Geology (GEOL)

Chairperson,	
Associate Professor	P. Jutras
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Assistant Professors	J. Hanley, A. MacRae
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We are directly dependent on the Earth for our survival. Geology is the study of the Earth, its materials, the processes that affect its surface and interior, and the history of change that it has undergone. For students enrolled in the degree of Bachelor of Science with a concentration, major, or Honours in geology, the department offers a full program of courses. Many of these courses may also be taken by students majoring in other science subjects. A combined geology/geography program emphasizes environmental aspects of geology and a program combining geology and business studies emphasize 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 the Earth and human society.

Science students interested in geology, including those who - are entering the double majors and Honours programs in geology, should take GEOL 1214 and GEOL 1215. This course provides a broad survey of the discipline, with practical experience provided through labs and field trips. Courses in mineralogy (GEOL 2301, GEOL 2302) and the history of life and sedimentary environments [GEOL 2323 and GEOL 2325] are also recommended as supporting science subjects for students majoring in other sciences.

GEOL 1202, 1203, 1206, 1207, 1208 and GEOL 1210 are designed chiefly for students in Commerce and Arts, including Atlantic Canada Studies. Of these, only GEOL 1206, 1207 and 1208 can be used as Science credits. In exceptional cases where a student has taken GEOL 1202 and GEOL 1203 (previously GEOL 204.0) with high standing, those courses may, with the permission of the Department, be accepted in the geology major or Honours program in lieu of GEOL 1214 and GEOL 1215.

Students in the major and Honours programs should seek the advice of the Department as to their elective and supporting courses. 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.

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. Consequently, when choosing Science electives to fulfill Faculty of Science regulation 6(e), Geology major and honours students should consult Association of Professional Geologists of Nova Scotia (APGNS) requirements, which are revised every five years by the Canadian Council of Professional Geoscientists (CCPG). For the 2008-2012 period, the CCPG requirements for professional geologists are:

Three credit hours (one course) in each of the following fields:
Chemistry
Mathematics
Physics

An additional 18 credit hours (six courses) distributed in the following fields (no more than two per induvidual field):
Biology
Chemistry
Mathematics
Computer Programming
Physics
Statistics

Three credit hours (one course) in each of the following geoscience topics:
Field Methods
Mineralogy
Sedimentology
Structural Geology

An additional 15 credit hours (five courses) distributed in the following geoscience topics (a minimum of one per sub-group):

Principles of Geochemistry
Applied Geochemistry
Geophysics

Igneous Petrology
Metamorphic Petrology
Sedimentary Petrology

Advanced Sedimentology
Glacial Geomorphology
Remote Sensing

An additional 28 credit hours (9 courses) must be taken in courses at the second-year level or higher in geosciences (Geology, Physical Geography or Environmental Studies). Also eligible are additional courses from the previously mentioned lists, or courses in Technical Writing or computer Programming. For more information, please consult the following website:

http://ccpg.ca/guidelines/recommended_minimum_requirements.html

1. Geology Major

The courses of the core program for a student majoring in geology are:

GEOL 1214	Understanding the Earth
GEOL 1215	The Dynamic Earth
GEOL 2301	Mineralogy
GEOL 2302	Optical Mineralogy
GEOL 2305	Geophysics
GEOL 2325	Sedimentology
GEOL 3312	Igneous Petrology
GEOL 3313	Metamorphic Petrology
GEOL 3326	Sedimentary Petrology and Stratigraphy
GEOL 3413	Structural Geology
GEOL 3453	Principles of Geochemistry

At least six credit hours, (two courses) from the following list:

GEOL 3323	Palaeontology: History of Life
GEOL 3300	Field Methods
GEOL 3454	Applied Geochemistry
GEOL 4441	Mineral Resources
GEOL 4466	Petroleum Geology

At least three additional credit hours (one course) from the previous list or from the following:

GEOL 3340	Surface and Groundwater Hydrology
GEOL 4414	Tectonics
GEOL 4423	Advanced Paleontology
GEOL 4450	Advanced Igneous and Metamorphic Petrology
GEOL 4465	Advanced Sedimentology

It is strongly recommended that all geology major and Honours students take GEOL 3300 Field Methods, which is required by the CGSB and the APGNS (see above).

The following first and second year course selections are recommended for students in the major and Honours programs in geology:

Year 1

1. GEOL 1214 and GEOL 1215
2. MATH requirement (see Faculty of Science regulations, Section 3 of this *Academic Calendar*)
3. non-geology science elective [six (6) credit hours]
4. ENGL 1205 and three (3) credit hours in humanities
5. Arts elective [six (6) credit hours]

Year 2

1. GEOL 2301 and 2302 [six (6) credit hours]
2. GEOL 2325 [three (3) credit hours]
3. GEOL 2305 [three (3) credit hours]
4. 3000 or 4000 level geology course with lab [six (6) credit hours]
5. non-geology science elective [six (6) credit hours]
6. Arts elective [six (6) credit hours]

For subsequent years, students should consult the Departmental Chairperson.

2. Geology Honours

The Honours program requires GEOL 4550 in addition to the core courses for majors, supplemented by sufficient geology courses for a minimum of sixty (60) credit hours.

3. Double Major and Honours

Students may pursue a double major in geology and another science subject, as outlined in Section 3 of this *Calendar*.

Students taking a double major are required to take at least thirty-six (36) credit hours in geology from the following list:

GEOL 1214	Understanding the Earth
GEOL 1215	The Dynamic Earth
GEOL 2301	Mineralogy
GEOL 2302	Optical Mineralogy
GEOL 2305	Geophysics
GEOL 2325	*Sedimentology or GEOL 3373
GEOL 3300	Field Methods
GEOL 3312	Igneous Petrology
GEOL 3313	Metamorphic Petrology
GEOL 3323	Palaeontology: History of Life
GEOL 3326	Sedimentary Petrology and Stratigraphy
GEOL 3340	Surface and Groundwater Hydrology
GEOL 3413	Structural Geology
GEOL 3453	Principles of Geochemistry
GEOL 3454	Applied Geochemistry
GEOL 4414	Tectonics
GEOL 4423	Advanced Paleontology
GEOL 4441	Mineral Resources
GEOL 4450	Advanced Igneous and Metamorphic Petrology
GEOL 4465	Advanced Sedimentology
GEOL 4466	Petroleum Geology
GEOL 4475	Glacial Geomorphology

***Note:** GEOL 2325 [cross-listed as GEOG 2325] or GEOL 3373 [cross-listed as GEOG 3313] cannot both be taken for credit.

4. Geology/Geography Combined Programs

a. Geology/Geography Major Program (Bachelor of Science)

i. At least thirty-six (36) credit hours from the list of geology courses under 'Double Major and Honours', above.

ii. At least thirty-six (36) geography credit hours including:

GEOG 1200	People, Place and Environment
GEOG 1100	Global Perspectives on Land and Life
GEOG 2100	Fundamentals of Physical Geography
GEOG 2325	*Sedimentology
GEOG 2316	Map and Air Photo Interpretation
GEOG 2336	Principles of Cartography
GEOG 3313	*Geomorphology

iii At least twelve (12) credit hours from:

GEOG 2305	The Oceans: A Physical Geography
GEOG 2333	Biogeography
GEOG 3343	Weather and Climate

GEOG 4413	Coastal Geomorphology
GEOG 4423	Glacial Geomorphology
GEOG 4433	Fluvial Geomorphology
GEOG 4443	Natural Hazards

Six (6) additional credit hours in geography from Group B or C courses.

b. Geology/Geography Honours Program (Bachelor of Science: Honours)

In addition to the above requirements, Honours students must complete:

i. GEOL 4550 Honours Project or GEOG 4526 Honours Research Project;
ii. six (6) additional credit hours in geology from the list of geology courses under "Double Major and Honours" above; and
iii. GEOG 4406 Seminar in Theoretical Geography and GEOG 4416 Seminar in Applied Geography.

In the Honours Bachelor of Science geology/geography program, topics for Honours projects should be approved by both Departments and may be carried out in either Department.

5. Geology/Business Studies Combined Programs

The Department of Geology and the Faculty of Commerce offer a double major/Honours science degree combining a major/Honours program in geology 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 geology. In the Honours program, a thesis on a field interrelating the two disciplines will be required. Students enrolled in the combined geology/business studies major/Honours may also pursue a co-op option in this dual program. The program appeals to geology students with an interest in the business-related aspects of their major. The geology/business studies major program requires a minimum grade of C in all geology and commerce courses while the geology/business studies Honours program requires (a) a minimum grade of C in all geology and commerce courses; and (b) a minimum quality point average of 3.00 in these same courses.

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

a. Commerce Faculty Requirements [total of forty-two (42) credit hours)]

ACCT 2241	Introductory Accounting I
ACCT 2242	Introductory Accounting II
ACCT 3332	Planning and Control
CMLW 2201	Legal Aspects of Business - Part I
COMM 2293	Managerial Communications
ECON 1201	Principles of Economics: Micro
ECON 1202	Principles of Economics: Macro
FINA 2360	Business Finance I
FINA 3361	Business Finance II
MGMT 1281	Introduction to Business Management
MGMT 3383	Organizational Behaviour I
MGMT 3384	Organizational Behaviour II
MGMT 4489	Strategic Management
MKTG 2270	Introduction to Marketing

b. Geology Requirements [at least thirty-six (36) credit hours]

GEOL 1214	Understanding the Earth
GEOL 1215	The Dynamic Earth
GEOL 1208	Environmental Geology
GEOL 2301	Mineralogy
GEOL 2302	Optical Mineralogy
GEOL 2305	Geophysics
GEOL 2325	Sedimentology
GEOL 3300	Field Methods
GEOL 3312	Igneous Petrology
GEOL 3313	Metamorphic Petrology
GEOL 3323	Palaeontology: History of Life
GEOL 3340	Surface and Groundwater Hydrology
GEOL 3373	Geomorphology
GEOL 3413	Structural Geology
GEOL 3453	Principles of Geochemistry
GEOL 3454	Applied Geochemistry
GEOL 4414	Tectonics
GEOL 4423	Advanced Paleontology
GEOL 4441	Mineral Resources
GEOL 4450	Advanced Igneous and Metamorphic Petrology
GEOL 4465	Advanced Sedimentology
GEOL 4466	Petroleum Geology
GEOL 4475	Glacial Geomorphology

c. Other Requirements

i. ENGL 1205 and three (3) credit hours in humanities.
ii. MATH requirement (see Faculty of Science regulations, Section 3 of this *Academic Calendar*).
iii. twelve (12) credit hours in science other than Geology, e.g., Biology, Psychology, Chemistry, Physics, and Mathematics excluding MATH 1207, and BIOL 2308.
iv. three (3) credit hours in statistics that covers probability theory including MATH 1207, MGSC 2207, GEOG 3326, BIOL 2308 and ECON 3303.
v. six (6) credit hours from Faculty of Arts' offering including GEOG 3326 and ECON 3303.
vi. nine (9) credit hours in electives from any faculty.

Notes:

(i) Students must take FINA 2361, MKTG 2270 and MGMT 3384 before registering for MGMT 4489. The other prerequisites for this course are waived for students in this combined program.
(ii) 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, Geology/Business Studies Honours students must complete GEOL 4550 Honours Project as one of the Geology requirements.

6. Cooperative Education Programs

a. Co-operative Education in Geology
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 Co-operative Education programs, the student receives the Bachelor of Science degree in geology, at the major or Honours level, with the added qualification of "Co-operative Education".

Further details and regulations on the Faculty of Science Co-operative Education program are found in *the Graduate Academic Calendar*.

b. Combined Co-operative Education in Geology/Geography
The students enrolled in the combined geology/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 Faculty of Science Co-operative Education program are found in in *the Graduate Academic Calendar*.

c. Combined Co-operative Education Program in General Business Studies/Geology
The students enrolled in the combined geology/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.

7. Minor in Geology

It is possible to combine a minor in Geology with a major in another discipline within or outside the Faculty of Science. A minor in Geology requires thirty (30) credit hours, including GEOL 1214 and GEOL 1215; no more than twelve (12) credit hours below the 2000-level can be counted toward the
minor in Geology.

Course Descriptions

1202 Planet Earth: Atlantic Canada Perspective
3 credit hours
Why is the Atlantic Ocean getting wider? Where in Atlantic Canada are there remnants of huge volcanic explosions and lava flows? How did a fault as big as the San Andreas cut through Nova Scotia? This course will provide an understanding of the Earth and the processes which affect it, using examples drawn from the geology of our region. You will study plate tectonics, learn to recognize and interpret Earth materials, and understand their impact on Atlantic Canada. Sections of this course may be offered via world-wide web. This course is intended mainly for non-science students including those in Atlantic Canada Studies.

Note: Please note that this course may not be used by B. Sc. Students to satisfy the requirement of a science elective under regulations 3.e., 6.e., 10.c., and 12.b. for B.Sc. degrees. This course may not be taken concurrently or subsequently to GEOL 1214 or 1215.

1203 Earth History: Atlantic Canada Perspective
3 credit hours
What was the origin of the Earth and when did life develop? When did dinosaurs and other fossil groups appear in our region, and how did they disappear? How have ancient deserts, rivers, oceans, and ice ages influenced our landscape? You will trace four billion years of Earth history using examples from the rock and fossil record of Atlantic Canada. Sections of this course may be offered via world-wide web. This course is intended mainly for non-science students including those in Atlantic Canada Studies.

Note: Please note that this course may not be used by B. Sc. Students to satisfy the requirement of a science elective under regulations 3.e., 6.e., 10.c., and 12.b. for B.Sc. degrees. This course may not be taken concurrently or subsequently to GEOL 1214 or 1215.

1206 Global Change
3 credit hours
This course examines global changes in the Earth's crust, oceans, biota and atmosphere caused by natural processes and human activity. Topics covered include the reconstruction of ancient environments, some of which were dramatically changed by meteorite impacts, volcanic activity and glaciation, and the evaluation of accelerating environmental change caused by phenomena such as ozone depletion and greenhouse gas emissions.

1207 Environment, Radiation and Society
3 credit hours
Radioactivity has an impact on our society and environment. Radiation given off during the process of radioactive decay is harmful, but is accompanied by the release of energy that can be harvested. The course reviews radioactive decay and explores geological sources of radiation, uranium deposits and mining, economics of nuclear power and the geological aspects of radioactive waste disposal. The course will foster an understanding of issues that surround the use of nuclear technology in our society.

1208 Environmental Geology: Atlantic Canada Perspective
3 credit hours
This course examines geological principles that lie behind environmental problems facing society. Topics considered may include geological hazards such as volcanoes, earthquakes, slope instability, and pollution and waste disposal, as well as energy and mineral resources, and the quality of water. The course will include examples of environmental geology in the Atlantic Provinces.

1210 Dinosaurs and Their World
3 credit hours
This course focuses on dinosaurs and the world in which they flourished for 135 million years, up to the time of their (near) extinction. Spectacular and sometimes controversial evidence indicates how dinosaurs and other creatures lived, died, and were preserved as fossils over geological time. Nova Scotian dinosaur localities will receive special attention in the class.

Note: Please note that this course may not be used by B. Sc. Students to satisfy the requirement of a science elective under regulations 3.e., 6.e., 10.c., and 12.b. for B.Sc. degrees.

1214 Introduction to Geology: Understanding the Earth
3 credit hours
Everything that is known about the history of the solid Earth has been determined from studying rocks and minerals. This course introduces the student to major types of rocks and minerals, how they are described, classified and interpreted, and how their age can be determined. Gemstones, fossils and other Earth materials will also be described.

Classes 3 hrs. and lab 3 hrs. a week.

1215 Introduction to Geology: The Dynamic Earth
3 credit hours
The study of the Earth as a dynamic and evolving planet. that has been in constant transformation since the beginning of its formation. This course introduces the students to both surface and subsurface processes which will be described using many geological examples from Atlantic Canada.

Classes 3 hrs. and lab 3 hrs. a week.

2301 Mineralogy
3 credit hours
An introduction to a systematic study of the major mineral groups,
including their crystal structure, chemical composition, physical properties, identification and practical use.

Classes 3 hrs. and lab 3 hrs. a week.

2302 Optical Mineralogy
3 credit hours
Prerequisite: GEOL 2301 or permission of Department.

Optical properties of minerals. Determinative mineralogy with emphasis on the optical methods of mineral identification. Petrography of the more common rocks.
Classes 3 hrs. and lab 3 hrs. a week.

2305 Geophysics
3 credit hours
Prerequisite: GEOL 1214 and 1215

The physics of the Earth, including rotation, gravity, seismology and internal structure, magnetic and electrical properties, radioactivity, and the Earth's heat. Geophysical exploration of the Earth's crust, including seismic refraction, seismic reflection, magnetic, gravity and electrical methods.

Classes 3 hrs. and lab 3 hrs. a week.

2325 Sedimentology [GEOG 2325]
3 credit hours
Weathering and the origin of sedimentary materials. Introduction to sediments and sedimentary rocks. Processes of sedimentation and the origin of sedimentary structures. Interpretation of clastic and carbonate sedimentary rocks in the light of comparison with modern environments in non-marine, marginal marine and marine settings.

Classes 3 hrs. and lab 3 hrs. a week.

2332 Introductory Analytical Chemistry: Wet Methods [CHEM 2332]
3 credit hours

2333 Introductory Analytical Chemistry: Instrumental Methods [CHEM 2333]
3 credit hours

3300 Field Methods
3 credit hours
Prerequisites: GEOL 1214, 1215, 2325, and attendance at Field Camp, held prior to the semester, or permission of instructor.

This course introduces the student to basic field techniques used by geologists. Field observations and measurements collected during a one week field camp and during the course are summarized by the student as a series of reports.

Classes 3 hrs. a week plus field work.

3312 Igneous Petrology
3 credit hours
Prerequisite: GEOL 2302.

This course emphasises the mineralogical and chemical characteristics of igneous rocks, and their classification, petrography, and tectonic setting. The processes responsible for the evolution of diverse igneous rock associations are also considered. Laboratory work involves the study of igneous rocks in hand sample and thin section.

Classes 3 hrs. and lab 3 hrs. a week.

3313 Metamorphic Petrology
3 credit hours
Prerequisite: GEOL 2302.

This course introduces aspects of the description and interpretation of metamorphic rocks by citing the effects of the progressive metamorphism of mafic, pelitic and carbonate rocks. Other topics include the use of composition-assemblage diagrams, methods of quantitative geothermobarometry, and the interpretation of pressure-temperature-time trajectories for metamorphic rocks. Laboratory work involves the study of metamorphic rocks in hand sample and thin section.

Classes 3 hrs. and lab 3 hrs. a week.

3323 Palaeontology: History of Life
3 credit hours
Prerequisite: one of GEOL 1214 , GEOL 1215, GEOL 1202, GEOL 1208, BIOL 1201, BIOL1202, or GEOG 2213.

An account of the 3800 million-year history of life on Earth, including theories of the origin of life, and modes of preservation of organisms as fossils, and the practical use of fossils for geological age, paleogeographic, and

paleoenvironment determinations. The course covers the expression of biological evolution in the fossil record, and the major patterns and crises in the history of life, such as mass extinctions. Although the main focus is on the paleontology of invertebrate macrofossils, there will be some coverage of fossil plants, vertebrates, and microfossils.

Classes 3 hrs. and lab 3 hrs. a week.

3326 Sedimentary Petrology and Stratigraphy
3 credit hours
Prerequisite: GEOL 2302 and 2325 (which may be taken concurrently).

Composition, provenance, and diagenesis of clastic sedimentary rocks, including conglomerates, sandstones and shales. Components and diagenesis of the main classes of non-clastic sedimentary rocks including carbonates, evaporites, siliceous and iron-rich sediments. Stratigraphy: correlation and the definition of stratigraphic units in outcrop and in the subsurface. Unconformities, sequences, sea-level change, and the interpretation of the stratigraphic record.

Classes 3 hrs. and lab 3 hrs. a week.

3340 Surface and Groundwater Hydrology
3 credit hours
Prerequisite: one of GEOL 1214, GEOL 1215, GEOL 1202, GEOL 1208; or GEOG 2213.

The course examines the fundamentals of hydrology, including the precipitation, infiltration and storage of water. It emphasizes practical approaches to the examination of water supply, the movement of groundwater through various geological materials, groundwater exploration, contaminant modelling and water resource management.

Classes 3 hrs. and lab 3 hrs. a week.

3373 Geomorphology [GEOG 3313]
3 credit hours
Prerequisite: one of GEOL 1214, GEOL 1215 or GEOG 2213.

The study of geomorphological processes and related landforms, with an emphasis on fluvial activity. Processes of weathering, soil formation, slope development and river action will be discussed. Laboratory work will include methods of field and data interpretation, soil analysis, sediment analysis and geomorphological mapping.

Classes 2 hrs. and lab 2 hrs. a week. Some field work may be required.

3413 Structural Geology
3 credit hours
Prerequisite: GEOL 1214 and 1215

Structures produced by deformation in the Earth's crust, including fabrics, folds, faults, and shear zones. Geometric, kinematic, and dynamic analysis of structures. Use of geometric and stereographic projection techniques in the interpretation of geological structures and geological maps. Introduction to stress and strain. Structures characteristic of selected tectonic environments, including rifts, thrust belts, and zones of strike-slip movement.

Classes 3 hrs. and lab 3 hrs. a week.

3453 Principles of Geochemistry
3 credit hours
Prerequisite: GEOL 1214 and 1215.

This course exposes students to the application of chemical thermodynamics for the prediction of geochemical processes in surficial and hydrothermal systems, igneous environments of the Earth and of the rest of the Solar system. Mineral formation and mineral stability are examined through the construction and use of phase and mineral stability diagrams for aqueous environments. The geochemical basis for the origins of life on Earth, the carbon cycle, stable and radiogenic isotopes, and the evolution of the most important reservioirs of Earth materials are evaluated through problem sets and laboratories.

Classes 3 hrs. and lab 3 hrs. a week.

Note: To fulfill the CCPG requirements for professional geologists, this course may be used as either a geosciences course or as a second chemistry course.

3454 Applied Geochemistry
3 credit hours
Prerequisite: GEOL 1214 and GEOL 1215

The application of graphical and numerical tools for classifying Earth materials according to their chemical composition is studied through field-based and computer-based laboratories. This course examines geochemical sampling, instrumental analysis, statistical evaluation of real geochemical data, and the methods of proper reporting and quality control. The students are introduced to novel methods (fluid inclusion microanalysis, alteration mapping in ore deposits, reaction path modeling) and their application in characterizing geochemical processes on Earth.

Classes 3 hrs. and lab 3 hrs. a week.

Note: To fulfill the CCPG requirements for professional geologists, this course may be used as either a geosciences course or as a second chemistry course.

4400 International Field Camp
3 credit hours
Prerequisite: GEOL 3300, and permission of the Department.

This course is offered on an irregular basis in the form of a Geology field trip abroad, allowing the students to be exposed to geological features that cannot be found in Canada. In practical terms, this course will acquaint the student with modern methods of structural, stratigraphic, petrologic and/or geophysical analysis. After mastering these skills, students will undertake an independent geological report project. Students may be required to travel at their own expense.

4414 Tectonics
3 credit hours
Prerequisite: GEOL 1214, GEOL1215, GEOL 3312, and GEOL 3413 (the latter two can be taken concurrently).

This course describes the major features of the Earth and its place in the solar system. It introduces the evidence for plate tectonics, the analysis of plate movements, and the characteristic rock associations formed in different tectonic environments. Aspects of global change will be considered, including the evolution of tectonic processes through geologic time, changes in the atmosphere and oceans, and the importance of meteorite impacts.

Classes 3 hrs. and lab 3 hrs. a week.

4423 Advanced Palaeontology
3 credit hours
Prerequisite: GEOL 3323

This course focuses on more specialized areas of palaeontology and their application to geological questions. One portion of the course deals with paleobotany (fossil plants) and microfossils (palynology, conodonts, foraminifera). The remainder focuses on applications of palaeontology. Among the topics to be covered are biostratigraphic techniques in subsurface wells and outcrop, integration with radiometric and sequence stratigraphic techniques, fossil sampling and preparation, practical nomenclature and taxonomy, and the use of fossils for paleoenvironmental determination.

Classes 3 hrs. and lab 3 hrs. a week.

4441 Mineral Resources
3 credit hours
Prerequisite: GEOL 1214, 1215 and 2301

A study of Earth's mineral resources, their classification, genesis and distribution in time and space. Important examples from Canada and abroad will be discussed. Topics will also include mineral exploration techniques, mining methods, metallurgical recovery, net smelter return, and ore reserve estimation/classification. Laboratories will examine a variety of base and precious metal ore deposit types in hand sample and thin section. Mining/exploration practice and resource exploitation are also examined in terms of their environmental impacts.

Classes 3 hrs. and lab 3 hrs. a week.

4450 Advanced Igneous and Metamorphic Petrology
3 credit hours
Prerequisite: GEOL 3312 and 3313.

The topics covered in this course include magmatic petrogenesis; magma types; petrographic provinces and their relations to their tectonic setting; differentiation indices; variation diagrams; distribution trends of major and trace elements; equilibrium and fractional crystallization in selected synthetic systems; phase equilibria in metamorphic systems; reaction balancing methods; porphyroblast-matrix relations; quantification of pressure-temperature-time trajectories. Laboratory work is centered on the acquisition and manipulation of microprobe data.

Classes 3 hrs. and lab 3 hrs. a week.

4465 Advanced Sedimentology [GEOG 4465]
3 credit hours
Prerequisite: GEOL 2325 (or GEOG 2325(and GEOL 3326.

This course examines current research on sedimentary rocks and basins and the methods used to understand them. Among the topics to be covered are modern carbonate and evaporite environments, exotic chemical sedimentary rocks and diagenetic cements, volcanogenic sedimentary rocks, sequence stratigraphy in carbonate and siliciclastic successions, applications of ichnology (trace fossils), the use of stable isotopes in the study of terrestrial carbonates, and the use of detrital minerals to interpret basin evolution.

Classes 3 hrs. and lab 3 hrs. a week.

4466 Petroleum Geology
3 credit hours
Prerequisite: GEOL 1214, 1215, 2305 and 2325 (the latter two can be taken concurrently).

The origin, migration and accumulation of oil and natural gas. Types of oil bearing structures and basic principles in oil exploration.

Classes 3 hrs. and lab 3 hrs. a week.

4475 Glacial Geomorphology [GEOG 4423]
3 credit hours
Prerequisite: GEOL 3373 or GEOG 3313.

4476 Coastal Geomorphology [GEOG 4413]
3 credit hours

4550 Honours Project
6 credit hours
Prerequisite: Honours standing and permission of Department.

Research project carried out under the supervision of one member of the Department or jointly by more than one faculty member. Originality of the research project is emphasized.

4826 – 4849 Special Topics in Geology
3 credit hours
Prerequisite: restricted to Year 4 students in the Honours program or permission of Department.

Readings and discussions of current literature in geology on selected topics. Such topics as plate tectonics, geochemistry, statistics in geology, isotope geochemistry, petrogenesis, ore genesis, may be included.

Classes 72 hrs. per semester; classes and labs.

4876 – 4899 Directed Study in Geology
3 credit hours
Prerequisite: restricted to Year 4 students in the Honours program or permission of Department.

Intended to supplement or provide an alternative to the regular geology courses in order to meet the special needs and interests of students. The course provides an opportunity to study a particular subject in detail and requires from the student some measure of independence and initiative.

Classes 72 hrs. per semester; classes and labs.

German (GRMN)

Chairperson, Modern Languages and Classics
Associate Professor S. Beaulé
Professor E. Enns
Assistant Professor J. Plews

Courses and programs in German are offered by the Department of Modern Languages and Classics

Department Policy - Modern Languages and Classics

1. Enrollment in some language courses involves the following formal placement procedures.

All students seeking entry into language courses who have not previously taken a language course at Saint Mary's University must complete and return the Language Profile Form to the Department of Modern Languages and Classics.

Based on the information provided in the Language Profile Form, students may receive notification from the Department to appear for an oral interview and/or a written placement test at a designated time.

The Department of Modern Languages determines the appropriate course placement for each student

(i) Permission to register or remain in a particular language course can be refused if the Department judges that the student's knowledge exceeds the level for that course.
(ii) Native speakers are not eligible to receive advanced credit for language courses.
(iii) Completion of Advanced Standing (transfer) courses does not exempt a student from taking the placement test.

2. The student's eligibility to enroll in language, culture, and literature courses, and in specific sections of those courses, is determined by the Chairperson in consultation with the instructor in light of the student's ability level in the language concerned, previous course work completed at university or elsewhere, and overall size of the course or section of a course. In matters of placement, the decision of the Chairperson is final.

3. In order to ensure the academic integrity in language courses, especially at the lower levels of instruction, the Department of Modern Languages and Classics does not allow native or near-native speakers of a particular target language to enroll in courses at the 2000 level or lower.

Students who misrepresent their knowledge of any given language by providing inaccurate or incomplete information about their linguistic educational history will be subject to disciplinary action as laid out in Academic Regulation 19.

4. The Department of Modern Languages and Classics supports a policy of regular class attendance by students. Frequent, unexplained absences from class will result in a lowering of the final grade in a manner to be determined by each faculty member.

5. Students should note that courses in literature and/or culture fulfill the BA Humanities requirement 3(c) but do not fulfill the 3(b) requirement. The courses designated with an * in front of the number satisfy the 3(c) requirement.

Programs in German
The following programs are available in German Studies: a a minor, a concentration, and a certificate in German Language and Culture.

Concentration in German Studies
To obtain a concentration in German Studies in partial fulfillment of the B.A. General Degree (i.e. one with a Double Arts Concentration and a minimum of ninety (90) credit hours), a minimum of twenty-four (24) credit hours in German Studies is required. At most 6 credit hours can be at the 1000 level. Also, the minimum grade point average is 2.00.

Minor in German Studies
A minor in German Studies consists of twenty-four (24) credit hours, with at least twelve (12) of these being at the 3000 level or above. Normally, the first twelve (12) credit hour courses for the minor will be 1000 and 2000 level German language courses, followed by twelve (12) credit hours to be chosen from offerings in literature and cultural studies. Students entering the minor program with previous knowledge of German must consult the Coordinator for German Studies or the Chairperson of Modern Languages and Classics. A minimum grade point average of 2.00 is required for courses in the minor program.