

# Environmental Geosciences

This degree is administered by the College of Engineering.

**Program in Environmental Geosciences.** The Environmental Geosciences program at Notre Dame was founded by the Department of Civil Engineering and Geological Sciences to provide students with a quantitative preparation for professional careers or continued higher education in the disciplines of earth and environmental science. The program provides a foundation in the physical sciences, with emphasis on processes that occur near or at the surface of Earth, and the impact of human activity on such processes. Students explore the geochemical, mineralogical and hydrological properties of Earth's crust, and develop an understanding of the interplay of natural processes such as mineral-water-rock-bacteria interactions, with anthropogenic issues such as transport of toxic heavy metals and safe disposal of nuclear waste.

The environmental geosciences program combines classroom, laboratory and field studies. Students are encouraged to participate in a semester study abroad, such as the Australia program (during the fall semester, junior year), which provides additional opportunity for field-based studies. All students are encouraged to conduct independent research under faculty supervision during their senior year.

An undergraduate major in environmental geosciences prepares a student for graduate study (M.S., Ph.D.) in many aspects of geology and environmental sciences, as well as for admission to a variety of professional schools. In addition, this program meets the criteria for graduates to become state-registered geologists in those states requiring such certification. Graduates with a B.S. degree may enter careers in diverse areas such as the National Park Service, industry, environmental consulting, and government research laboratories. An environmental geosciences degree is also ideal background for those planning to teach in secondary schools at all levels. Further details can be found at [www.nd.edu/~envgeo](http://www.nd.edu/~envgeo).

The flexibility of our undergraduate program allow engineering and science students to major in the Environmental Geosciences. Below you will find an example of the curriculum that can be followed by a student that commits to the **College of Engineering**. This is followed by an example

of how a student committed to the **College of Science** may also take advantage of this major.

## First Year

### First Semester

EG 10111 <sup>1</sup> : Intro. to Engineering Systems I	3
CHEM 10121 <sup>2</sup> : General Chemistry I	4
MATH 10550 <sup>3</sup> : Calculus I	4
Arts and Letters course <sup>4</sup>	3
FYC 110 <sup>4</sup>	3
Physical Education/ROTC	0
	<u>17</u>

### Second Semester

EG 10112 <sup>1</sup> : Intro. to Engineering Systems 2	3
CHEM 10122 <sup>2</sup> : General Chemistry II	3
MATH 10560 <sup>3</sup> : Calculus II	4
PHYS 10310: Physics I	4
Arts and Letters course <sup>4</sup>	3
Physical Education/ROTC	0
	<u>17</u>

## Sophomore Year

### First Semester

ENVG 20110: Physical Geology + lab	4
ENVG 20200: Mineralogy & Optical Min.	4
PHYS 10320: Physics II	4
MATH 20550: Calculus III	3.5
	<u>15.5</u>

### Second Semester

ENVG 20120: Historical Geology	4
ENVG 20210: Ign. & Meta. Petrology	4
MATH 20580: Linear Alg. Diff. Equations	3.5
Arts and Letters course <sup>4</sup>	3
ENVG 45200: Field Trip	1
	<u>15.5</u>

## Junior Year

### First Semester

ENVG 30230: Sediment. and Stratigraphy	4
ENVG 40300: Geochemistry	3
Arts and Letters course <sup>4</sup>	3
Free Elective	3
Technical Elective <sup>5</sup>	3
	<u>16</u>

### Second Semester

ENVG 30400: Str. Geology & Rock Mech.	4
ENVG 30300: Surficial Proc. Surf. Hydrol.	3
MATH 20340: Introductory Statistics	3
Arts and Letters course <sup>4</sup>	3
ENVG 45200: Field Trip	1
	<u>14</u>

## Senior Year

### First Semester

ENVG 40410: Geophysics	3
CE 40460: Groundwater Hydrology	4
Technical Elective <sup>5</sup>	3
Arts and Letters course <sup>4</sup>	3
Arts and Letters course <sup>4</sup>	3
	<u>16</u>

## Second Semester

ENVG 40310: Env. Imp. Res. Utilization	3
ENVG 40340: Water-Rock Interaction	3
ENVG 40360: Geomicrobiology	3
Technical Elective <sup>5</sup>	3
Technical Elective <sup>5</sup>	3
	<u>15</u>

Total for the 4 years: 126 semester hours.

**For students in the College of Science** wishing to major in the Environmental Geosciences, the curriculum is very similar with the following differences (underlined):

## First Year

### First Semester

<u>ENVG 10110<sup>6</sup>: Physical Geology + lab</u>	<u>4</u>
CHEM 10113 <sup>7</sup> : General Chemistry I	4
MATH 10550: Calculus I <sup>3</sup>	4
Arts and Letters course <sup>4</sup>	3
FYC 110 <sup>4</sup>	3
Physical Education/ROTC	0
	<u>18</u>

### Second Semester

<u>ENVG 10100: Environmental Geosciences</u>	<u>3</u>
CHEM 10114 <sup>7</sup> : General Chemistry II	3
MATH 10560: Calculus II <sup>3</sup>	4
PHYS 10310: Physics I	4
Arts and Letters course <sup>4</sup>	3
Physical Education/ROTC	0
	<u>17</u>

## Sophomore Year

### First Semester

<u>Arts and Letters course<sup>4</sup></u>	<u>3</u>
ENVG 20200: Mineralogy & Optical Min.	4
PHYS 10320: Physics II	4
MATH 22550: Calculus III	3.5
	<u>14.5</u>

From the Spring Semester, Sophomore Year, the curriculum is the same as that listed above for engineering students, except a Technical Elective is taken in place of an Arts and Letters course during the Fall Semester, Senior Year. The total number of semester credit hours is the same.

## Minor in Environmental Geosciences<sup>4</sup>

A minor in Environmental Geosciences requires the completion of 23 credit hours in geological sciences as follows:

ENVG 20110: Physical Geology + lab	4
ENVG 20120: Historical Geology	4
ENVG 20200: Mineralogy	4
ENVG 45200: Field Trip	1

**Total: 13**

*One of:*

ENVG 20210: Ig. & Met. Petrology	4
ENVG 30400: Str. Geology & Rock Mech.	4
ENVG 30230: Sediment. & Stratigraphy	4

**Total: 4**

*Two of:*

ENVG 30300: Surficial Proc. Surf. Hydrol.	3
ENVG 40300: Geochemistry	3
ENVG 40310: Env. Imp. Res. Utilization	3
ENVG /SC 40380: Paleontology	3
ENVG 40340: Water-Rock Interaction	3
ENVG 40360: Geomicrobiology	3

**Total: 6**

Total for the Minor: 23 semester hours.

## Notes:

- EG 10111 and EG 10112 are acceptable credits for the Environmental Geosciences degree but are not required courses.
- CHEM 10113, or 10117 may be substituted for CHEM 10121; CHEM 10114 or 10118 may be substituted for CHEM 10122. Other substitutions will be considered on a case-by-case basis.

SUMMARY OF REQUIREMENTS FOR GRADUATION FOR ENVIRONMENTAL GEOSCIENCES MAJOR	
	Credits*
Environmental Geosciences	44 (47)
Chemistry	7
Mathematics	18
Physics	8
Civil Engineering	10 (4)
Technical Electives (science and engineering)	12 (15)
FYC 110	3
Philosophy	6
Theology	6
History	3
Social Science	3
Fine Arts or Literature	3
Free Electives	3
<b>TOTAL</b>	<b>126</b>

\*Credits in parentheses refer to students in the College of Science

**SUMMARY OF THE REQUIREMENTS FOR A MINOR IN ENVIRONMENTAL GEOSCIENCES<sup>4</sup>**

	Credits		Credits
ENVG /SC 20110: Physical Geology	4	<i>Two of:</i>	
ENVG /SC 20120: Historical Geology	4	ENVG 4010: Geophysics	3
ENVG /SC 20200: Mineralogy & Optical Mineralogy	4	ENVG 40310: Environmental Impact of Resource Utilization	3
ENVG 45200: Field Trip	1	ENVG 40340: Water-Rock Interaction	3
	Sub-total: 13	ENVG /SC 40380: Paleontology	3
<i>One of:</i>		ENVG 40360: Geomicrobiology	3
ENVG 20210: Igneous & Metamorphic Petrology	4	ENVG /SC 40300: Geochemistry	3
ENVG 30400: Structural Geology	4		Sub-total: 6
ENVG /SC 30230: Sedimentation & Stratigraphy	4		
	Sub-total: 4		<b>TOTAL: 23 Credit Hours</b>

3. Under special circumstances, MATH 10240 may be an acceptable substitute for MATH 10550, and the sequence MATH 10350-10360 may be considered as an acceptable substitute for MATH 10550-10560.

4. University requirements include:

FYC	3 hours
*Theology	6 hours
*Philosophy	6 hours
*History	3 hours
*Social Science	3 hours
*Fine Arts or Literature	3 hours

\* one of these must be a University Seminar.

5. Technical Electives are typically junior and senior level courses in science or engineering that have been approved by the chair of Civil Engineering & Geological Sciences. Students must ensure they have met prerequisite requirements for Technical Elective courses. Courses that may be used as Technical Electives include:

- ENVG 40380: Paleontology
- ENVG 48600: Undergraduate Research
- CHEM 20223: Elem. Organic Chem. I
- CHEM 20224: Elem. Organic Chem. II
- CHEM 20247: Organic Chemistry + Lab
- CHEM 20248: Organic Chemistry + Lab
- CHEM 20243: Inorganic Chemistry
- CHEM 30321: Physical Chemistry
- CHEM 30322: Physical Chemistry II
- CHEM 30333: Analytical Chemistry + Lab
- CHEM 30341: Fundamentals of Biochemistry
- CHEM 40420: Principles of Biochemistry
- BIOS 10107: Biological Sciences I
- BIOS 10108: Biological Sciences II
- BIOS 20201: General Biology I
- BIOS 20202: General Biology II
- BIOS 30401: Principles of Microbiology
- AME 20221: Mechanics I
- AME 20222: Mechanics II
- AME 30331: Fluid Mechanics
- CE 40450: Hydraulics
- CE 40340: Waste Treatment
- MATH 30650: Differential Equations

6. If ENVG /SC 20110 is a required course for a Science major, it may also be counted for the minor in Environmental Geosciences.

7. CHEM 10117, or 10121 may be substituted for CHEM 10113; CHEM 10118 or 10122 may be substituted for CHEM 10114. Other substitutions will be considered on a case-by-case basis.

**ENVIRONMENTAL GEOSCIENCES COURSE DESCRIPTIONS**

The following course descriptions give the number and title of each course. Lecture hours per week, laboratory hours per week and credits each semester are in parentheses. The instructor's last name is also included.

**ENVG 10100/20100. Environmental Geosciences**

(3-0-3) Neal

*Prerequisites:* CHEM 10121 or equivalent.

This course introduces the student to Earth processes, and focuses on how these processes affect people, and how people affect these processes. The course explores the interactions between Earth's biosphere, geosphere, atmosphere, and hydrosphere, with the objective of demonstrating how our physical environment is controlled by geological, biological, and human forces.

**ENVG 10110/20110. Physical Geology**

(3-2-4) Neal

*Corequisite(s):* ENVG 11110/21110

An introduction to the Earth, its processes, composition, evolution, and structure. The course introduces the student to mineralogy, petrology, structural geology, oceanography, surficial processes, geophysics, environmental geology, and planetology. Lecture and laboratory meetings.

**ENVG 11110/21110. Physical Geology Laboratory**

(0-1-0) Neal

*Corequisite(s):* ENVG 10110/20110.

This is the laboratory portion of ENVG 10110/20110.

**ENVG 20120. Historical Geology**

(3-2-4) Rigby

*Prerequisites:* ENVG 20110 or consent of instructor.

*Corequisite(s):* ENVG 21120

This course introduces the student to the concept of geologic time, absolute and relative age-dating, Earth processes and features through time, and the major features of evolution and distribution of fossils. Lecture and laboratory meetings. One-day field trip is required.

**ENVG 21120. Historical Geology Laboratory**

(0-1-0) Rigby

*Corequisites:* ENVG 20120

This is the laboratory portion of ENVG 20120.

**ENVG 20200. Mineralogy and Optical Mineralogy**

(3-2-4) Burns

*Prerequisites:* CHEM 10122, ENVG 20110, or consent of instructor.

Crystallography and mineral optics: physical and chemical mineralogy – its application to mineral identification in hand-specimen and using the petrographic microscope.

**ENVG 20210. Igneous and Metamorphic Petrology**

(3-2-4) Neal

*Prerequisites:* ENVG 20110 or consent of instructor.

Origin and identification of igneous and metamorphic rocks within a plate tectonic framework. Geochemistry and petrography are used to investigate mineral equilibria, magma generation and crystallization, pressure and temperatures of deformation, and the interior of the Earth.

**ENVG 30400. Structural Geology & Rock Mechanics**

(3-3-4) Staff

*Prerequisites:* ENVG 20110 or consent of instructor. Shapes and fabric of deformed rocks, physical properties of rocks, processes and mechanisms of deformation with associated stresses and strains, and regional and global structural events. Weekend field trip is required.

**ENVG 30300. Surficial Processes & Surficial Hydrology**

(2-3-3) Rigby

*Prerequisites:* ENVG 20110 or consent of instructor.

A quantitative study of natural chemical and physical processes (e.g., weathering, flooding, wind) that produce both erosional and depositional landforms. Their effects on human structures and developments are explored. One-day field trip is required.

**ENVG 30230. Sedimentation and Stratigraphy**

(3-2-4) Rigby

*Prerequisites:* ENVG 20110 or consent of instructor.

Sedimentary environments from a physical, biological and tectonic perspective are explored, along with processes such as lithification. Identification of sedimentary rocks and the interpretation of the succession of layered rocks in North America are emphasized.

**ENVG 40300. Geochemistry**

(3-0-3) Fein

*Prerequisites:* CHEM 10121, 10122; MATH 10550, 10560, or consent of instructor.

An introduction to the use of chemical thermodynamics and chemical kinetics in modeling geochemical processes. Special emphasis is placed on water-rock interactions of environmental interest.

**ENVG 40310. Environmental Impact of Resource Utilization**

(3-0-3) Neal

*Prerequisites:* ENVG 20110, ENVG 40300, or consent of instructor.

The environmental effects of utilizing natural resources are examined from their extraction, refining, to use. Pivotal in this course is environmental impact assessment and rehabilitation/remediation technologies. A number of case studies will be examined to highlight the environmental impact of using the Earth's natural resources and how such impacts can be mitigated.

**ENVG 45200. Field Trip**

(0-2-1) Burns

*Prerequisites:* ENVG 20110 or consent of instructor.

Field trip during the fall/spring vacation; emphasis on regional field geology and field relationships. Classic localities are studied in order to demonstrate geological concepts.

**ENVG 40410. Geophysics**

(2-2-3) Staff

*Prerequisites:* MATH 20580, PHYS 10320, or consent of instructor.

Physics of the solid Earth: seismic wave, gravity, resistivity and electromagnetic methods of probing the structure of the Earth. Applications to environmental concerns as well as to groundwater, mineral and petroleum exploration are discussed.

**ENVG 40380. Paleontology**

(2-2-3) Rigby

*Prerequisites:* ENVG 20120 or consent of instructor.

The fossil record – morphology, taxonomy, evolution, statistical population systematics and paleoecology. One day field trip is required.

**ENVG 40340. Water-Rock Interactions**

(3-0-3) Maurice

*Prerequisites:* ENVG 40300 or consent of instructor.

Fundamental properties of mineral surfaces and of the mineral-water interface. Methods of surface and interface analysis. The electric double layer. Interface reactions including adsorption, mineral growth and dissolution, photoredox phenomena, and controls on bacterial adhesion.

**ENVG 40360 Geomicrobiology.**

(3-0-3) Fein

*Prerequisites:* ENVG 40300 or consent of instructor.

This course explores current research involving the interaction between microbes and geologic systems, focusing on the ability of microbes to affect mass transport in fluid-rock systems.

Readings concentrate on laboratory, field, and modeling studies of environmental and/or geologic interest.

**ENVG 47600. Special Studies**

(0-V-V) Staff

*Prerequisites:* Permission of the chair of the Department of Civil Engineering and Geological Sciences and the individual instructor.

Research of literature on a specific geoscience topic. Preparation of reports and presentations.

**ENVG 48600. Undergraduate Research**

(0-V-V) Staff

*Prerequisites:* Permission of the chair of the Department of Civil Engineering and Geological Sciences. Three to 15 hours each week, arranged individually for each student.

The following graduate courses, described in the Graduate School Bulletin of Information, are also open to advanced undergraduates with permission:

**ENVG 60300: Geochemistry**

**ENVG 60400: Surface and Subsurface  
Geophysics**

**ENVG 60500: ICP Analytical Techniques**

**ENVG 60310: Surficial Processes**

**ENVG 60410: Geodynamics**

**ENVG 60340: Water-Rock Interactions**

**ENVG 60380: Environmental Isotope  
Chemistry**

**ENVG 60560: Geomicrobiology**

**ENVG 60370: Environmental &  
Technological Aspects of Minerals.**