

# EARTH SCIENCE, BS

**Banner Code:** SC-BS-ESCI

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This degree is intended for students interested in studying the Earth and its processes. Students receive a broad background in the Earth sciences and select one of five specialty concentrations. The concentrations in Earth surface processes, environmental geoscience, geology, and paleontology are solely offered by the Department of Atmospheric, Oceanic and Earth Sciences. The concentration in oceanography and estuarine science is offered jointly with the Department of Environmental Science and Policy, where specific advising is also available.

This is a Green Leaf program.

## Teacher Licensure

Students who wish to become teachers and plan to seek teacher licensure should consider the following options:

- Secondary Education – Earth Science (6-12) Undergraduate Certificate
- Earth Science, BS/Curriculum and Instruction, Accelerated MED (Secondary Education Earth Science concentration)

Interested students should attend an information session early in their undergraduate career. For more information, visit the Graduate School of Education's website (<http://gse.gmu.edu>).

## Admissions & Policies

### Admissions

University-wide admissions policies can be found in the Undergraduate Admissions Policies section of this catalog.

To apply for this program, please complete the George Mason University Admissions Application (<https://www2.gmu.edu/admissions-aid/apply-now>).

### Policies

Students must fulfill all Requirements for Bachelor's Degrees, including the Mason Core.

For policies governing all undergraduate degrees, see AP.5 Undergraduate Policies.

### Writing Intensive Requirement

GEOL 317 Geomorphology fulfills the writing intensive requirement for this major, with the exception of:

- The Environmental Geoscience Concentration, whereby GEOL 305 Environmental Geology fulfills the writing intensive requirement.

- The Paleontology Concentration, whereby GEOL 334 Vertebrate Paleontology fulfills the writing intensive requirement.

## Requirements

### Degree Requirements

Total credits: minimum 120

Students should refer to the Admissions & Policies tab for specific policies related to this program.

Students must complete the all coursework with a minimum GPA of 2.00.

### Core Science and Mathematics

GEOL 101	Introductory Geology I (Mason Core)	4
GEOL 309	Introduction to Oceanography	3
or BIOL 309	Introduction to Oceanography	
GEOL 406	Seminar in Earth and Environmental Science	3
or GEOL 420	Earth Science and Policy (Mason Core)	
CHEM 211 & CHEM 213	General Chemistry I (Mason Core) and General Chemistry Laboratory I (Mason Core)	4
CHEM 212 & CHEM 214	General Chemistry II (Mason Core) and General Chemistry Laboratory II (Mason Core)	4
MATH 113	Analytic Geometry and Calculus I (Mason Core)	4
MATH 114	Analytic Geometry and Calculus II	4
STAT 250	Introductory Statistics I (Mason Core)	3

Select one of the following options: 3-4

#### Option A:

CLIM 111 Introduction to the Fundamentals of Atmospheric Science (Mason Core)

CLIM 112 Introduction to the Fundamentals of Atmospheric Science Lab (Mason Core)

#### Option B:

PHYS 111 Introduction to the Fundamentals of Atmospheric Science (Mason Core)

PHYS 112 Introduction to the Fundamentals of Atmospheric Science Lab (Mason Core)

#### Option C:

GGG 309 Meteorology and Climate

Total Credits 32-33

### Physics

Select one 8-credit sequence from the following: 8

PHYS 160 & PHYS 161 & PHYS 260 & PHYS 261	University Physics I (Mason Core) and University Physics I Laboratory (Mason Core) and University Physics II (Mason Core) and University Physics II Laboratory (Mason Core)
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PHYS 243 & PHYS 244 & PHYS 245 & PHYS 246	College Physics (Mason Core) and College Physics Lab (Mason Core) and College Physics (Mason Core) and College Physics Lab (Mason Core)	
Total Credits		8

### Concentration in Earth Surface Processes (EP)

This concentration focuses on a broad understanding of the physical processes and natural materials found at or near the Earth's surface that have produced the primary landforms and landscapes observed today. Fundamental concepts, methods and techniques of landscape analysis are also examined. Students choosing this concentration must complete the following coursework:

GEOL 102 or EVPP 110	Introductory Geology II (Mason Core) The Ecosphere: An Introduction to Environmental Science I (Mason Core)	4
GEOL 302	Mineralogy	4
GEOL 303	Field Mapping Techniques	3
GEOL 306	Soil Science	3
GEOL 317	Geomorphology <sup>1</sup>	4
GGS 311	Introduction to Geographic Information Systems	3
Select 10-15 credits from the following:		10-15
GEOL 304	Sedimentary Geology <sup>2</sup>	
GEOL 305	Environmental Geology	
GEOL 313	Hydrogeology	
GEOL 315	Topics in Geology II	
GEOL 363	Coastal Morphology and Processes	
GEOL 401	Structural Geology	
GEOL 403	Geochemistry	
GEOL 417	Geophysics	
Total Credits		31-36

<sup>1</sup> Fulfills writing intensive requirement.

<sup>2</sup> GEOL 302 Mineralogy with a C or better is required as a prerequisite.

### Concentration in Environmental Geoscience (EVGS)

This concentration provides the tools for applying geologic information (on soils, rocks, water, weather, and landscapes) to contemporary environmental problems (including: pollution, waste management, resource extraction, natural hazards, land-use, habitat restoration, species preservation, and human health). Environmental geoscience studies the physical environment in which biological interactions take place, whereby aiding the understanding of ecology. Students choosing this concentration must complete the following coursework:

GEOL 102	Introductory Geology II (Mason Core)	4
GEOL 302	Mineralogy	4
GEOL 305	Environmental Geology <sup>1</sup>	3
GEOL 306	Soil Science	3
GEOL 313	Hydrogeology	3
GEOL 320	Geology of Earth Resources	3
GEOL 321	Geology of Energy Resources	3
GEOL 403 or CHEM 427	Geochemistry Aquatic Environmental Chemistry	3

EVPP 336 or EVPP 361	Human Dimensions of the Environment Introduction to Environmental Policy	3
Select 6-12 credits from the following:		6-12
CLIM 101	Global Warming: Weather, Climate, and Society (Mason Core)	
CLIM 412	Physical Oceanography	
GEOL 304	Sedimentary Geology	
EVPP 201	Environment and You: Issues for the Twenty-First Century (Mason Core)	
EVPP 336	Human Dimensions of the Environment	
EVPP 361	Introduction to Environmental Policy	
EVPP 432	Energy Policy	
EVPP 436	The Human Dimensions of Global Climate Change	
GGS 302	Global Environmental Hazards	
GGS 311	Introduction to Geographic Information Systems	
GGS 322	Issues in Global Change	
PHYS 331	Fundamentals of Renewable Energy	
CONF 101	Conflict and Our World (Mason Core)	
INTS 211	Introduction to Conservation Studies	
PRLS 300	People with Nature	
PRLS 402	Human Behavior in Natural Environments	
Total Credits		35-41

<sup>1</sup> Fulfills writing intensive requirement for this concentration only.

### Concentration in Geology (GEOL)

This concentration is fashioned after traditional geology bachelor's degrees. It allows graduates to be employed as geologists in the field or to pursue graduate studies in geology. Students choosing this concentration must complete the following coursework:

GEOL 102	Introductory Geology II (Mason Core)	4
GEOL 302	Mineralogy	4
GEOL 304	Sedimentary Geology <sup>1</sup>	4
GEOL 308	Igneous and Metamorphic Petrology <sup>1</sup>	4
GEOL 312	Invertebrate Paleontology	4
GEOL 317	Geomorphology <sup>2</sup>	4
GEOL 401	Structural Geology	4
Six credits of		6
GEOL 404	Geological Field Techniques <sup>3</sup>	
Total Credits		34

<sup>1</sup> Prerequisite requires a grade of 'C' or better in GEOL 302 Mineralogy

<sup>2</sup> Fulfills writing intensive requirement.

<sup>3</sup> A 6-credit geology field camp may be substituted for this requirement, see advisor for details.

### Concentration in Oceanography and Estuarine Science (OEST)

This concentration provides students with a comprehensive knowledge of oceanography. Additional coursework in physical and chemical oceanography give insight into the aquatic environment and its link to both ecosystems and climate. Within the concentration, students can choose an open ocean or coastal ocean option. The curriculum will

emphasize local and regional case studies, in particular the Chesapeake Bay. The program will provide students with the basic training required to allow them to obtain entry level positions in oceanographic and estuarine career tracks or an appropriate graduate degree program. Students choosing this concentration must complete the following coursework:

CLIM 412	Physical Oceanography	3
or GEOL 412	Physical Oceanography	
GEOL 102	Introductory Geology II (Mason Core)	4
GEOL 458	Chemical Oceanography	3
or CHEM 458	Chemical Oceanography	
Select one of the following 8-credit sequences:		8
BIOL 103	Introductory Biology I (Mason Core)	
& BIOL 104	and Introductory Biology II (Mason Core)	
BIOL 213	Cell Structure and Function (Mason Core)	
& BIOL 303	and Animal Biology	
EVPP 110	The Ecosphere: An Introduction to	
& EVPP 111	Environmental Science I (Mason Core)	
	and The Ecosphere: An Introduction to	
	Environmental Science II (Mason Core)	
Select one of the following options:		15-16
<b>Open Ocean Option:</b>		
GEOL 364	Marine Geology	
BIOL 449	Marine Ecology	
Three additional courses from the electives list below (minimum of 9 credits)		
<b>Coastal Ocean Option:</b>		
GEOL 363	Coastal Morphology and Processes	
EVPP 581	Estuarine and Coastal Ecology	
Three additional courses from the electives list below (minimum of 9 credits)		
Total Credits		33-34

### Electives

GEOL 302	Mineralogy	4
GEOL 304	Sedimentary Geology	4
GEOL 308	Igneous and Metamorphic Petrology	4
GEOL 312	Invertebrate Paleontology	4
GEOL 363	Coastal Morphology and Processes	4
GEOL 364	Marine Geology	3
GEOL 565	Paleoceanography	3
BIOL 440	Field Biology <sup>1</sup>	4
BIOL 449	Marine Ecology	3
EVPP 350	Freshwater Ecosystems	4
EVPP 377	Applied Ecology	3
EVPP 419	Marine Mammal Biology and Conservation	3
EVPP 581	Estuarine and Coastal Ecology	3
EVPP 582	Estuarine and Coastal Ecology Laboratory	1
INTS 395	Field-Based Work <sup>2</sup>	1-18
Additional recommended course:		
RECR 161	Scuba Diving: Basic	2

<sup>1</sup> When topic is Coral Reef Ecology

<sup>2</sup> When topic is Exploring Underwater Ecology.

## Concentration in Paleontology (PLEO)

This concentration focuses on a broad understanding of Earth's history and the evolution of life on Earth as revealed through the fossil record. Fundamental concepts, methods and techniques of historical geology and paleontological data and analysis are also examined. This concentration may not be taken in conjunction with the paleontology minor. Be aware that some of the courses below may have additional prerequisites. Students choosing this concentration must complete the following coursework:

GEOL 102	Introductory Geology II (Mason Core)	4
GEOL 302	Mineralogy	4
GEOL 304	Sedimentary Geology	4
GEOL 312	Invertebrate Paleontology	4
GEOL 334	Vertebrate Paleontology <sup>1</sup>	4
BIOL 103	Introductory Biology I (Mason Core)	4
or BIOL 213	Cell Structure and Function (Mason Core)	
Select 9-10 credits from the following additional Geology courses:		9-10
GEOL 306	Soil Science	
GEOL 317	Geomorphology	
GEOL 332	Paleoclimatology	
GEOL 364	Marine Geology	
GEOL 403	Geochemistry	
GEOL 412	Physical Oceanography	
GEOL 458	Chemical Oceanography	
GEOL 565	Paleoceanography	
Select 3-5 credits from the following additional Biology course:		3-5
BIOL 310	Biodiversity	
& BIOL 330	and Biodiversity Lab and Recitation	
BIOL 320	Comparative Chordate Anatomy	
BIOL 331	Invertebrate Zoology	
BIOL 374	Biogeography: Space, Time, and Life	
or GGS 321	Biogeography	
BIOL 468	Vertebrate Natural History	
or EVPP 468	Vertebrate Natural History	
BIOL 470	Dinosaur Biology	
BIOL 471	Evolution	
Total Credits		36-39

<sup>1</sup> Fulfills writing intensive requirement for this concentration only.

## Mason Core and Elective Credits

In order to meet a minimum of 120 credits, this degree requires additional credits (specific credit counts by concentration are shown below), which may be applied toward any remaining Mason Core requirements, Requirements for Bachelor's Degrees, and elective courses. Students are strongly encouraged to consult with their advisors to ensure that they fulfill all requirements.

- ESE concentration without Teacher Licensure: 50-51 credits
- ESE concentration with Teacher Licensure: 29-30 credits
- EP concentration: 43-49 credits
- EVGS concentration: 38-45 credits
- GEOL concentration: 45-46 credits

- PLEO concentration: 40-44 credits
- OEST concentration: 42-47 credits

### Mason Core

Note: Some Mason Core requirements may already be fulfilled by the major requirements listed above. Students are strongly encouraged to consult their advisors to ensure they fulfill all remaining Mason Core requirements.

Code	Title	Credits
<b>Foundation Requirements</b>		
	Written Communication	6
	Oral Communication	3
	Quantitative Reasoning	3
	Information Technology	3-7
<b>Core Requirements</b>		
	Arts	3
	Global Understanding	3
	Literature	3
	Natural Science	7
	Social and Behavioral Sciences	3
	Western Civilization/World History	3
<b>Synthesis/Capstone Requirement</b> <sup>1</sup>		
	Synthesis/Capstone	3
	Total Credits	40

<sup>1</sup> minimum 3 credits

## Honors

### Honors in the Major

Earth science and geology majors who have completed 16 credits of math and science, including GEOL 302 Mineralogy with a GPA of 3.00 or higher are eligible to enter the departmental honors program. Transfer students who have an incoming GPA of 3.10 or higher in math and science and a grade of 'B' or better in GEOL 302 Mineralogy are also eligible. To graduate with honors in Earth Science, students are required to maintain a minimum GPA of 3.00 in math and science courses and complete one of the two following sets of courses with an average GPA of 3.50 or better:

#### Course List

Code	Title	Credits
<b>First Set of Courses</b>		
GEOL 410	Research Proposal Preparation	1
GEOL 411	Geological Research	3
GEOL 420	Earth Science and Policy (Mason Core)	3
<b>Second Set of Courses</b>		
CLIM 408	Senior Research	3
CLIM 409	Research Internship	3
GEOL 420	Earth Science and Policy (Mason Core)	3

## Accelerated Master's

### Bachelor's Degree (Green Leaf)/ Environmental Science and Policy, Accelerated MS

#### Overview

This degree option allows highly qualified George Mason University students to earn an Environmental Science and Policy, MS in less time than if they had first graduated with an environmentally-focused Green Leaf-designated BA or BS degree and then applied to the MS program sequentially.

For more detailed information, see AP.6.7 Bachelor's/Accelerated Master's Degrees. For policies governing all graduate programs, see AP.6 Graduate Policies.

#### Admission Requirements

Students with an overall GPA of at least 3.20 who are pursuing any Green Leaf-designated major or minor may apply for provisional acceptance into this accelerated master's program after completing two semesters of chemistry (including CHEM 211 General Chemistry I (Mason Core) and CHEM 212 General Chemistry II (Mason Core)) and three semesters of biology, including a course in ecology, or the equivalent, for example:

Code	Title	Credits
Select one of the following options:		
13		
<b>Option 1:</b>		
BIOL 213	Cell Structure and Function (Mason Core)	
BIOL 214	Biostatistics for Biology Majors	
BIOL 308	Foundations of Ecology and Evolution	
<b>Option 2:</b>		
EVPP 210	Environmental Biology: Molecules and Cells	
EVPP 301	Environmental Science: Biological Diversity and Ecosystems	
EVPP 302	Environmental Science: Biomes and Human Dimensions	
EVPP 305	Environmental Microbiology Essentials	
EVPP 306	Environmental Microbiology Essentials Laboratory	
<b>Option 3:</b>		
CONS 401	Conservation Theory	
CONS 402	Applied Conservation	
6 credits of 6 credits of BIOL or CONS electives		
<b>Option 4:</b>		
CONS 403	Ecology and Conservation Theory	
CONS 404	Biodiversity Monitoring	
BIOL or CONS electives		

By the beginning of the undergraduate's senior year, they should first submit a Graduate Application for Accelerated Master's Program form (obtained from the Office of Academic and Student Affairs (<https://cos.gmu.edu/about/contact-us>)). Secondly, in their senior year accelerated master's students must complete the two graduate courses indicated on their Accelerated Master's Program Application with a

minimum grade of 3.00 in each course. They must maintain a minimum GPA of 3.00 in all coursework and in coursework applied to their major. Upon completion and conferral of the undergraduate degree in a Green Leaf-designated program, in the semester indicated in the application, they must additionally submit the Bachelor's/Accelerated Master's Transition form (found on the Office of the University Registrar website (<http://registrar.gmu.edu/forms>)) and will subsequently be admitted into graduate status.

By at least the beginning of their senior year, they should seek out a faculty member in the Department of Environmental Science and Policy who is willing to serve as their advisor (unless the student is planning to enroll in the MS concentration in Environmental Management). This advisor will aid the student in choosing the appropriate graduate courses to take and help to prepare the student for graduate studies. Admission into a research-oriented master's concentration is dependent upon securing the agreement of a faculty advisor. Faculty from a variety of departments and colleges at George Mason (called "program faculty") can serve as master's advisors. Potential students are encouraged to speak with the graduate program coordinator in the department to obtain guidance on this issue.

## Application Requirements

Applicants to all graduate programs at Mason must meet the admission standards and application requirements for graduate study as specified in the Graduate Admission Policies section of this catalog, *excluding* the GRE exam requirement (which is not required for those enrolled in the accelerated program). This includes three letters of recommendation (at least one from a former professor or someone with a PhD), a recent resume, a statement of interest/research goals and interests (including information on the candidate's proposed MS research), and a letter from their advisor stating that the advisor agrees to take on the candidate as an MS student, how the candidate would be a good fit for them and why candidate's research topic would be suitable (please note that a letter of endorsement from an advisor not necessary for candidates taking the Environmental Management concentration).

For information specific to the accelerated Environmental Science and Policy, MS, see Graduate Admissions on the department's website (<http://esp.gmu.edu/academic-programs/graduate/admissions>).

## Reserve Graduate Credits

Students admitted to this program may take graduate courses after completing 90 undergraduate credits, and up to 6 credits of appropriate environmentally-focused graduate coursework may be used in partial satisfaction of the requirements for the undergraduate degree. If students earn at least a 3.00 GPA in these classes, they are granted advanced standing in the master's program and must then complete an additional 27-31 credits to receive the master's degree.

To apply these credits to the master's degree, students must request that the credits be moved from the undergraduate degree to the graduate degree using the Bachelor's/Accelerated Master's Transition form found on the Office of the University Registrar website (<http://registrar.gmu.edu/forms>) (as noted above).

Students may take up to 6 additional environmentally-focused graduate credits as reserve graduate credit. These credits do not apply to the undergraduate degree but will reduce the subsequent master's degree credits accordingly (e.g., with 6 credits counted towards undergraduate degree plus the maximum 6 reserve credits, an MS could be completed with 21 post-bachelor's credits). The ability to take courses for reserve

graduate credit is available to all high achieving undergraduates with the permission of the department.

## Earth Science, BS/Curriculum and Instruction, Accelerated MEd (Secondary Education Earth Science concentration)

### Overview

Highly-qualified undergraduates may be admitted to the bachelor's/accelerated master's option and obtain both a BS in Earth Science and an MEd in Curriculum and Instruction (concentration in secondary education earth science) in an accelerated time-frame after satisfactory completion of 149 credits. See AP.6.7 Bachelor's/Accelerated Master's Degree for policies related to this program.

This accelerated option is offered jointly by the Department of Atmospheric, Oceanic and Earth Sciences and the Graduate School of Education.

Students in an accelerated degree program must fulfill all university requirements for the master's degree. For policies governing all graduate degrees, see AP.6 Graduate Policies.

### Application Requirements

Applicants to all graduate programs at George Mason University must meet the admission standards and application requirements for graduate study as specified in Graduate Admissions Policies. For information specific to this accelerated master's program, see Application Requirements and Deadlines (<https://cehd.gmu.edu/bachelors-accelerated-masters-program>).

### Accelerated Option Requirements

Students complete the following courses in their senior year:

Senior			
Fall Semester	Credits	Spring Semester	Credits
EDCI 573	3	EDCI 673	3
EDUC 672	3	EDRD 619	3
	6		6

Total Credits 12

While undergraduate students, accelerated master's students are able to apply two of the courses listed above to both the bachelor's and master's degrees. These courses are considered advanced standing for the MEd. A minimum grade of B must be earned to be eligible to count as advanced standing. The other two courses are taken as reserve graduate credit and do not apply to the undergraduate degree. Early in their final undergraduate semester, students must submit the Bachelor's/Accelerated Master's Transition Form to the CEHD Admissions Office and specify which of the four courses are to be designated as advanced standing and reserve graduate credit.