

HANDBOOK FOR GEOLOGY MAJORS

(2014-2015 curriculum year and subsequent years)

DEPARTMENT OF ENVIRONMENTAL ENGINEERING AND EARTH SCIENCES

COLLEGE OF ENGINEERING, COMPUTING AND APPLIED SCIENCES

CLEMSON UNIVERSITY



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- *Room Keys or Key-Pad Combinations (classrooms or labs)*
- *Time Sheets*
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- *Want more detailed information about the Geology program*
- *Are interested in majoring in Geology*
- *Have specific advising questions*

Geology & Career Opportunities in the 21st Century

Geology is the study of the Earth. It is an applied science that integrates principles from physics, chemistry, biology, engineering, and other disciplines to better understand the natural processes and human influences that shape our planet.

Geology helps people in several ways:

- Locate natural resources needed to support society
- Develop sustainable approaches to energy and resource management
- Predict, assess and manage natural disasters and global change
- Deduce the natural history of Earth.

Forbes magazine ranks geology as the 7th-most valuable college major, and job growth in geology is projected to be excellent over the next 10 years. Employment opportunities for geologists are numerous and varied. Examples include the following:

- Environmental and engineering consulting firms
- Energy exploration and production companies
- Mineral and metal industries
- Municipal, state, and federal governments
- Natural resource conservation organizations
- Water authorities.

More information about salaries and careers in geology is available at the department's website (<http://www.clemson.edu/ces/ees/undrgrad/geology/index.html>). Upon receiving a B.S. degree in Geology from Clemson University, many qualified students elect to continue their studies by going to graduate school in the geosciences, environmental sciences, or other related fields (see pg. 16 or the departmental website listed above for more information).

Geology is a recognized profession and state certification as a registered professional geologist is available to graduates of the B.S. degree program in Geology from Clemson University. Although registration requirements may vary somewhat from state to state, a professional geologist typically:

- has at minimum a four-year college degree in geology or related field
- has passed the Fundamentals of Geology exam
- has four or more years of work experience in geology, and
- has passed the Professional Geology exam.

More information about becoming a professional geologist is available at the website of the National Association of State Boards of Geology (<http://www.asbog.org/>).

B.S. Degree Program in Geology at Clemson University

The Geology program at Clemson has been carefully designed to help students develop quantitative and other critical skills while familiarizing them with the topics, technologies and resources needed for a variety of career paths in the geosciences. The program is built around three critical themes:

- Appreciation for spatial and temporal scales
- Knowledge of earth materials and compositions of environmental systems
- Understanding of geological and environmental processes.

Degree Requirements

The Geology B.S. degree requires a minimum of 120 credit hours (average 15/semester).

- General education requirements: All Clemson University students must complete these.
- Field experience: Because geology is a field-based discipline, all students are required to take one or more courses (six credits) that provide them with field experience (see pg. 12).
- Research requirement: All Geology majors participate in a multi-semester research program that provides them with hands-on experience conducting geologic research (see pg. 13).
- Electives: The Geology degree is flexible, enabling students to choose additional classes from approved lists so they can tailor the degree to their specific interests and career goals.

It is also possible for geology majors to pursue the *Engineering Cluster Minor*; students interested in this pathway should consult with their advisor early in their program of study.

Concentrations

In addition to the basic B.S. degree in geology, the program offers two focused concentrations that have specialized requirements. The concentrations provide more structured pathways through the curriculum for students with career interests in the following areas:

- *Environmental Science*. The Environmental Science Concentration in Geology focuses on environmental aspects of geoscience and is well suited for students interested in topics such as environmental policy, natural hazard assessment and remediation, evaluation of land use impacts, understanding geochemical cycles, and environmental systems analysis. This concentration provides a rigorous background in the sciences so that students can scientifically address environmental issues and integrate material from several fields to solve complex environmental problems.
- *Hydrogeology*. The Hydrogeology Concentration in Geology is designed for students who want to specialize in areas such as surface- and ground-water systems, treatment of water and cleanup of contaminated sites, contaminant flow and fluid transport, and water resource sustainability.

The following pages outline the requirements for the Geology B.S. degree, the Geology B.S. degree with the Hydrogeology concentration, and the Geology B.S. degree with the Environmental Science concentration. Courses that fit each category of electives are on the page immediately following the degree plan.

Geology B.S. Degree
(Curriculum Beginning Fall 2014)

First Semester

Second Semester

FRESHMAN YEAR

CH 1010 General Chemistry	....	4	CH 1020 General Chemistry	....	4
ENGL 1030 Composition and Rhetoric	....	3	GEOL 1120 Earth Resources	....	3
GEOL 1010 Physical Geology	....	3	MATH 1080 Calculus of One Variable II	....	4
GEOL 1030 Physical Geology Lab.	....	1	Arts and Humanities (Non.-Lit.) Reqt. ¹	....	3
MATH 1060 Calculus of One Variable I	<u>....</u>	<u>4</u>	Social Science Requirement ¹	<u>....</u>	<u>3</u>
		15			17

SOPHOMORE YEAR

GEOL 2050 Mineral. and Intro. Petrol.	....	3	GEOL 2020 Earth History	....	4
GEOL 2070 Mineral. and Intro. Petrol. Lab.	....	1	GEOL 2920 Introduction to Research II	....	1
GEOL 2910 Introduction to Research I	....	1	Quantitative Science Requirement ³	....	3
PHYS 1220 Physics with Calculus I	....	3	STEM Requirement ²	<u>....</u>	<u>3</u>
Arts and Humanities (Literature) Reqt. ¹	....	3	STEM Requirement ²	<u>....</u>	<u>4</u>
Social Science Requirement ¹	....	3			15
STEM Requirement ²	<u>....</u>	<u>3</u>			
		17			

JUNIOR YEAR

GEOL 3020 Structural Geology	....	4	GEOL 3920 Research Methods II	....	2
GEOL 3910 Research Methods I	....	2	Geology Requirement ⁴	....	3
Quantitative Science Requirement ³	....	3	STEM Requirement ²	....	3
STEM Requirement ²	<u>....</u>	<u>3</u>	Geology Requirement ⁴	<u>....</u>	<u>4</u>
		12			12

Field Experience⁵ 6

SENIOR YEAR

GEOL 4910 Research Synthesis I	....	3	GEOL 4920 Research Synthesis II	....	3
Geology Requirement ⁴	....	4	Geology Requirement ⁴	....	4
STEM Requirement ²	<u>....</u>	<u>3</u>	STEM Requirement ²	<u>....</u>	<u>3</u>
STEM Requirement ²	<u>....</u>	<u>3</u>	STEM Requirement ²	<u>....</u>	<u>3</u>
		13			13

120 Total Semester Hours

¹See General Education Requirements. Three of these credit hours must also satisfy the Cross-Cultural Awareness Requirement.

²Twenty-eight credit hours selected from department approved list. No more than 14 hours below the 3000-level and no more than eight hours below the 2000-level. Courses may not be used to satisfy any other requirement.

³Select from department approved list. Courses may not be used to satisfy any other requirement.

⁴Fifteen credit hours. Select from GEOL 3130, 3180, 4050, 4090, 4150, 4210, or 4820. Only excess hours may be used to satisfy STEM requirement hours.

⁵GEOL 4750, or other six-credit summer geology field camp, or a combination of GEOL 2750 plus a three-credit field course in geology or other approved discipline. Students desiring to become registered professional geologists should take a six-credit summer field camp in geology/hydrogeology.

Department Approved Lists for Geology B.S. Degree

2. STEM Requirement

Courses used to satisfy the STEM Requirement may not be used to satisfy any other geology degree requirement. Pick a minimum of **28** credit hours total from the disciplines below subject to the following limitations:

- (1) No more than 14 credit hours below the 3000-level and no more than 8 credit hours below the 2000-level.
- (2) No creative inquiry courses without prior approval from the advisor.
- (3) No research-based or independent study-type course outside GEOL without prior approval from the advisor, and
- (4) Credit for GEOL 4110 is limited to a maximum of 3 hours.

Acceptable course prefixes are: ASTR, BCHM, BE, BIOE, BIOL, CE, CH, CHE, ECE, EES, ETOX, GEOL, IE, MATH, ME, MICR, MSE, PHYS

Other acceptable courses, subject to the limitations above, are:

PES 2020 Soils	4
ENSP 2000 Introduction to Environmental Science	3
ENGR 1020 Engineering Disciplines and Skills	2
ENGR 1410 Programming and Problem Solving	3
EM 2020 Engineering Mechanics: Dynamics	3
CPSC 1110 or CPSC 1150 or CPSC 1610	3

(Note: Credit can be received for only one of these introductory programming courses)

3. Quantitative Science

Courses selected to satisfy the Quantitative Science Requirement may not be used to satisfy any other geology degree requirement. Pick two courses from the groupings below:

Pick one or two courses from: GEOL 4150, MATH 2060, MATH 2080, MATH 3110

Pick up to one course from: STAT 2300, MATH 3020, MATH 3600, ENGR 1410
CPSC 1610, CPSC 1150, CPSC 1110

5. Field Experience

In addition to the courses specifically listed in the footnote, other currently approved three credit field courses at Clemson University are:

GEOL 3700 Western US Field Study
GEOL 3750 Bahamian Field Study
GEOL 3800 Caribbean Field Studies

Other field courses at Clemson University or at other universities may be approved on a case-by-case basis. See your advisor for guidance and assistance.

Geology B.S. Degree
HYDROGEOLOGY CONCENTRATION
(Curriculum Beginning Fall 2014)

First Semester

Second Semester

FRESHMAN YEAR

CH 1010 General Chemistry	....	4	CH 1020 General Chemistry	....	4
ENGL 1030 Composition and Rhetoric	....	3	GEOL 1120 Earth Resources	....	3
GEOL 1010 Physical Geology	....	3	MATH 1080 Calculus of One Variable II	....	4
GEOL 1030 Physical Geology Lab	....	1	Arts and Humanities (Non.-Lit.) Req ¹	....	3
MATH 1060 Calculus of One Variable I	....	<u>4</u>	Social Science Requirement ¹	....	<u>3</u>
		15			17

SOPHOMORE YEAR

GEOL 2050 Mineral. and Intro. Petrol.	....	3	GEOL 2020 Earth History	....	4
GEOL 2070 Mineral. and Intro. Petrol. Lab.	....	1	GEOL 2920 Introduction to Research II	....	1
GEOL 2910 Introduction to Research I	....	1	MATH 3020 Statistics for Sci. and Engr. <i>or</i>		
PHYS 1220 Physics with Calculus I	....	3	STAT 2300 Statistical Methods I	....	3
PHYS 1240 Physics Lab I	....	1	PHYS 2210 Physics with Calculus II	....	3
Arts and Humanities (Literature) Req ¹	....	3	Social Science Requirement ¹	....	3
Hydrogeology Requirement ²	....	<u>3</u>	Hydrogeology Requirement ²	....	<u>3</u>
		15			17

JUNIOR YEAR

GEOL 3000 Environmental Geology	....	3	GEOL 3130 Sedimentology and Strat.	....	4
GEOL 3020 Structural Geology	....	4	GEOL 3180 Introduction to Geochemistry	....	3
GEOL 3910 Research Methods I	....	2	GEOL 3920 Research Methods II	....	2
GEOL 4150 Analysis of Geological Proc. ³	....	<u>4</u>	GEOL 4210 GIS Applications in Geology	....	<u>3</u>
		13			12

GEOL 4750 Summer Geology Field Camp 6

SENIOR YEAR

GEOL 4820 Groundwat. and Cont. Transp.	....	3	EES 4010 Environmental Engineering	....	3
GEOL 4910 Research Synthesis I	....	3	GEOL 4050 Surficial Geology	....	4
Hydrogeology Requirement ²	....	3	GEOL 4090 Envr. and Explor. Geophysics	....	4
Hydrogeology Requirement ²	....	<u>3</u>	GEOL 4920 Research Synthesis II	....	<u>3</u>
		12			14

121 Total Semester Hours

¹See General Education Requirements. Three of these credit hours must also satisfy the Cross-Cultural Awareness Requirement.

²Total of 12 credit hours selected from department approved list. Courses may not be used to satisfy any other requirement.

³MATH 2060 may be substituted.

Department Approved List for Hydrogeology Concentration

2. Hydrogeology Requirement

Courses used to satisfy the Hydrogeology Requirement may not be used to satisfy any other geology degree requirement. Pick a minimum of **12** credit hours total from the courses/disciplines below subject to the limitations specified.

CH 2230 or CH 2010 Organic Chemistry	3
PES 2020 Soils	4
ENSP 2000 Introduction to Environmental Science	3
GEOL 2700 Experiences in Sustainable Development: Water	3
GEOL 2750 Field Methods in Geology	3
MATH 2060 Calculus of Several Variables	4
MATH 2080 Introduction to Ordinary Differential Equations	4
ENGR 1020 Engineering Disciplines and Skills	2
ENGR 1410 Programming and Problem Solving	3
CE 2010 Statics	3
CE 2080 Dynamics	2
EM 2020 Engineering Mechanics: Dynamics	3
CPSC 1110 or CPSC 1150 or CPSC 1610	3

(Note: Credit can be received for only one of these introductory programming courses)

3000- and 4000-level courses in ASTR, BCHM, BE, BIOE, BIOL, CE, CH, CHE, ECE, EES, ETOX, GEOL, IE, MATH, ME, MICR, MSE, PHYS may also be used to satisfy the Hydrogeology Requirement subject to the following limitations: (1) No creative inquiry courses without prior approval, (2) No research-based or independent study-type course outside GEOL without prior approval, and (3) Credit for GEOL 4110 is limited to a maximum of 3 hours.

Geology B.S. Degree
ENVIRONMENTAL SCIENCE CONCENTRATION
(Curriculum Beginning Fall 2014)

First Semester

Second Semester

FRESHMAN YEAR

CH 1010 General Chemistry	.... 4	CH 1020 General Chemistry	.... 4
ENGL 1030 Composition and Rhetoric	.... 3	GEOL 1120 Earth Resources	.... 3
GEOL 1010 Physical Geology	.... 3	MATH 1080 Calculus of One Variable II	.... 4
GEOL 1030 Physical Geology Lab	.... 1	Arts and Humanities (Non.-Lit.) Req ¹	.... 3
MATH 1060 Calculus of One Variable I	<u>.... 4</u>	Social Science Requirement ¹	<u>.... 3</u>
	15		17

SOPHOMORE YEAR

BIOL 1030 General Biology I	.... 3	BIOL 1040 General Biology II	.... 3
BIOL 1050 General Biology Lab. I	.... 1	BIOL 1060 General Biology Lab. II	.... 1
ENSP 2000 Intro. to Environ. Science	.... 3	CH 2010 Survey of Organic Chemistry <i>or</i>	
GEOL 2050 Mineral. and Intro. Petrol.	.... 3	CH 2230 Organic Chemistry	.... 3
GEOL 2070 Mineral. and Intro. Petrol. Lab.	.... 1	GEOL 2020 Earth History	.... 4
GEOL 2910 Introduction to Research I	.... 1	GEOL 2920 Introduction to Research II	.... 1
Arts and Humanities (Literature) Req ¹	<u>.... 3</u>	PHYS 1220 Physics with Calculus I	<u>.... 3</u>
	15		15

JUNIOR YEAR

GEOL 3000 Environmental Geology	.... 3	GEOL 3180 Introduction to Geochemistry	.... 3
GEOL 3020 Structural Geology	.... 4	GEOL 3920 Research Methods II	.... 2
GEOL 3910 Research Methods I	.... 2	GEOL 4210 GIS Applications in Geology	.... 3
GEOL 4150 Analysis of Geological Proc. ²	<u>.... 4</u>	MATH 3020 Statistics for Sci. and Engr. <i>or</i>	
	13	STAT 2300 Statistical Methods I	.... 3
		Environmental Science Requirement ³	<u>.... 4</u>
			15

Field Experience⁴ 6

SENIOR YEAR

ENSP 4000 Studies in Environ. Science	.... 3	GEOL 4920 Research Synthesis II	.... 3
GEOL 4820 Groundwat. and Cont. Transp.	.... 3	Environmental Science Requirement ³	<u>.. 10</u>
GEOL 4910 Research Synthesis I	.... 3		13
Social Science Requirement ¹	<u>.... 3</u>		
	12		

121 Total Semester Hours

¹See General Education Requirements. Three of these credit hours must also satisfy the Cross-Cultural Awareness Requirement.

²MATH 2060 may be substituted.

³Total of 14 credit hours selected from department approved list. No more than eight hours below the 3000-level. Courses may not be used to satisfy any other requirement.

⁴GEOL 4750 or a combination of GEOL 2750 plus a three-credit field course in geology, ecology or other approved discipline. Students desiring to become registered professional geologists should take a six-credit summer field camp in geology/hydrogeology.

Department Approved Lists for Environmental Science Concentration

3. Environmental Science Requirement

Courses used to satisfy the Environmental Science Requirement may not be used to satisfy any other geology degree requirement. Pick a minimum of **14** credits from the courses listed. No more than eight credits may be selected from courses below the 3000-level. Students desiring to become a registered professional geologist should take GEOL 3130 and 4050.

ENSP 3150 Environment and Agriculture	3
AGRB 2570 Natural Resources, Environment, and Economics	3
AGRB 3570 Natural Resource Economics	3
AGRB 4570 Natural Resource Use, Technology, and Policy	3
BE 3220 Small Watershed Hydrology and Sedimentology	3
BE 4220 Hydrologic Modeling of Small Watersheds	3
BIOL (WFB) 3130 Conservation Biology	3
BIOL 4100 Limnology	3
BIOL (ENR) 4130 Restoration Ecology	3
BIOL 4410 Ecology	3
BIOL 4430 Freshwater Ecology	3
CH 4130 Chemistry of Aqueous Systems	3
PES 2020 Soils	4
PES (BE) 4080 Land Treatment of Wastewater and Sludges	3
PES (GEOL) 4850 Environmental Soil Chemistry	3
EES 4010 Environmental Engineering	3
EES 4100 Environmental Radiation Protection I	3
EES 4800 Environmental Risk Assessment	3
EES 4840 Municipal Solid Waste Management	3
EES 4850 Hazardous Waste Management	3
FNR 2040 Soil Information Systems	4
GEOL 2700 Experiences in Sustainable Development: Water	3
GEOL 2750 Field Methods in Geology	3
GEOL 3130 Sedimentology and Stratigraphy	4
GEOL 3700 Western US Field Study	3
GEOL 3750 Bahamian Field Study	3
GEOL 3800 Caribbean Field Studies	3
GEOL 4050 Surficial Geology	4
GEOL 4090 Environmental and Exploration Geophysics	4
GEOL 4590 Biogeochemistry	3
GEOL 4750 Summer Geology Field Camp	6
MATH 2060 Calculus of Severable Variables	4
MATH 2080 Introduction to Ordinary Differential Equations	4
MATH 3110 Linear Algebra	3
MATH 3600 Intermediate Mathematical Computing	3
MICR 3050 General Microbiology	4
MICR 4010 Microbial Diversity and Ecology	4
MICR 4020 Environmental Microbiology	3
MICR 4100 Soil Microbiology	3
PHYS 2210 Physics with Calculus II	3
PHYS 2400 Physics of the Weather	3
PHYS 2450 Physics of Global Climate Change	3

4. Field Experience

In addition to the courses specifically listed in the footnote, other currently approved three credit field courses at Clemson University are:

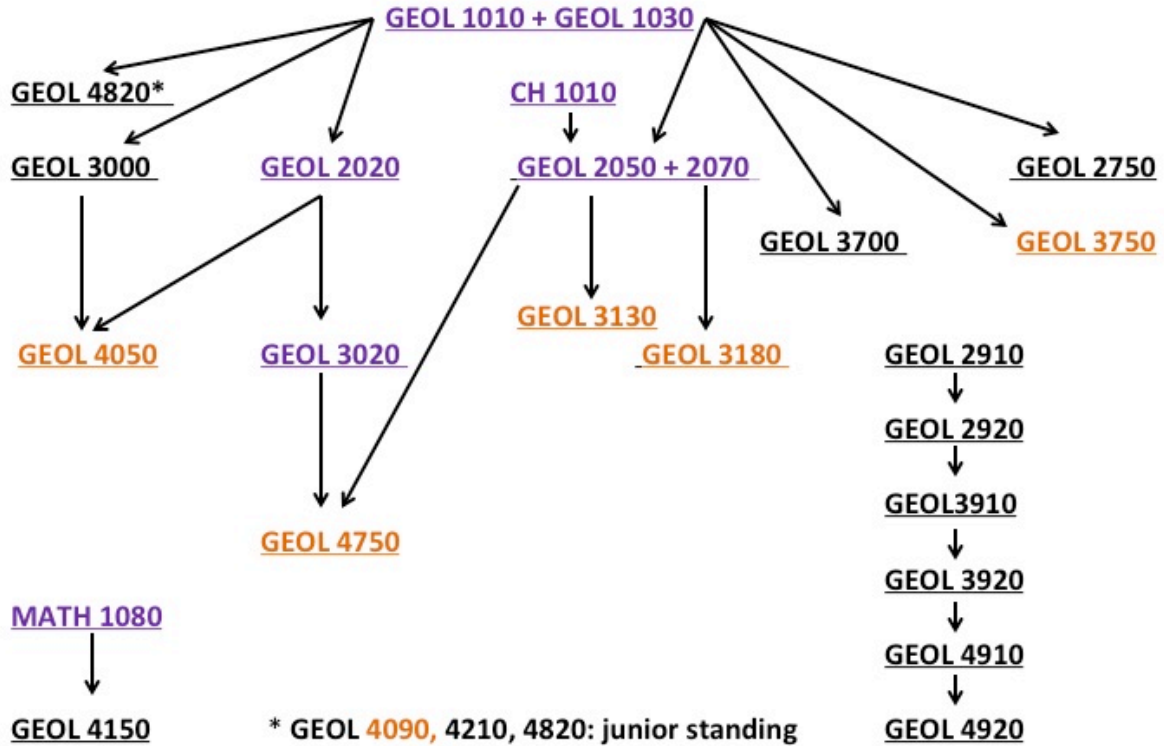
- GEOL 3700 Western US Field Study
- GEOL 3750 Bahamian Field Study
- GEOL 3800 Caribbean Field Studies

Other field courses at Clemson University or at other universities may be approved on a case-by-case basis. See your advisor for guidance and assistance.

PREREQUISITES FOR GEOL COURSES

Purple = required of all GEOL majors

Orange = offered every other year



Four-Year Teaching Plan for GEOL

Below is the expected schedule of geology course offerings in the fall, spring and summer semesters from Fall 2014 through Summer 2018. The courses listed in **orange font** are offered only once every two years. As students proceed through the curriculum they should verify with their advisor that the expected course schedule has not changed from that shown below.

Fall 2014	Spring 2015	Fall 2016	Spring 2017
Geol 1010	Geol 1010	Geol 1010	Geol 1010
Geol 1030	Geol 1030	Geol 1030	Geol 1030
Geol 2050	Geol 1120	Geol 2050	Geol 1120
Geol 2070	Geol 1140	Geol 2070	Geol 1140
Geol 2700	Geol 2020	Geol 2700	Geol 2020
Geol 2750	Geol 2920	Geol 2750	Geol 2920
Geol 2910	Geol 3750	Geol 2910	Geol 3920
Geol 3000	Geol 3920	Geol 3000	Geol 4050
Geol 3020	Geol 4050	Geol 3020	Geol 4090
Geol 3910	Geol 4090	Geol 3910	Geol 4210
Geol 4150	Geol 4210	Geol 4150	Geol 4920
Geol 4820	Geol 4920	Geol 4820	
Geol 4910		Geol 4910	

Fall 2015	Spring 2016	Fall 2017	Spring 2018
Geol 1010	Geol 1010	Geol 1010	Geol 1010
Geol 1030	Geol 1030	Geol 1030	Geol 1030
Geol 2050	Geol 1120	Geol 2050	Geol 1120
Geol 2070	Geol 1140	Geol 2070	Geol 1140
Geol 2700	Geol 2020	Geol 2700	Geol 2020
Geol 2750	Geol 2920	Geol 2750	Geol 2920
Geol 2910	Geol 3130	Geol 2910	Geol 3130
Geol 3000	Geol 3180	Geol 3000	Geol 3180
Geol 3020	Geol 3920	Geol 3020	Geol 3920
Geol 3910	Geol 4210	Geol 3910	Geol 4210
Geol 4150	Geol 4920	Geol 4150	Geol 4920
Geol 4820		Geol 4820	
Geol 4910		Geol 4910	

Summer 2015	Summer 2016	Summer 2017	Summer 2018
Geol 1010 (online)	Geol 1010 (online)	Geol 1010 (online)	Geol 1010 (online)
Geol 1120 (online)	Geol 1120 (online)	Geol 1120 (online)	Geol 1120 (online)
Geol 1140 (online)	Geol 1140 (online)	Geol 1140 (online)	Geol 1140 (online)
Geol 3700	Geol 3700	Geol 3700	Geol 3700
	Geol 4750	Geol 3750	Geol 4750

FIELD EXPERIENCE

Students pursuing the B.S. degree in geology must have at least six credits of field experience. For students planning to take a six-credit summer field camp, the requirement is completed during the summer before or after their senior year. It is common for geology students to attend a summer field camp after the spring semester of their senior year and then graduate in August.

Several field courses are offered through the Clemson University geology program (*offerings subject to change*):

- GEOL 2750 Field Methods (3 credits) - This course teaches students hands-on methods, on-site observational skills, and how to collect and record pertinent information while working in the field. Typically taught in the fall semester each year.
- GEOL 3700 Western US Field Study (3 credits) - Students travel to the Western United States to hike through famous geologic formations, allowing them to apply what they have learned in the classroom to a real-world setting. Typically offered each year during a summer session.
- GEOL 3750 Bahamas Field Study (3 credits) - Students travel to the Bahamas to participate in projects involving coastal processes, sediment transport, and nearshore environments. Offered intermittently, typically during spring break or a summer session.
- GEOL 3800 Caribbean Field Studies (3 credits) - Students travel to the island of Dominica to explore the geologic evolution of the Caribbean volcanic island arc system. Students observe firsthand a boiling lake, fumaroles, hot springs, geologic hazards, deposits from numerous volcanic eruptions, and how humans have adapted to this volcanically active tropical paradise. New course expected to be offered each year during spring break or a summer session.
- GEOL 4750 Summer Geology Field Camp (6 credits) - This course is a hydrogeology-oriented field camp. Students work in both field and laboratory settings collecting and processing hydrologic data from sites near Clemson and also from other areas in the Southeast. GEOL 4750 is required for students in the Hydrogeology Concentration. In recent years it has been offered each year during the first summer session, but historically it was offered only in Summer I of even-numbered years.
- Students can also submit a request to take a field course offered through another program and/or university. This is a good option for students who want to gain field experience in a specialty not covered by one of the field courses described above.

Students interested in becoming licensed as a professional geologist should plan to take a six-credit summer geology field camp, either GEOL 4750 or a more traditional summer field camp from another university.

A comprehensive listing of geology field camps and related information is available at <http://geology.com/field-camp.shtml>. Internet websites of other organizations (e.g., National Association of Geoscience Teachers, American Geosciences Institute, Geological Society of America) have information on scholarships and other means to help offset the cost of summer field camps.

RESEARCH OPPORTUNITIES

Group Research. All undergraduate geology students at Clemson are required to take the 12-credit, six-semester sequence of research courses:

- Sophomore year: GEOL 2910/2920 (1 credit each semester)
- Junior year: GEOL 3910/3920 (2 credits each semester)
- Senior year: GEOL 4910/4920 (3 credits each semester)

Each year there are about four to five group projects directed by various faculty mentors. Many of the mentored projects are multi-year in duration and students may choose to work on the same project all three years if it is continuing.

Student learning objectives over the six semesters include basics of conducting geological research, documenting data collected in a research notebook, writing a research proposal, and organizing research results into effective written reports and oral presentations. General education competencies for academic and professional development, oral communication, and ethical judgment are all incorporated into the six-semester course sequence.

Independent Research. Highly motivated students are encouraged to conduct individual research on a topic of interest to them. GEOL 4110 (Research Problems) provides students the opportunity to obtain academic credit for their individual research projects under the supervision of a geology faculty member. This variable credit course is available to seniors or, with special consent of the instructor, junior geology majors.

In general, a student's individual research project should be within the expertise area of one of the geology faculty, who then will serve as the major advisor. The student and his/her major advisor will work together to formulate and design the research project based on their collaborative interests. The project itself may involve field, laboratory, or library research, and typically some combination of the three. Once an advisor is selected and the research topic is approved, the student can register for the appropriate number of credits of GEOL 4110. Depending on the scope of the project, credits may range from one to three each semester. GEOL 4110 may be repeated for a total maximum of six credits. The research topic from one semester of GEOL 4110 may be continued in a subsequent semester with the same advisor or students may select a different topic and/or advisor.

For students pursuing their departmental honors program in Geology, an honors section of GEOL 4110 is available for students to obtain honors research credit as described at the EEES department's website (<http://www.clemson.edu/ces/ees/undrgrad/geology/index.html>).

SCHOLARSHIPS & AWARDS

Geology Scholarships & Financial Assistance

In addition to the general scholarships available to all undergraduate students at Clemson University, other sources of financial assistance for geology students may be available from organizations outside of Clemson University. Students are encouraged to visit the websites of these organizations (e.g., National Association of Geoscience Teachers, American Geosciences Institute, Geological Society of America) to learn about the opportunities available and to obtain applications. Examples include scholarships from AGI for underrepresented groups in the geosciences and from the Mayo Educational Foundation to juniors and seniors pursuing a degree in the earth sciences and who are affiliated with a Southeast Federation Mineralogical Society (e.g., Pendleton District Gem and Mineral Society; <http://www.pdgms.org/>). As noted on page 12, scholarships may be available to help offset the cost of summer field camps.

Geology Student Awards

Each year the department gives two awards to undergraduate students majoring in Geology.

- The **Thomas F. Logan, Jr. Geology Merit Award** is presented to a senior student with outstanding achievement in geology and possessing personal attributes necessary for successful accomplishments in the discipline. The award is given in memory of Thomas F. Logan, Jr., a 1965 geology graduate of Clemson University, who died in an automobile accident just prior to receiving his PhD from the University of Georgia.
- The **Jean G. Stillwell Award** is presented to the outstanding junior student in geology. The award was established in the memory of Jean G. Stillwell, a 1982 geology graduate of Clemson University who then taught as a Lecturer in Geology until her death from cancer in 1993.

Departmental Honors in Geology

Students enrolled in the Calhoun College Honors Program may pursue Departmental Honors in Geology. Additional information about the Geology Honors program is available at the EEES department's website (<http://www.clemson.edu/ces/eees/undrgrad/geology/index.html>).

SUPPLEMENTARY ACADEMIC INFORMATION AND PROFESSIONAL OPPORTUNITIES

Geology Club

The Clemson Geology Club is an official University student organization that provides members with a variety of educational, professional, and social experiences. Membership is open to any Clemson student interested in geology, and undergraduate geology students are particularly encouraged to join the club and participate in its activities. Meeting times, agendas, optional field trips, etc., typically are scheduled by the club officers in consultation with the faculty advisor. Past field trips have visited Mammoth Cave and the Great Smoky Mountains National Parks, Linville Gorge, Graves Mountain Mine, Diamond Hill Mine, Congaree National Park, the Atlantic Coastal Plain, as well as the annual Carolina Geological Society field trip held each fall (<http://www.carolinageologicalsociety.org/CGS/Information.html>).

Bob Campbell Geology Museum

The Bob Campbell Geology Museum (<http://www.clemson.edu/public/geomuseum/>) is located in the South Carolina Botanical Garden at Clemson University. First established as the Geology Museum in Brackett Hall in 1989, a rapid increase in the number of visitors soon led to the creation of a separate museum building to house the collections. Clemson alumnus Bob Campbell generously donated funds to construct the new museum which now bears his name. The various collections maintained by the museum have been acquired over the years through many individual gifts representing specimens from around the world.

Volunteers, work-study students, and interns are welcome to assist and learn at the museum. Geology students are particularly encouraged to take advantage of these opportunities.

Study Abroad

Academic, personal and career benefits resulting from study abroad programs are well established. For example, many employers are seeking employees with international skills and experiences because increased globalization has changed the way the world works. Study Abroad opportunities expand students' learning environments beyond the classroom into unique and often challenging cultural contexts. The Study Abroad office at Clemson University (<http://www.clemson.edu/studyabroad/>) provides operational support to student engagement programs outside the U.S. and enhances the University's international focus through development of activities, programs, exchanges and events that foster global and intercultural awareness, knowledge and understanding among faculty, staff, and students.

Students interested in pursuing a potential Study Abroad program are encouraged to visit their website for information on how to get started, applying for a program, and learning about the resources that may be available. It is highly recommended that Study Abroad be done during your freshmen or sophomore years; doing so later is difficult because students may have trouble getting into higher level courses at other universities. Studying abroad during your junior or senior year also disrupts the research course sequence that all geology majors are required to complete (see Research Opportunities section).

Internships and Cooperative Education

Internship opportunities can provide students with both financial assistance and the added benefit of receiving practical experience in the geology field. Governmental organizations such as the US Department of Energy, US Geological Survey, US Environmental Protection Agency, and the National Park Service typically sponsor summer internships, as do a number of other organizations (e.g., Student Conservation Association).

The Cooperative Education Program at Clemson University is a planned program in which students alternate semesters of academic study with work semesters at a business, agency, or organization. Work periods normally take place during the sophomore and junior years, including summers. Participation in the co-op program will prolong your education by one or more semesters but can be an excellent way to obtain relevant work experience. Often, a co-op experience can give you an “inside track” on job opportunities.

Students interested in seeking an internship and/or co-op experience should begin their search using the resources available at the Clemson University Cooperative Education Office (http://career.clemson.edu/cooperative_education/) and the Michelin Career Center (http://career.clemson.edu/michelin_career_center/). In addition to the information available there, students should plan to broadly search for other opportunities via the internet.

Graduate School

Students considering graduate school should begin planning early, preferably before their senior year. Talking with your advisor and other geology professors may help you narrow down the field or fields that most interest you, which in turn may enable you to better select elective courses to prepare you for that particular field or fields. Discussions with professors also may help you decide which universities to consider for your graduate studies.

Information about graduate school programs are often posted in Brackett Hall, but an internet search of suitable programs also will be beneficial. You should thoroughly review the websites of promising university graduate programs to learn about their admission requirements, application procedures and deadlines, opportunities for fellowships and research/teaching assistantships, etc. In general, most universities will require that you submit:

- Formal application form
- Two or more letters of recommendation
- Graduate Record Exam (GRE) scores
- Application fee
- Official transcript(s)

Additional information about the GRE is available at <http://www.ets.org/gre>. It is generally a good idea to take the GRE early in the fall semester of your senior year so that you can retake the exam, if necessary, and still meet application deadlines.

Making personal contact (e.g., typically at the beginning with a graduate program coordinator by email or phone) is often beneficial and can be done before or after submitting an official application. Have a prepared list of questions you want to ask. If at all possible, arrange a visit to the schools so you can see the departments and meet with faculty, especially if you have been offered admission to more than one program. Be sure to talk with some current graduate students, especially those working in your field(s) of interest, to see how they like the environment of the school and program.

APPENDIX

Geology BS Degree

Student Worksheet for Curriculum Beginning Fall 2014

FRESHMAN YEAR			
___ CH 1010 General Chemistry	4	___ CH 1020 General Chemistry	4
___ ENGL 1030 Composition and Rhetoric	3	___ GEOL 1120 Earth Resources	3
___ GEOL 1010 Physical Geology	3	___ MATH 1080 Calculus of One Variable II	4
___ GEOL 1030 Physical Geology Lab	1	___ SS / A&H Lit / A&H Non-Lit Reqt ¹ _____	3
___ MATH 1060 Calculus of One Variable I	4	___ SS / A&H Lit / A&H Non-Lit Reqt ¹ _____	3
	15		17
SOPHOMORE YEAR			
___ GEOL 2050 Mineralogy and Intro. Petrology	3	___ GEOL 2020 Earth History	4
___ GEOL 2070 Mineral. And Intro. Petrology Lab	1	___ GEOL 2920 Introduction to Research II	1
___ GEOL 2910 Introduction to Research I	1	___ STEM Reqt ² _____	4
___ PHYS 1220 Physics with Calculus I	3	___ STEM Reqt ² _____	3
___ STEM Reqt ² _____	3	___ Quantitative Science ³ _____	3
___ SS / A&H Lit / A&H Non-Lit Reqt ¹ _____	3		
___ SS / A&H Lit / A&H Non-Lit Reqt ¹ _____	3		
	17		15
JUNIOR YEAR			
___ GEOL 3020 Structural Geology	4	___ GEOL 3920 Research Methods II	2
___ GEOL 3910 Research Methods I	2	___ Geology Reqt ⁴ _____	3
___ Quantitative Science ³ _____	3	___ Geology Reqt ⁴ _____	4
___ STEM Reqt ² _____	3	___ STEM Reqt ² _____	3
	12		12
FIELD EXPERIENCE			
___ Field Experience ⁵	6		
SENIOR YEAR			
___ GEOL 4910 Research Synthesis I	3	___ GEOL 4920 Research Synthesis II	3
___ Geology Reqt ⁴ _____	4	___ Geology Reqt ⁴ _____	4
___ STEM Reqt ² _____	3	___ STEM Reqt ² _____	3
___ STEM Reqt ² _____	3	___ STEM Reqt ² _____	3
	13		13

120 Total Semester Hours

<p>1 See General Education Requirements. Three of these credits must also satisfy the Cross Cultural Awareness Requirement.</p> <p>2 Twenty-eight credit hours selected from department approved list. No more than 14 hours below the 3000-level and no more than eight hours below the 2000-level. Courses may not be used to satisfy any other requirement.</p> <p>3 Select from department approved list. Courses may not be used to satisfy any other requirement.</p> <p>4 Fifteen credit hours. Select from GEOL 3130, 3180, 4050, 4090, 4150, 4210, or 4820. Only excess hours may be used to satisfy STEM requirement hours.</p> <p>5 GEOL 4750, or other six-credit summer geology field camp, or a combination of GEOL 2750 plus a three-credit field course in geology or other approved discipline. Students desiring to become registered professional geologists should take a six-credit summer field camp in geology/hydrogeology.</p>	<p>STS Requirement: _____</p> <p>CCA Requirement: _____</p> <p>Arts&Humanities Lit Requirement: _____</p> <p>Arts&Humanities Non-Lit Requirement: _____</p> <p>Social Science Requirement: _____</p> <p>Social Science Requirement: _____</p> <p>Total # of General Education Hours Completed: _____</p>
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- SEE OPPOSITE SIDE FOR DEPARTMENT APPROVED LISTS**
- 2. STEM Requirement (28 credits total)**
- 3. Quantitative Science Requirement (6 credits total)**
- 5. Field Experience (6 credits total)**

Department Approved Lists for Geology B.S. Degree

2. STEM Requirement

Courses used to satisfy the STEM Requirement may not be used to satisfy any other geology degree requirement. Pick a minimum of **28** credit hours total from the disciplines below subject to the following limitations:

- (1) No more than 14 credit hours below the 3000-level and no more than 8 credit hours below the 2000-level.
- (2) No creative inquiry courses without prior approval from the advisor.
- (3) No research-based or independent study-type course outside GEOL without prior approval from the advisor, and
- (4) Credit for GEOL 4110 is limited to a maximum of 3 hours.

Acceptable course prefixes are: ASTR, BCHM, BE, BIOE, BIOL, CE, CH, CHE, ECE, EES, ETOX, GEOL, IE, MATH, ME, MICR, MSE, PHYS

Other acceptable courses, subject to the limitations above, are:

PES 2020 Soils	4
ENSP 2000 Introduction to Environmental Science	3
ENGR 1020 Engineering Disciplines and Skills	2
ENGR 1410 Programming and Problem Solving	3
EM 2020 Engineering Mechanics: Dynamics	3
CPSC 1110 or CPSC 1150 or CPSC 1610	3

(Note: Credit can be received for only one of these introductory programming courses)

3. Quantitative Science

Courses selected to satisfy the Quantitative Science Requirement may not be used to satisfy any other geology degree requirement. Pick two courses from the groupings below:

Pick one or two courses from: GEOL 4150, MATH 2060, MATH 2080, MATH 3110

Pick up to one course from: STAT 2300, MATH 3020, MATH 3600, ENGR 1410
CPSC 1610, CPSC 1150, CPSC 1110

5. Field Experience

In addition to the courses specifically listed in the footnote, other currently approved three credit field courses at Clemson University are:

GEOL 3700 Western US Field Study
GEOL 3750 Bahamian Field Study
GEOL 3800 Caribbean Field Studies

Other field courses at Clemson University or at other universities may be approved on a case-by-case basis. See your advisor for guidance and assistance.

Geology BS Degree

Student Worksheet for Curriculum Beginning Fall 2014

HYDROGEOLOGY CONCENTRATION			
FRESHMAN YEAR			
___ CH 1010 General Chemistry	4	___ CH 1020 General Chemistry	4
___ ENGL 1030 Composition and Rhetoric	3	___ GEOL 1120 Earth Resources	3
___ GEOL 1010 Physical Geology	3	___ MATH 1080 Calculus of One Variable II	4
___ GEOL 1030 Physical Geology Lab	1	___ SS / A&H Lit / A&H Non-Lit Reqt ¹ _____	3
___ MATH 1060 Calculus of One Variable I	4	___ SS / A&H Lit / A&H Non-Lit Reqt ¹ _____	3
	15		17
SOPHOMORE YEAR			
___ GEOL 2050 Mineralogy and Intro Petrology	3	___ GEOL 2020 Earth History	4
___ GEOL 2070 Mineralogy and Intro Petrology Lab	1	___ GEOL 2920 Introduction to Research II	1
___ GEOL 2910 Introduction to Research I	1	___ MATH 3020 <i>or</i> STAT 2300 (Statistics)	3
___ PHYS 1220 Physics with Calculus I	3	___ PHYS 2210 Physics with Calculus II	3
___ PHYS 1240 Physics Lab I	1	___ Hydrogeology Requirement ² : _____	3
___ Hydrogeology Requirement ² : _____	3	___ SS / A&H Lit / A&H Non-Lit Reqt ¹ _____	3
___ SS / A&H Lit / A&H Non-Lit Reqt ¹ _____	3		
	15		17
JUNIOR YEAR			
___ GEOL 3000 Environmental Geology	3	___ GEOL 3130 Sedimentology and Stratigraphy	4
___ GEOL 3020 Structural Geology	4	___ GEOL 3180 Introduction to Geochemistry	3
___ GEOL 3910 Research Methods I	2	___ GEOL 3920 Research Methods II	2
___ GEOL 4150 Analysis of Geological Processes ³	4	___ GEOL 4210 GIS Applications in Geology	3
	13		12
FIELD EXPERIENCE			
___ GEOL 4750 Summer Geology Field Camp	6		
SENIOR YEAR			
___ GEOL 4820 Groundwater and Contaminant Transport	3	___ EES 4010 Environmental Engineering	3
___ GEOL 4910 Research Synthesis I	3	___ GEOL 4050 Surficial Geology	4
___ Hydrogeology Requirement ² : _____	3	___ GEOL 4090 Envr and Exploration Geophysics	4
___ Hydrogeology Requirement ² : _____	3	___ GEOL 4920 Research Synthesis II	3
	12		14
121 Total Semester Hours			
<p>1 See General Education Requirements. Three of these credits must also satisfy the Cross Cultural Awareness Requirement</p> <p>2 Total of 12 credit hours selected from department approved list. Courses may not be used to satisfy any other requirement.</p> <p>3 MATH 2060 may be substituted.</p>		<p>STS Requirement: _____</p> <p>CCA Requirement: _____</p> <p>Arts&Humanities Lit Requirement: _____</p> <p>Arts&Humanities Non-Lit Requirement: _____</p> <p>Social Science Requirement: _____</p> <p>Social Science Requirement: _____</p> <p>Total # of General Education Hours Completed: _____</p>	

SEE OPPOSITE SIDE FOR DEPARTMENT APPROVED LISTS
2. Hydrogeology Requirement (12 credits total)

Department Approved List for Hydrogeology Concentration

2. Hydrogeology Requirement

Courses used to satisfy the Hydrogeology Requirement may not be used to satisfy any other geology degree requirement. Pick a minimum of **12** credit hours total from the courses/disciplines below subject to the limitations specified.

CH 2230 or CH 2010 Organic Chemistry	3
PES 2020 Soils	4
ENSP 2000 Introduction to Environmental Science	3
GEOL 2700 Experiences in Sustainable Development: Water	3
GEOL 2750 Field Methods in Geology	3
MATH 2060 Calculus of Several Variables	4
MATH 2080 Introduction to Ordinary Differential Equations	4
ENGR 1020 Engineering Disciplines and Skills	2
ENGR 1410 Programming and Problem Solving	3
CE 2010 Statics	3
CE 2080 Dynamics	2
EM 2020 Engineering Mechanics: Dynamics	3
CPSC 1110 or CPSC 1150 or CPSC 1610	3

(Note: Credit can be received for only one of these introductory programming courses)

3000- and 4000-level courses in ASTR, BCHM, BE, BIOE, BIOL, CE, CH, CHE, ECE, EES, ETOX, GEOL, IE, MATH, ME, MICR, MSE, PHYS may also be used to satisfy the Hydrogeology Requirement subject to the following limitations: (1) No creative inquiry courses without prior approval, (2) No research-based or independent study-type course outside GEOL without prior approval, and (3) Credit for GEOL 4110 is limited to a maximum of 3 hours.

Geology BS Degree

Student Worksheet for Curriculum Beginning Fall 2014

ENVIRONMENTAL SCIENCE CONCENTRATION			
FRESHMAN YEAR			
___ CH 1010 General Chemistry	4	___ CH 1020 General Chemistry	4
___ ENGL 1030 Composition and Rhetoric	3	___ GEOL 1120 Earth Resources	3
___ GEOL 1010 Physical Geology	3	___ MATH 1080 Calculus of One Variable II	4
___ GEOL 1030 Physical Geology Lab	1	___ SS / A&H Lit / A&H Non-Lit Reqt ¹ _____	3
___ MATH 1060 Calculus of One Variable I	4	___ SS / A&H Lit / A&H Non-Lit Reqt ¹ _____	3
	15		17
SOPHOMORE YEAR			
___ BIOL 1030 General Biology I	3	___ BIOL 1040 General Biology II	3
___ BIOL 1050 General Biology Lab I	1	___ BIOL 1060 General Biology Lab II	1
___ ENSP 2000 Intro. To Environmental Science	3	___ CH 2010 <i>or</i> CH 2230 (Organic Chemistry)	3
___ GEOL 2050 Mineralogy and Intro. Petrology	3	___ GEOL 2020 Earth History	4
___ GEOL 2070 Mineral. And Intro. Petrology Lab	1	___ GEOL 2920 Introduction to Research II	1
___ GEOL 2910 Introduction to Research I	1	___ PHYS 1220 Physics with Calculus I	3
___ SS / A&H Lit / A&H Non-Lit Reqt ¹ _____	3		
	15		15
JUNIOR YEAR			
___ GEOL 3000 Environmental Geology	3	___ GEOL 3180 Introduction to Geochemistry	3
___ GEOL 3020 Structural Geology	4	___ GEOL 3920 Research Methods II	2
___ GEOL 3910 Research Methods I	2	___ GEOL 4210 GIS Applications in Geology	3
___ GEOL 4150 Analysis of Geological Processes ²	4	___ MATH 3020 <i>or</i> STAT 2300 (Statistics)	3
		___ Env Sci Requirement ³ _____	4
	13		15
FIELD EXPERIENCE			
___ Field Experience ⁴	6		
SENIOR YEAR			
___ ENSP 4000 Studies in Environmental Science	3	___ GEOL 4920 Research Synthesis II	3
___ GEOL 4820 Groundwater and Contaminant Transport	3	___ Env Sci Requirement ³ _____	4
___ GEOL 4910 Research Synthesis I	3	___ Env Sci Requirement ³ _____	3
___ SS / A&H Lit / A&H Non-Lit Reqt ¹ _____	3	___ Env Sci Requirement ³ _____	3
	12		13
121 Total Semester Hours			

<p>¹ See General Education Requirements. Three of these credits must also satisfy the Cross Cultural Awareness Requirement</p> <p>² MATH 2060 may be substituted.</p> <p>³ Total of 14 credit hours selected from department approved list. No more than eight hours below the 3000-level. Courses may not be used to satisfy any other requirement.</p> <p>⁴ GEOL 4750 or a combination of GEOL 2750 plus a three-credit field course in geology, ecology, or other approved discipline. Students desiring to become registered professional geologists should take a six-credit summer field camp in geology/hydrogeology.</p>	<p>STS Requirement: _____</p> <p>CCA Requirement: _____</p> <p>Arts&Humanities Lit Requirement: _____</p> <p>Arts&Humanities Non-Lit Requirement: _____</p> <p>Social Science Requirement: _____</p> <p>Social Science Requirement: _____</p> <p>Total # of General Education Hours Completed: _____</p>
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SEE OPPOSITE SIDE FOR DEPARTMENT APPROVED LISTS

3. Env Sci Requirement (14 credits total)

4. Field Experience (6 credits total)

Department Approved Lists for Environmental Science Concentration

3. Environmental Science Requirement

Courses used to satisfy the Environmental Science Requirement may not be used to satisfy any other geology degree requirement. Pick a minimum of **14** credits from the courses listed. No more than eight credits may be selected from courses below the 3000-level. Students desiring to become a registered professional geologist should take GEOL 3130 and 4050.

ENSP 3150 Environment and Agriculture	3
AGRB 2570 Natural Resources, Environment, and Economics	3
AGRB 3570 Natural Resource Economics	3
AGRB 4570 Natural Resource Use, Technology, and Policy	3
BE 3220 Small Watershed Hydrology and Sedimentology	3
BE 4220 Hydrologic Modeling of Small Watersheds	3
BIOL (WFB) 3130 Conservation Biology	3
BIOL 4100 Limnology	3
BIOL (ENR) 4130 Restoration Ecology	3
BIOL 4410 Ecology	3
BIOL 4430 Freshwater Ecology	3
CH 4130 Chemistry of Aqueous Systems	3
PES 2020 Soils	4
PES (BE) 4080 Land Treatment of Wastewater and Sludges	3
PES (GEOL) 4850 Environmental Soil Chemistry	3
EES 4010 Environmental Engineering	3
EES 4100 Environmental Radiation Protection I	3
EES 4800 Environmental Risk Assessment	3
EES 4840 Municipal Solid Waste Management	3
EES 4850 Hazardous Waste Management	3
FNR 2040 Soil Information Systems	4
GEOL 2700 Experiences in Sustainable Development: Water	3
GEOL 2750 Field Methods in Geology	3
GEOL 3130 Sedimentology and Stratigraphy	4
GEOL 3700 Western US Field Study	3
GEOL 3750 Bahamian Field Study	3
GEOL 3800 Caribbean Field Studies	3
GEOL 4050 Surficial Geology	4
GEOL 4090 Environmental and Exploration Geophysics	4
GEOL 4590 Biogeochemistry	3
GEOL 4750 Summer Geology Field Camp	6
MATH 2060 Calculus of Severable Variables	4
MATH 2080 Introduction to Ordinary Differential Equations	4
MATH 3110 Linear Algebra	3
MATH 3600 Intermediate Mathematical Computing	3
MICR 3050 General Microbiology	4
MICR 4010 Microbial Diversity and Ecology	4
MICR 4020 Environmental Microbiology	3
MICR 4100 Soil Microbiology	3
PHYS 2210 Physics with Calculus II	3
PHYS 2400 Physics of the Weather	3
PHYS 2450 Physics of Global Climate Change	3

4. Field Experience

In addition to the courses specifically listed in the footnote, other currently approved three credit field courses at Clemson University are:

- GEOL 3700 Western US Field Study
- GEOL 3750 Bahamian Field Study
- GEOL 3800 Caribbean Field Studies

Other field courses at Clemson University or at other universities may be approved on a case-by-case basis. See your advisor for guidance and assistance.