Concentration in Geology (<https://smu-ca-public.courseleaf.com/undergraduate/faculties/faculty-science/bachelor-science--general-w-concentration/>). Students must complete thirty (30) credit hours in GEOL courses with no more than twelve (12) credit hours at the 1000-level and at least twelve (12) credit hours (four (4) courses) at the 3000-level or higher.

Minor in Earth Science

It is possible to combine a minor in Geology with a major in another discipline within or outside the Faculty of Science. To obtain a minor in Geology, students must complete thirty (30) credit hours in GEOL courses, according to 9(b) (<https://smu-ca-public.courseleaf.com/undergraduate/faculties/faculty-science/bachelor-science--major-minor/>) of this *Calendar*, including Understanding the Earth (GEOL 1200) and The Dynamic Earth (GEOL 1201), with no more than twelve (12) credit hours at the 1000-level.

Combined Programs

***Pending MPHEC Approval

Earth Science/Geography Combined Programs

Earth Science/Geography Combined Major Program

| Code | Title | Credit Hours |
|---|--|--------------|
| Students must complete 36 credit hours in GEOL: ¹ | | |
| GEOL 1200 | Understanding the Earth | 3 |
| GEOL 1201 | The Dynamic Earth | 3 |
| GEOL 2326 | Applied Earth Science Techniques | 3 |
| Select 27 other credit hours in GEOL at the 2000, 3000, or 4000 level | | 27 |
| Students must complete 36 credit hours in GEOG: ² | | |
| GEOG 1100 | Global Perspectives on Land and Life (Group D) | 3 |
| GEOG 1200 | People, Place and Environment (Group D) | 3 |
| GEOG 2306 | Geospatial Concepts (Group C) | 3 |
| GEOG 2313 | Geomorphology (Group B) | 3 |
| GEOG 2386 | Introduction to Mapping and Geographic Information Systems (GIS) (Group C) | 3 |
| Select 12 credit hours from the following: | | 12 |
| GEOG 2315 | The Oceans (Group D) | |
| GEOG 2333 | Biogeography (Group B) | |
| GEOG 2343 | Weather and Climate (Group B) | |
| GEOG 3213 | Applied Geomorphology (Group B) | |
| GEOG 3433 | River Dynamics, Landforms, and Landscapes (Group B) | |
| GEOG 4413 | Coastal Geomorphology (Group B) | |
| GEOG 4423 | Glaciers and Glaciation (Group B) | |
| GEOG 4443 | Natural Hazards and Climate Change (Group B) | |
| Select nine other credit hours in GEOG Group B or Group C | | 9 |
| Total Credit Hours | | 72 |

¹

At least nine credit hours in GEOL must be at the 3000 or 4000 level.

²

At least nine credit hours in GEOG must be at the 3000 or 4000 level.

Earth Science/Geography Combined Honours Program

In addition to the requirements listed for the Earth Science/Geography Combined Major Program (72 credit hours), Honours students must complete 18 additional credit hours, for a **total of 90 credit hours**.

Honours students complete a thesis in either Earth Science or Geography.

Select either the requirements for the GEOL thesis option or the requirements for the GEOG thesis option.

| Code | Title | Credit Hours |
|--|-----------------------------|--------------|
| GEOL thesis option | | |
| GEOL 4550 | Honours Project GEOL | 6 |
| GEOL 4650 | Research Methods in Geology | 3 |
| Select three credit hours in GEOL at the 2000, 3000, or 4000 level | | 3 |

| | | |
|---------------------------|--|-----------|
| GEOG 3326 | Statistical Methods in Geography (Group C) | 3 |
| GEOG 4406 | Capstone Seminar in Geography (Group D) | 3 |
| Total Credit Hours | | 18 |

| Code | Title | Credit Hours |
|--|--|--------------|
| GEOG thesis option | | |
| GEOG 4526 | Honours Thesis (Group D) | 6 |
| Select six credit hours in GEOL at the 2000, 3000, or 4000 level | | 6 |
| GEOG 3326 | Statistical Methods in Geography (Group C) | 3 |
| GEOG 4406 | Capstone Seminar in Geography (Group D) | 3 |
| Total Credit Hours | | 18 |

Note: In the Earth Science/Geography Combined Honours Program, topics for Honours thesis projects may be carried out in either Department but should be approved by both Departments.

Earth Science/Business Studies Combined Programs

The Department of Earth Science and the Faculty of Commerce offer a double major/Honours science degree combining a major/Honours program in Earth Science with a major program of business studies in the Faculty of Commerce.

This program offers Bachelor of Science major and Bachelor of Science Honours degrees, under the general requirements of the Faculty of Science. For a combined major degree, students will be required to take a minimum of forty-two (42) credit hours in the Faculty of Commerce in addition to at least thirty-six (36) credit hours in Earth Science. In the Honours program, a thesis on a field interrelating the two disciplines will be required. Students enrolled in the combined Earth Science/business studies major/Honours may also pursue a co-op option in this dual program. The program appeals to Earth Science students with an interest in the business-related aspects of their major. The Earth Science/business studies major program requires a minimum grade point average (GPA) of 2.20 in all Earth Science and commerce courses while the Earth Science/business studies Honours program requires (a) a minimum grade of C in all Earth Science and commerce courses; and (b) a minimum GPA of 3.00 in these same courses.

The following courses are required for the Earth Science/Business Studies Major (B.Sc.):

Commerce Faculty Requirements

| Code | Title | Credit Hours |
|-----------|---|--------------|
| ACCT 2241 | Introductory Financial Accounting | 3 |
| ACCT 2242 | Introductory Managerial Accounting | 3 |
| ACCT 3332 | Planning and Control | 3 |
| CMLW 2201 | Legal Aspects of Business - Part I | 3 |
| COMM 2293 | Business Communication Essentials | 3 |
| ECON 1201 | Principles of Economics: Micro | 3 |
| ECON 1202 | Principles of Economics: Macro | 3 |
| FINA 2360 | Business Finance I | 3 |
| FINA 3361 | Business Finance II | 3 |
| MGMT 1281 | Introduction to Business Management | 3 |
| MGMT 2383 | Micro Organizational Behavior | 3 |
| | or MGMT 2382 Introduction to Organizational Behaviour | |
| MGMT 2384 | Macro Organizational Behavior | 3 |

| | | |
|--|---------------------------|-----------|
| or MGMT 2385 Introduction to Human Resource Management | | |
| MGMT 4489 | Strategic Management | 3 |
| MKTG 2270 | Introduction to Marketing | 3 |
| Total Credit Hours | | 42 |

Earth Science Requirements

Students must complete 36 credit hours in GEOL:

| Code | Title | Credit Hours |
|---|----------------------------------|--------------|
| GEOL 1200 | Understanding the Earth | 3 |
| GEOL 1201 | The Dynamic Earth | 3 |
| GEOL 2326 | Applied Earth Science Techniques | 3 |
| Select 27 other credit hours in GEOL at the 2000, 3000, or 4000 level | | 27 |

Note: At least nine credit hours in GEOL must be at the 3000 or 4000 level.

Other Requirements

| Code | Title | Credit Hours |
|---|----------------------------|--------------|
| ENGL 1205 | Introduction to Literature | 3 |
| Select three credit hours in humanities | | 3 |
| MATH requirement ¹ | | |
| Select 12 credit hours in science ² | | 12 |
| Select three credit hours in statistics ³ | | 3 |
| Select six credit hours from Faculty of Arts ⁴ | | 6 |
| Select nine credit hours in electives from any Faculty | | 9 |

1

See Faculty of Science regulations, Section 3 of this *Academic Calendar*.

2

Other than Geology, e.g., Biology, Psychology, Chemistry, Physics, and Mathematics excluding Biostatistics (BIOL 3308).

3

That covers probability theory including Introductory Statistics (MGSC 2207), Statistical Methods in Geography (Group C) (GEOG 3326), Biostatistics (BIOL 3308) and Intermediate Economic Statistics (ECON 3303).

4

Offering including Statistical Methods in Geography (Group C) (GEOG 3326) and Intermediate Economic Statistics (ECON 3303).

Notes:

1. Students must take Business Finance I (FINA 2360), Introduction to Marketing (MKTG 2270) and Macro Organizational Behavior (MGMT 2384) before registering for Strategic Management (MGMT 4489). The other prerequisites for this course are waived for students in this combined program.
2. Students must register no later than the beginning of Year 2 in the science program and will be under the general requirements of the Faculty of Science.

In addition to the above requirements, Earth Science/Business Studies Honours students must complete Honours Project GEOL (GEOL 4550) as one of the Earth Science requirements.

Combined Cooperative Education in Earth Science/Geography

The students enrolled in the combined Earth Science/geography major/Honours may also pursue a Co-op option in this dual program. Application to and completion of this combined option is the same as those for other Science Co-op major programs.

Further details and regulations on the Cooperative Education program (<https://smu-ca-public.courseleaf.com/undergraduate/faculties/faculty-science/cooperative-education-programs-major-honours/>) are found in the Faculty of Science listing of this Calendar.

Combined Cooperative Education Program in General Business Studies/Earth Science

The students enrolled in the combined Earth Science/business studies major/Honours programs may pursue a Co-op option in these dual programs. Applications to and completion of this combined option is the same as those for other Science Co-op major/Honours programs.