Earth Science, BS

Banner Code: SC-BS-ESCI

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Website: cos.gmu.edu/aoes/academics/undergraduate-programs/

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:

- Curriculum and Instruction 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 AP5 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.

Requirements

Degree Requirements

Total credits: minimum 120

This is a Green Leaf program.

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

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

Core Science and Mathematics

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEOL 101</td>
<td>Introductory Geology I (Mason Core)</td>
<td>4</td>
</tr>
<tr>
<td>GEOL 309</td>
<td>Introduction to Oceanography</td>
<td>3</td>
</tr>
<tr>
<td>or BIOL 309</td>
<td>Introduction to Oceanography</td>
<td></td>
</tr>
<tr>
<td>GEOL 420</td>
<td>Earth Science and Policy (Mason Core)</td>
<td>3</td>
</tr>
<tr>
<td>CHEM 211 &amp; CHEM 213</td>
<td>General Chemistry I (Mason Core)</td>
<td>4</td>
</tr>
<tr>
<td>CHEM 212 &amp; CHEM 214</td>
<td>General Chemistry Laboratory I (Mason Core)</td>
<td></td>
</tr>
<tr>
<td>MATH 113</td>
<td>Analytic Geometry and Calculus I (Mason Core)</td>
<td>4</td>
</tr>
<tr>
<td>MATH 114</td>
<td>Analytic Geometry and Calculus II</td>
<td>4</td>
</tr>
<tr>
<td>STAT 250</td>
<td>Introductory Statistics I (Mason Core)</td>
<td>3</td>
</tr>
</tbody>
</table>

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:

- GGS 309 Meteorology and Climate

Total Credits 32-33
### Physics

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHYS 160 &amp; PHYS 161 &amp; PHYS 260 &amp; PHYS 261</td>
<td>University Physics I (Mason Core) and University Physics Laboratory (Mason Core) and University Physics II (Mason Core) and University Physics II Laboratory (Mason Core)</td>
<td>8</td>
</tr>
<tr>
<td>PHYS 243 &amp; PHYS 244 &amp; PHYS 245 &amp; PHYS 246</td>
<td>College Physics I (Mason Core) and College Physics Lab (Mason Core) and College Physics II (Mason Core) and College Physics Lab (Mason Core)</td>
<td>8</td>
</tr>
</tbody>
</table>

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:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEOL 102 or EVPP 110</td>
<td>Introductory Geology II (Mason Core) or The Ecosphere: An Introduction to Environmental Science I (Mason Core)</td>
<td>4</td>
</tr>
<tr>
<td>GEOL 302</td>
<td>Mineralogy</td>
<td>4</td>
</tr>
<tr>
<td>GEOL 303</td>
<td>Field Mapping Techniques</td>
<td>3</td>
</tr>
<tr>
<td>GEOL 306</td>
<td>Soil Science</td>
<td>3</td>
</tr>
<tr>
<td>GEOL 317</td>
<td>Geomorphology</td>
<td>4</td>
</tr>
<tr>
<td>GGS 311</td>
<td>Introduction to Geographic Information Systems</td>
<td>3</td>
</tr>
</tbody>
</table>

Select 10-15 credits from the following:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEOL 304</td>
<td>Sedimentary Geology</td>
<td></td>
</tr>
<tr>
<td>GEOL 305</td>
<td>Environmental Geology</td>
<td></td>
</tr>
<tr>
<td>GEOL 313</td>
<td>Hydrogeology</td>
<td></td>
</tr>
<tr>
<td>GEOL 315</td>
<td>Topics in Geology II</td>
<td></td>
</tr>
<tr>
<td>GEOL 363</td>
<td>Coastal Morphology and Processes</td>
<td></td>
</tr>
<tr>
<td>GEOL 401</td>
<td>Structural Geology</td>
<td></td>
</tr>
<tr>
<td>GEOL 403</td>
<td>Geochemistry</td>
<td></td>
</tr>
<tr>
<td>GEOL 417</td>
<td>Geophysics</td>
<td></td>
</tr>
</tbody>
</table>

Select 6-12 credits from the following:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLIM 101</td>
<td>Global Warming: Weather, Climate, and Society (Mason Core)</td>
<td></td>
</tr>
<tr>
<td>CLIM 412</td>
<td>Physical Oceanography</td>
<td></td>
</tr>
<tr>
<td>GEOL 304</td>
<td>Sedimentary Geology</td>
<td></td>
</tr>
<tr>
<td>EVPP 201</td>
<td>Environment and You: Issues for the Twenty-First Century (Mason Core)</td>
<td></td>
</tr>
<tr>
<td>EVPP 336</td>
<td>Human Dimensions of the Environment</td>
<td></td>
</tr>
<tr>
<td>EVPP 361</td>
<td>Introduction to Environmental Policy</td>
<td></td>
</tr>
<tr>
<td>EVPP 432</td>
<td>Energy Policy</td>
<td></td>
</tr>
<tr>
<td>EVPP 436</td>
<td>The Human Dimensions of Global Climate Change</td>
<td></td>
</tr>
<tr>
<td>GGS 302</td>
<td>Global Environmental Hazards</td>
<td></td>
</tr>
<tr>
<td>GGS 311</td>
<td>Introduction to Geographic Information Systems</td>
<td></td>
</tr>
<tr>
<td>GGS 322</td>
<td>Issues in Global Change</td>
<td></td>
</tr>
<tr>
<td>PHYS 331</td>
<td>Fundamentals of Renewable Energy</td>
<td></td>
</tr>
<tr>
<td>CONF 101</td>
<td>Conflict and Our World (Mason Core)</td>
<td></td>
</tr>
<tr>
<td>INTS 211</td>
<td>Introduction to Conservation Studies (Mason Core)</td>
<td></td>
</tr>
<tr>
<td>PRLS 300</td>
<td>People with Nature</td>
<td></td>
</tr>
<tr>
<td>PRLS 402</td>
<td>Human Behavior in Natural Environments</td>
<td></td>
</tr>
</tbody>
</table>

Total Credits 35-41

1 Fulfill 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:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEOL 102</td>
<td>Introductory Geology II (Mason Core)</td>
<td>4</td>
</tr>
<tr>
<td>GEOL 302</td>
<td>Mineralogy</td>
<td>4</td>
</tr>
<tr>
<td>GEOL 304</td>
<td>Sedimentary Geology</td>
<td>4</td>
</tr>
<tr>
<td>GEOL 308</td>
<td>Igneous and Metamorphic Petrology</td>
<td>4</td>
</tr>
<tr>
<td>GEOL 312</td>
<td>Invertebrate Paleontology</td>
<td>4</td>
</tr>
<tr>
<td>GEOL 317</td>
<td>Geomorphology</td>
<td>4</td>
</tr>
<tr>
<td>GEOL 401</td>
<td>Structural Geology</td>
<td>4</td>
</tr>
</tbody>
</table>

Six credits of

1 Fulfills writing intensive requirement.
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 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:

**Course Code** | **Course Title** | **Credits**
--- | --- | ---
CLIM 412 | Physical Oceanography | 3
or GEOL 412 | Physical Oceanography | 3
GEOL 102 | Introductory Geology II (Mason Core) | 4
or GEOL 458 | Chemical Oceanography | 3
or CHEM 458 | Chemical Oceanography | 3

Select one of the following 8-credit sequences:

**Course Code** | **Course Title**
--- | ---
BIOL 103 & BIOL 107 & BIOL 106 | Introductory Biology I (Mason Core) and Intro Biology II Lecture (Mason Core) and Introductory Biology II Laboratory (Mason Core) | 8
BIOL 213 & BIOL 303 | Cell Structure and Function (Mason Core) and Animal Biology | 8
EVPP 110 & EVPP 111 | The Ecosphere: An Introduction to Environmental Science I (Mason Core) and The Ecosphere: An Introduction to Environmental Science II (Mason Core) | 8

Select one of the following options: 15-16

**Open Ocean Option:**

**Course Code** | **Course Title**
--- | ---
GEOL 364 | Marine Geology | 3
BIOL 449 | Marine Ecology | 3

Three additional courses from the electives list below (minimum of 9 credits)

**Coastal Ocean Option:**

**Course Code** | **Course Title**
--- | ---
GEOL 363 | Coastal Morphology and Processes | 4
EVPP 581 | Estuarine and Coastal Ecology | 4

Three additional courses from the electives list below (minimum of 9 credits)

Total Credits 33-34

**Electives**

**Course Code** | **Course Title** | **Credits**
--- | --- | ---
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 1 | 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 2 | 1-18

Additional recommended course:

**Course Code** | **Course Title** | **Credits**
--- | --- | ---
RECR 161 | Scuba Diving: Basic | 2

1 When topic is Coral Reef Ecology
2 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 (https://catalog.gmu.edu/colleges-schools/science/atmospheric-oceanic-earth-sciences/paleontology-minor). Students choosing this concentration must complete the following coursework:

**Course Code** | **Course Title** | **Credits**
--- | --- | ---
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 | 4
BIOL 103 | Introductory Biology I (Mason Core) or BIOL 213 | 4
or BIOL 213 | Cell Structure and Function (Mason Core) | 4

Select 9-10 credits from the following additional courses: 9-10

**Course Code** | **Course Title** | **Credits**
--- | --- | ---
GEOL 306 | Soil Science | 4
GEOL 317 | Geomorphology | 4
GEOL 332 | Paleoclimatology | 4
GEOL 364 | Marine Geology | 4
GEOL 403 | Geochemistry | 4
GEOL 412 | Physical Oceanography | 4
GEOL 458 | Chemical Oceanography | 4
GEOL 565 | Paleoclimatology | 4
GEOL 566 | Paleoceanography | 4

Select 3-5 credits from the following additional course: 3-5

**Course Code** | **Course Title** | **Credits**
--- | --- | ---
BIOL 310 & BIOL 330 | Biodiversity and Biodiversity Lab and Recitation | 4
BIOL 320 | Comparative Chordate Anatomy | 4
BIOL 331 | Vertebrate Zoology | 4
BIOL 374 | Biogeography: Space, Time, and Life or GGS 321 | 4
BIOL 468 | Vertebrate Natural History | 4
BIOL 470 | Dinosaur Biology | 4
Earth Science, BS

Total Credits 36-39

1 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.

- EP concentration: 43-49 credits
- EVGS concentration: 38-45 credits
- GEOL concentration: 45-46 credits
- OEST concentration: 42-47 credits
- PLEO concentration: 40-44 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

Foundation Requirements
Written Communication (ENGH 101) 3
Oral Communication 3
Quantitative Reasoning 3
Information Technology and Computing 3

Exploration Requirements
Arts 3
Global Understanding 3
Literature 3
Natural Science 7
Social and Behavioral Sciences 3
Western Civilization/World History 3

Integration Requirements
Written Communications (ENGH 302) 3
Writing-Intensive 1 3
Synthesis/Capstone 2 3

Total Credits 40

1 Most programs include the writing-intensive course designated for the major as part of the major requirements; this course is therefore not counted towards the total required for Mason Core.

2 Minimum 3 credits required.

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.

Code Title Credits

First Set of Courses
GEOL 410 Research Proposal Preparation 1
GEOL 411 Geological Research 3
GEOL 420 Earth Science and Policy (Mason Core) 3

Second Set of Courses
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 (selected)/ 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

Option 1:
BIOL 213 Cell Structure and Function (Mason Core) 1
BIOL 214 Biostatistics for Biology Majors 1
BIOL 308 Foundations of Ecology and Evolution 1

Option 2:
EVPP 210 Environmental Biology: Molecules and Cells 1
EVPP 301 Environmental Science: Biological Diversity and Ecosystems 1
EVPP 302 Environmental Science: Biomes and Human Dimensions 1
EVPP 305 Environmental Microbiology Essentials 1

1 Minimum 3 credits required.
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 graduate courses 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 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 AP6 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 Requirements**

Students complete the following courses in their senior year:

<table>
<thead>
<tr>
<th>Senior</th>
<th>Fall Semester</th>
<th>Credits</th>
<th>Spring Semester</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EDCI 573</td>
<td>3</td>
<td>EDCI 673</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>EDUC 672</td>
<td>3</td>
<td>EDRD 619</td>
<td>3</td>
</tr>
</tbody>
</table>

|             | 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.