Program Change Request

New Program Proposal

Date Submitted: 02/15/22 3:16 pm

Viewing: : Geology and Earth Sciences, PhD

Last edit: 02/18/22 2:42 pm

Changes proposed by: jbazaz

No Longer Accepting Students	2023-2024
Anticipated closure date (i.e., calendar	
Rationale for	

Are you completing this form on someone else's behalf?

Yes

Requestor:

Name	Extension	Email
Mark Uhen	5264	muhen@gmu.edu

Effective Catalog: 2023-2024

Program Level: Graduate

Program Type: Doctoral

Degree Type: Doctor of Philosophy

Title: Geology and Earth Sciences, PhD

Banner Title: Geology & Earth Sciences, PhD

Is this a retitling of an existing program? No

Existing Program

Registrar/OAPI Use Only – SCHEV Status Pending Approval

Registrar's Office Use Only – Program Start Term

In Workflow

1. **AOES Committee**
2. AOES Chair
3. SC Curriculum Committee
4. SC Associate Dean
5. Assoc Provost-Graduate
6. SACSCOC New Program Approval
7. SCHEV New Program Approval
8. Registrar: Activate Code
9. Registrar-Programs

Registrar/OAPI Use Only – SCHEV Letter

Registrar/OAPI Use Only – SACSCOC Status

Concentration(s):

INTO Major(s):

Registrar/IRR Use Only – Concentration CIP Code

College/School: College of Science

Department / Academic Unit: Atmospheric, Oceanic, & Earth Sciences

Jointly Owned Program? No

Participating

Participating

Justification

What: Creating a new PhD in Geology and Earth Sciences.

Why: The purpose of the proposed PhD degree program in Geology and Earth Science is to provide students with advanced education and training in preparation for high-level career opportunities in geology and Earth science. The proposed program is intended to respond to the rapidly growing worldwide demand by government, industry, and academia for experts with knowledge in critical minerals exploration, ice sheet dynamics and sea level change, renewable energy resources and technologies, and the evolution of Earth surface systems on a warming planet.

Catalog Published Information

Total Credits Required: Total credits: 72

Registrar's Office Use Only - Program Code:

Registrar/IRR Use Only – Program CIP Code 40.0401 - Atmospheric Sciences and Meteorology, General.

Admission Requirements:

Admissions

University-wide admissions policies can be found in the Graduate Admissions Policies section of this catalog. Applicants should have an undergraduate or graduate degree in geology, Earth sciences, or a related field from an institution of higher education accredited by a Mason-recognized U.S. institutional accrediting agency or international equivalent with a GPA of at least 3.00 in their undergraduate work.
To apply for this program, please complete the George Mason University Admissions Application and supply three letters of recommendation.

Program-Specific Policies:

Policies

For policies governing all graduate programs, see AP.6 Graduate Policies.

Reduction of Credit

For students entering the doctoral program with a master's degree in a related field from an institution of higher education accredited by a Mason-recognized U.S. institutional accrediting agency or international equivalent, the number of required credits may be reduced up to 30 credits, subject to approval of the program faculty and the college's associate dean for student affairs. See AP.6.5.2 Reduction of Credits for more information.

Degree Requirements:

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

Core Courses

Geology and Earth Science Foundation		
GEOL 503	Special Topics in Earth Science (when the topic is "Geochemistry")	3
GEOL 532	Paleoclimatology	3
GEOL 541	Great Events in Earth History	3
GEOL 601	The Lithosphere	3
GEOL 720	Bayesian Methods in Geology and Earth Sciences	3
Quantitative Techniques		
GEOL 525	Modeling Earth Signals and Systems	3
GEOL 540	Modern Methods in Geology	3
Geology and Earth Science Seminars		6
Select one, or a combination of the courses below to fulfill this requirement:		
GEOL 536	Paleontology Seminar (2 credits, can be repeated up to three times)	
GEOL 792	Seminar in Earth Systems Science, Geology, Earth Science (1 credit, can be repeated up to six times)	
Pedagogy		2
GEOL 752	Earth Sciences in Academia	
Total Credits		29

Restricted Elective Courses

Select 7 credits from the suggested courses below or choose other relevant graduate-level courses; all courses must be chosen in consultation with, and approved by, the student's advisor. 1		7
GEOL 500	Selected Topics in Modern Geology	
GEOL 501	Selected Topics in Modern Geology	
GEOL 504	Sedimentary Geology	
GEOL 506	Soil Science	
GEOL 510	Advanced Structural Geology	
GEOL 512	Invertebrate Paleontology	
GEOL 513	Hydrogeology	
GEOL 521	Geology of Energy Resources	
GEOL 525	Modeling Earth Signals and Systems	
GEOL 534	Vertebrate Paleontology	
GEOL 535	Quantitative Stratigraphy	
GEOL 553	Field Mapping Techniques	
GEOL 563	Coastal Morphology and Processes	
GEOL 565	Paleoceanography	
GEOL 720	Bayesian Methods in Geology and Earth Sciences	
GEOL 734	Paleobiology	
GEOL 741	Isotopes in Geology	
GEOL 996	Doctoral Reading and Research (can be repeated for up to 12 credits)	
Total Credits		7

1 Select courses that have not previously been completed at the undergraduate course level.

Elective Courses

Students select 12 additional credits from the list of restricted electives or other relevant coursework. All elective coursework must be approved by the student's advisor.		12
Total Credits		12

Dissertation Committee

The student’s dissertation committee must have at least three members who are full-time members of George Mason University’s instructional faculty. The Dissertation Committee Chair must be a faculty member in the Department of Atmospheric, Oceanic, and Earth Sciences. The second member must be a faculty member in good standing at Mason. The third member of the committee may be from the Department of Atmospheric, Oceanic, and Earth Sciences or another academic unit at Mason. Students may select a fourth member for the committee from another academic unit or outside the institution, with approval of the PhD Program Director. This option typically would be employed in order to include an external expert relevant to the student’s field of study.

Comprehensive Exam

The comprehensive exam includes written and oral components to assess whether students have the subject matter knowledge and skills to successfully propose and complete a dissertation research project and an oral

component. Students must complete the comprehensive exam within two semesters after the completion of all core and concentration coursework on their approved program of study. The comprehensive exam will consist of a set of questions tailored to the individual student. The committee will be comprised of the same individuals as the Dissertation Committee. Exams will be graded on a pass/fail basis. Students must successfully pass both the written and oral portions of the comprehensive exam in order to advance to candidacy. Students who fail either the written or the oral portion of the comprehensive exam will be granted one attempt to retake the examination the following semester. Students who do not pass the second attempt will be dismissed from the PhD program.

Written Comprehensive Exam

The written portion of the comprehensive exam will assess the student's ability to apply theoretical concepts towards the designing of potential research studies necessary to write a doctoral dissertation. It will also assess the student's capability to form research questions and present appropriate methodologies to test such questions (including, for example: Study design, analytical model development, data acquisition or collection, data management, and analysis and interpretation). The questions on the exam will be linked with the student's program of study and proposed research subject matter.

Oral Comprehensive Exam

The oral portion of the comprehensive exam will assess the student's knowledge and comprehension of the subject matter background to the field of geology and Earth sciences as a whole, as well as the specific body of knowledge related to the student's chosen area of specialty and research. The student must demonstrate mastery in articulating answers including the limitations around data to prepare them for effectively working with various audiences.

Dissertation

Students must take 24 credits in a combination of GEOL 998 and GEOL 999. Details on the advancement to candidacy and dissertation processes are outlined below.		24
GEOL 998	Doctoral Dissertation Proposal (repeated for a minimum of 12 credits)	
GEOL 999	Doctoral Dissertation (repeated for a minimum of 3 credits)	
Total Credits		24

Advancement to Candidacy

Advancement to candidacy is based upon the student's successful completion of all required coursework and passing the comprehensive examination. Advancement to candidacy is a prerequisite for admission into GEOL 998 Doctoral Dissertation Proposal.

Dissertation Proposal

Students who have advanced to candidacy begin working on the dissertation proposal the semester after passing their comprehensive exams by registering for GEOL 998 Doctoral Dissertation Proposal. Students design the conceptual framework for their research projects in consultation with the dissertation committee. A draft dissertation proposal should be submitted to the student's dissertation committee within two semesters of completing the comprehensive exam. The proposal should include a detailed literature review that provides the

context and rationale for the research questions and describes the proposed study design and analytic methods. The proposal must address the feasibility of completing the dissertation research within an appropriate time. A list of dissertation committee members must be included in the proposal, confirming each committee members' agreement to serve on the committee.

An oral proposal defense will be scheduled with all dissertation committee members in attendance. During the oral proposal defense, students describe their proposed research and address questions by the committee members. At the conclusion of the oral defense, the dissertation committee either approves the dissertation or provides written recommendations for improving the proposed research with clearly stated expectations for resubmission. All proposal defenses are open to faculty and students in the College of Science. Candidates attending the oral defense may be allowed to ask questions. The dissertation committee holds an executive session after the formal defense to finalize a decision for the student. Passing the proposal defense is a prerequisite for GEOL 999 Doctoral Dissertation. Failure to submit the proposal in a timely manner is grounds for academic probation.

Dissertation Defense

The dissertation defense is an oral presentation of the dissertation work in a public forum open to all members of the university community. An abstract and draft dissertation approved by the dissertation committee in conformance with University Library requirements is required before the defense can be scheduled. The student consults with the dissertation committee to identify a date and time for the dissertation defense. Once a date and time has been confirmed, the student works with the appropriate area administrative assistant to reserve a room for the defense. All dissertation committee members should be present. The dissertation committee convenes after the public session to discuss and approve the dissertation. The student is notified after the committee's executive session. The student is responsible for making all required edits before final acceptance of the dissertation adhering to the university's timeline for graduation.

Retroactive Requirements Updates:

Plan of Study:

Honors Information:

Accelerated Description/Dual Degree Description:

INTO-Mason Requirements:

College Requirements & Policies:

Department / Academic Unit Requirements & Policies:

Program Outcomes

Learning Outcomes

1. Demonstrate a breadth of knowledge of geology and earth sciences across the subfields of geology and earth sciences, along with a depth knowledge in their area(s) of specialization.

2. Exhibit expertise in research methodologies, analytical techniques, and interpretation of findings applicable to a variety of geologic research questions.
3. Effectively conduct critical reviews of relevant scientific literature.
4. Incorporate appropriate ethical standards in all research activities.
5. Produce original, reproducible research that contributes to the knowledge base of geology and earth sciences.
6. Expertly communicate research results to both scientific peers and general audiences.
7. Master the skills to conduct a research program including running a research laboratory and writing effective grant proposals.
8. Design instructional strategies in geology and Earth sciences that facilitate student learning in higher education.

Additional Program Information

This information is required by the Office of Accreditation and Program Integrity.

Courses offered via distance (if applicable):

Indicate whether students are able

What is the primary delivery format for the program? Face-to-Face Only

Does any portion of this program occur off-campus?

No

Off-campus details:

Are you working with a vendor / other collaborators to offer your program?

No

Please explain:

Related Departments

Could this program prepare students for any type of professional licensure, in Virginia or elsewhere?

No

Please explain:

Are you adding or removing a licensure component?

No

Please explain:

Additional SCHEV & SACSCOC Information

Is the content of the new program closely related to that of an existing approved program at the same instructional level (i.e., baccalaureate, master's, doctoral)?

No

Which existing approved program(s)?

Is this new program considered to be "advancing the degree level of a currently approved program" (i.e. existing content is at lower degree level, new content is at the higher degree level)?

No

Which existing approved program(s)?

Is this new program considered to be "lowering the degree level of a currently approved program" (i.e. existing content is at higher degree level, new content is at the lower degree level)?

No

Which existing approved program(s)?

Is this a re-opening of a program that was closed to admission within the last five years?

No

Date of Program Closure

What are the methods of delivery for the program?

Face-to-Face Only

Does this program include a course/credit-based competency-based education delivery option?

No

Is this change a simple retitling of an existing program, with no other changes, to an existing program content, curriculum requirements, etc?

Does this change represent a repackaging of content in an existing approved degree/certificate program at the same instructional level (i.e., baccalaureate,

Which existing approved program(s)?

Percentage of total credits containing new course content. ("New course content" is defined by SACSCOC as content that is not currently included in an existing approved degree/certificate program at the same instructional level. Do not exclude gen ed credits in calculations for undergraduate programs.)

25%-49%

Does this change include the addition of a distance education or face-to-face method o delivery for this program?

What is the new method of delivery?

Does this change include the addition of a course/credit-based competency-based

Will any additional equipment/facilities be needed?

No

Description of institutional impact:

Will any additional faculty be required?

No

Description of institutional impact:

Will any additional financial resources be needed?

No

Description of institutional impact:

Additional library/learning resources needed?

No

Description of institutional impact:

OAPI Use Only – Determination of SACSCOC Impact

Comments or Notes

Green Leaf Program Designation

Is this a Green Leaf program?

Green Leaf

Sustainability-focused academic programs require at least one green leaf course. Either that course is itself sustainability-focused or else the program requires a set of sustainability-related courses with aggregated

Relationship to

Relationship to

List sustainability-focused courses currently required

Sustainability-related academic programs either require at least one sustainability-related

List sustainability-related courses

Does this program cover material which crosses into another department?

No

Impacted

Additional Attachments

SCHEV Proposal PhD Geology Earth Sciences 021822.pdf

Executive Summary

Currently, Virginia offers only one PhD degree program in Geology, Earth Sciences and Geoscience. Virginia will need additional doctoral-level geoscientists in the future to train other geoscientists, to lead at government agencies, and to staff museums and other informal educational positions. The proposed degree program is intended to respond to the growing demand for experts with knowledge in critical minerals exploration, ice sheet dynamics and sea level change, renewable energy resources and technologies, and the evolution of Earth surface systems on a warming planet. The proposed program addresses the need for trained professionals in the Earth sciences. The proposed program emphasizes a research-oriented, global systems approach to studying the Earth and its systems: the atmosphere, the hydrosphere, and the lithosphere, including their interrelationships with the biosphere. Emphasis is on the observation, measurement, and analysis of Earth's systems. The need for Earth scientists in Virginia is expected to increase due to needs for mineral resources (particularly for electronics), energy resources, and due to increased threats of coastal erosion and erosion due to changes in precipitation patterns due to climate change. George Mason University can help meet these needs with this proposed doctoral program.

Reviewer Comments

Additional Comments

This program will need a new CIP code, the current one populated as I was working off of another PhD's template.

Is this course required of all students in this degree program?

%wi_required.eschtml%

Attached

Key: 965

Description of the Proposed Program

Program Background

George Mason University requests approval to initiate a Doctor of Philosophy (PhD) degree program in Geology and Earth Sciences. The proposed degree program will be administered by the Department of Atmospheric, Oceanic, and Earth in the College of Science. The target date of the degree program's initiation is Fall 2023.

The purpose of the proposed PhD degree program in Geology and Earth Science is to prepare students with advanced knowledge and skills in the observation, measurement, and analysis of Earth's systems: the atmosphere, the hydrosphere, and the lithosphere. The proposed degree program will focus on the interrelationships of these systems and their interactions with the biosphere. Students will gain advanced education in minerals exploration. Students will learn about renewable energy resources and technologies. Students will be educated in ice sheet dynamics and sea level change. Graduates of the proposed program will be able to supervise the work of technicians and coordinate work with other scientists, both in the field and in the lab. Graduates will be prepared for research and development of natural resources, such as petroleum. Graduates will be able to teach undergraduates and graduate students at community colleges, colleges, and universities.

Geology is the study of the ancient Earth from the perspective of the rock record. Earth science is the study of present-day Earth processes. Geologists and earth scientists—collectively known as geoscientists—must be educated and trained in the use of a wide variety of tools. In the field, geoscientists use hammers and chisel sto collect rock samples, and then use ground-penetrating radar equipment to search for earth resources. In the lab, x rays and electron microscopes are used to determine the chemical and physical composition of rock samples. Remote sensing equipment is used to collect data, and geographic information systems and modeling software are used to analyze the data collected. The propoded degree program is designed to provide students with training in the use and analysis of these tools and technologies?

Compared to other natural sciences, geology is a young field of study. While naturalists from classical times through the Middle Ages have discussed aspects of geology, James Hutton is often cited as the father of modern geology because of his analytical approach and writings in the late 18th century. It was not until World War II and the years immediately following that the technology was developed to make observations that allowed geologists to propose a unifying paradigm for geology. During the1960-1970s more observations from across the subfields of geology were able to be explained by the unifying paradigm of plate tectonics, which led to this theory being broadly accepted. Thus, geology is in many ways the youngest of all of the natural sciences.

Brief discussion of the proposed program's focus areas and why? "Earth history and paleobiology, climate and ocean evolution, geological structure and solid-Earth processes, and geochemistry and geobiology."?

Need a concluding paragraph that provides information that indicates what is currently happening in industry/society/the discipline that warrants a new standalone degree program at this time. This will be fleshed out in the the Specific Demand (Response to Current Needs) section. Statements made in the background will be supported in other areas of the program proposal.

Institutional Mission

The mission of George Mason University states, "A public, comprehensive research university established by the Commonwealth of Virginia in the National Capital region, we are an innovative and inclusive academic community committed to creating a more just, free, and prosperous world."

The proposed degree aligns with the mission of the university as a comprehensive research university by encompassing and facilitating a doctoral level research program in Geology and Earth Sciences involving both graduate faculty and PhD students in the Commonwealth of Virginia. The proposed degree program contributes to the university's emphasis on being an innovative and inclusive academic community by including faculty and students of diverse backgrounds with diverse, globally inclusive research programs. The proposed degree program creates a more just, free, and prosperous world by conducting research around the world, including economically-disadvantaged nations, while critically including researchers and students from those nations in the research, helping to build capacity for education and research through this process. The research results generated by this program will inform the people of the world regarding earth resources, hazards, and lessons from Earth's past, including those who are most vulnerable in the face of expected global environmental change.

The proposed degree program was included in George Mason University's 2021 six-year plan.

Admission Criteria

All students will be required to fulfill the graduate admission requirements of the University. Applicants must:

- Complete an online Application for Graduate Study.
- Pay a nonrefundable application fee.
- Have earned an baccalaureate and/or graduate degree from a regionally accredited institution of higher education, or international equivalent, with verified official transcripts**.**
- Have a minimum 3.00 GPA on a 4.00 scale in baccalaureate study**.**
- Submit two official transcripts from all institutions attended for each program applied to unless the programs are in the same college or school.
- Submit a goals statement.
- Submit three letters of recommendation as required by the program.
- Submit an application for Virginia In-State Tuition Rates, if claiming entitlement to these rates.

Applicants who have not earned a baccalaureate degree in the U.S. must submit:

- Official English translations of all diplomas, certificates, and transcripts that are not already in English. Also, documents from foreign institutions must meet the university's guidelines for international transcript submission.
- Proof of English proficiency: either the Test of English as a Foreign Language (TOEFL), the International English Language Testing System (IELTS) academic exam, or the Pearson Tests of English (PTE) meeting the minimum requirements:
    - TOEFL: 88 points total and a minimum of 20 points in each section
    - IELTS: 6.5 total band score
    - PTE: 59 overall score.

Transfer
Students admitted to the degree program with a Master's degree in Geology are eligible to transfer up to 30 credits of previous graduate coursework toward the requirements for the proposed program upon recommendation of the doctoral advisor and approval of the College of Science's Associate Dean for Academic Affairs. Approved transfer credits may be applied toward the core, concentration, or elective requirements for the degree program providing those courses were completed with an earned grade of a "B" or better. Courses in which approved transferred credits are accepted must be clearly relevant to the PhD in Geology and Earth Sciences curriculum. Requests for reduction of credit are reviewed only after acceptance into the doctoral program. **The following core courses cannot be substituted:** GEOL 601: The Lithosphere, GEOL 720: Bayesian Methods in Geology and Earth Sciences**,** GEOL 751: Geoscience in Academia, GEOL 792: Seminar in Earth Systems Science, Geology, Earth Science.

Curriculum

The proposed PhD Program in Geology and Earth Science will require 72 credit hours beyond the baccalaureate degree. A doctoral research dissertation is required for the degree.

The curriculum provides students with foundational knowledge in the four major geology and Earth science sub-disciplines: Earth history and paleobiology, climate and ocean evolution, geological structure and solid-Earth processes, and geochemistry and geobiology. Students must complete coursework that explores these foundational sub-disciplines, quantitative techniques, and seminars.

Nine new courses have been developed for the proposed program. New courses are marked with an asterisk.

Program Requirements

Core Courses: 29 credit hours

Geology and Earth Science Foundational Courses: 12 credits
GEOL 503: Geochemistry (3 credits)*
GEOL 532: Paleoclimatology (3 credits)

GEOL 541: Great Events in Earth History (3 credits)
GEOL 601: The Lithosphere (3 credits)
GEOL 720: Bayesian Methods in Geology and Earth Sciences* (3 credits)

Quantitative Techniques Courses: 6 credits
GEOL 525: Modeling Earth Signals and Systems (3 credits)
GEOL 540: Modern Methods of Geology (3 credits)

Geology and Earth Science Seminars: 6 credits
GEOL 536: Paleontology Seminar (2 credits), repeat up to 3 times
GEOL 792: Seminar in Earth Systems Science, Geology, & Earth Science (1 credit), repeatable for 6 credits

Pedagogy: 2 credits
GEOL 751: Geoscience in Academia* (2 credits)

Restricted Electives: 7 credits
Students select at least seven (7) credits from the following courses.

GEOL 500: Selected Topics in Modern Geology (1-3 credits)
GEOL 501: Selected Topics in Modern Geology (1-3 credits)
GEOL 504: Sedimentary Geology (4 credits)
GEOL 506: Soil Science (3 credits)
GEOL 510: Advanced Structural Geology (3 credits)
GEOL 512: Invertebrate Paleontology (4 credits)
GEOL 513: Hydrogeology (3 credits)
GEOL 521: Geology of Energy Resources (3 credits)
GEOL 525: Modeling Earth Signals and Systems (3 credits)
GEOL 534: Vertebrate Paleontology (4 credits)
GEOL 535: Quantitative Stratigraphy (3 credits)
GEOL 553: Field Mapping Techniques(3 credits)
GEOL 563: Coastal Morphology/Processes (3 credits)
GEOL 565: Paleoceanography(3 credits)
GEOL 734: Paleobiology* (3 credits)
GEOL 741: Isotopes in Geology* (3 credits)
GEOL 996: Doctoral Reading and Research, repeat up to 24 credits (1-6 credits)*

Electives: 12 credits
Students select 12 additional credits from the list of restricted electives or other relevant coursework. All elective coursework must be approved by the Graduate Coordinator.

Dissertation: 24 credits
GEOL 998: Doctoral Dissertation Proposal (3 credits), minimum 12 credits*
GEOL 999: Doctoral Dissertation (1-12 credits), minimum 3 credits*

Total: 72 credit hours

Doctoral Requirements and Procedures

Dissertation Committee

The student's dissertation committee must have at least three members, who must be full-time members of Mason's instructional faculty. The Dissertation Committee Chair must be a faculty member in the Department of Atmospheric, Oceanic, and Earth Sciences. The second member must be a faculty member in good standing at George Mason University. The third member of the committee may be from the Department of Atmospheric, Oceanic, and Earth Sciences or another academic unit at George Mason University. Students may select a fourth member for the committee from another academic unit or outside the institution, with approval of the PhD Program Director. This typically would be done to include an external expert relevant to the student's field of study.

Comprehensive Exam

The comprehensive exam includes written and oral components to assess whether students have the subject matter knowledge and skills to successfully propose and complete a dissertation research project as well as an oral component. Students must complete the comprehensive exam within two semesters after the completion of all core and concentration coursework on their approved program of study. The comprehensive exam will consist of a set of questions tailored to the individual student. The committee will be comprised of the same individuals as the Dissertation Committee. Exams will be graded on a pass/fail basis. Students must successfully pass both the written and oral portions of the comprehensive exam to advance to candidacy. Students who fail either the written or the oral portion of the comprehensive exam will be granted one attempt to retake the examination the following semester. Students who do not pass the second attempt will be dismissed from the degree program.

Written Comprehensive Exam

The written portion of the comprehensive exam will assess the student's ability to apply theoretical concepts towards the designing of potential research studies necessary to write a doctoral dissertation. It will also assess the student's capability to form research questions and present appropriate methodologies to test such questions (including for example study design, analytical model development, data acquisition or collection, data management, analysis and interpretation). The questions on the exam will be linked with one's program of study and proposed research subject matter.

Oral Comprehensive Exam

The oral portion of the comprehensive exam will assess the student's, knowledge and comprehension of the subject matter background to the field of geology and earth sciences as a whole, as well as the specific body of knowledge related to the student's chosen area of specialty and research. The student must demonstrate mastery in articulating answers including the limitations around data to prepare them for effectively working with various audiences.

Advancement to Candidacy

Advancement to candidacy is based on the student's successful completion of all required coursework and passing the comprehensive examination. Advancement to candidacy is a pre-requisite for admission to GEOL 998: Doctoral Dissertation Proposal.

Dissertation Proposal

Students who have advanced to candidacy begin working on the dissertational proposal the semester after passing their comprehensive exams by registering for GEOL 998: Dissertation Proposal. Students design the conceptual framework for their research projects in consultation with the dissertation committee. A draft dissertation proposal should be submitted to the student's dissertation committee within two semesters of completing the comprehensive exam. The proposal should include a detailed literature review that provides the context and rationale for the research questions and describes the proposed study design and analytic methods. The proposal must address the feasibility of completing the dissertation research within an appropriate time. A list of dissertation committee members must be included in the proposal, confirming each committee members' agreement to serve on the committee.

An oral proposal defense will be scheduled with all dissertation committee members in attendance. During the oral proposal defense, students describe their proposed research and address questions by the committee members. At the conclusion of the oral defense, the dissertation committee either approves the dissertation or provides written recommendations for improving the proposed research with clearly stated expectations for resubmission. All proposal defenses are open to faculty and students in the College of Science. Candidates attending the oral defense may be allowed to ask questions. The dissertation committee holds an executive session after the formal defense to finalize a decision for the student. Passing the proposal defense is a prerequisite for GEOL 999: Doctoral Dissertation Research. Failure to submit the proposal in a timely manner is grounds for academic probation.

Dissertation Defense

The dissertation defense is an oral presentation of the dissertation work in a public forum open to all members of the University community. An abstract and draft dissertation approved by the dissertation committee in conformance with University Library requirements is required before the defense can be scheduled. The student consults with the dissertation committee to identify a date and time for the dissertation defense. Once a date and time has been confirmed, the student works with the appropriate area administrative assistant to reserve a room for the defense. All dissertation committee members should be present. The dissertation committee convenes after the public session to discuss and approve the dissertation. The student is notified after the committee's executive session. The student is responsible for making all required edits before final acceptance of the dissertation adhering to the University's timeline for graduation, which is nine years from admittance into the program.

See Appendix A for sample plans of study.
See Appendix B for course descriptions.

Time to Degree

The proposed PhD degree program in Geology/Earth Sciences will be offered full-time. For students taking nine credits per semester, the program will take four years to complete. Per University policy, the total time to degree for all doctoral students will not exceed nine calendar years from enrolling as a doctoral student. Doctoral students are expected to advance to candidacy within six years from admission to the doctoral program.

Faculty Resources

The Department of Atmospheric, Oceanic, and Earth Sciences is comprised of 17 tenure and tenure track faculty, 11 instructional faculty, and 13 affiliate faculty members. [How many?] existing faculty members in will teach **core and required courses** in the proposed degree program. These faculty members hold doctoral degrees in ..... or related fields such as ..... The faculty in the Department of Atmospheric, Oceanic, and Earth Sciences have more than [how many?] years of combined teaching and research experience in geology. Faculty are internationally recognized for transformational research in paleobiology, sedimentary geochemistry, paleoclimatology and paleoceanography, and structural geology and tectonics. Faculty conduct research in field areas around the world Three faculty members are currently engaged in leadership positions for major research initiatives.

In Fall 2021, the Department of Atmospheric, Oceanic, and Earth Sciences launched a search for an open rank (assistant, associate, full professor) tenured or tenure track faculty in geochemistry.

No adjunct faculty will be utilized to initiate or maintain the proposed program.

See Appendix C for abbreviated curriculum vitae of faculty.
See Appendix D for faculty-funded research.

Graduate Assistants

The proposed degree program will support Graduate Teaching Assistants (GTA). In the initial year, three (3) graduate assistants will be secured. GTAs will be responsible for assisting faculty with course instruction and research. By the target year 2027-2028, 3 additional GTAs will be supported by the proposed program. At least 4 Graduate Research Assistants (GRA) will be utilized in the proposed program, funded by the George Mason University Office of Graduate Education within the Office of the. Additional Graduate Research Assistants will be funded by competitive grant funding, with the exact number each year dependent on funding availability.

Student Learning Assessment

Students who complete the proposed PhD program in Geology and Earth Sciences will possess the required expertise to teach at the college and university level, lead governmental programs in various agencies, and lead for profit and not-for-profit scientific endeavors. Assessment of student learning in the proposed PhD program in Geology and Earth Sciences will be conducted through analysis of metrics specifically designed to measure student performance. Student learning will be assessed throughout the program through a variety of formative and summative measures. Assessment measures will include but will not be limited to course assignments/

activities, quizzes and exams, and an array of applied projects designed to facilitate the achievement of learning outcomes.

Learning Outcomes

Students will be able to:

- Demonstrate a breadth of knowledge of geology and earth sciences across the subfields of geology and earth sciences, along with a depth knowledge in their area(s) of specialization.
- Exhibit expertise in research methodologies, analytical techniques, and interpretation of findings applicable to a variety of geologic research questions.
- Effectively conduct critical reviews of relevant scientific literature.
- Incorporate appropriate ethical standards in all research activities.
- Produce original, reproducible research that contributes to the knowledge base of geology and earth sciences.
- Expertly communicate research results to both scientific peers and general audiences
- Master the skills to run a research program including running a research laboratory and writing effective grant proposals.
- Design instructional strategies in geology and earth sciences that facilitate student learning in higher education.

Curriculum map for PhD in Geology and Earth Sciences

Learning Outcomes	**Core or Required Courses**	**Assessment Measures**
Demonstrate a breadth of knowledge of geology and earth sciences across the subfields of geology and earth sciences, along with a depth knowledge in their area(s) of specialization.	GEOL 541: Great Events in Earth History (3 credits) GEOL 601: The Lithosphere (3 credits)	Formative: Class discussions; written assignments; problem solving activities Summative: Final Exam/Project
Exhibit expertise in research methodologies, analytical techniques, and interpretation of findings applicable to a variety of geologic research questions.	GEOL 540: Modern Methods of Geology (3 credits) GEOL 720: Bayesian Methods in Geology and Earth Sciences (3 credits)	Formative: Class discussions; written assignments; problem solving activities Summative: Final Exam/Project
Effectively conduct critical reviews of relevant scientific literature.	GEOL 536: Paleontology Seminar (2 credits) GEOL 792: Seminar in Earth Systems Science, Geology, Earth Science (1 credit)	Formative: Class discussions; critical reading and written assignments; lead discussions Summative: Final oral review by instructor
Incorporate appropriate ethical standards in all research activities.	GEOL 503: Geochemistry (3 credits GEOL 751: Geoscience in Academia (2 credits)	Formative: Class discussions; written assignments; problem solving activities Summative: Final Exam/Project

Learning Outcomes	Core or Required Courses	Assessment Measures
Produce original, reproducible research that contributes to the knowledge base of geology and earth sciences.	GEOL 525: Modeling Earth Signals and Systems (3 credits) GEOL 532 Paleoclimatology (3 credits)	Formative: Class discussions; written assignments; problem solving activities Summative: Final Exam/Project
Expertly communicate research results to both scientific peers and general audiences.	GEOL 792: Seminar in Earth Systems Science, Geology, Earth Science (1 credit)	Formative: Class discussions; critical reading and written assignments; lead discussions Summative: Final Project/Presentation
Master the skills to run a research program including running a research laboratory and writing effective grant proposals	GEOL 751: Geoscience in Academia (2 credits)	Formative: Class discussions; real-world observations and critiques Summative: Final report/analysis
Design instructional strategies in geology and earth sciences that facilitate student learning in higher education	GEOL 751: Geoscience in Academia (2 credits)	Formative: Class discussions; real-world observations and critiques Summative: Final report/analysis; new course proposal

Employment Skills

All Geology and Earth Science PhD program graduates will be able to:

- Identify and solve geologic problems based on rigorous scientific principles using scientific tools to analyze and model observations.
- Analyze and model research data with quantitative methods.
- Communicate research and findings to peers as well as the general public via scientific publications and presentations, popular writings, audio and visual media of all types.
- Procure resources and funding from governmental and nongovernmental sources to support research and training activities.
- Conduct field work to collect both data and samples including, but not limited to physical specimens (fossils, rocks, minerals, soils etc.), mapping, and resource exploration.
- Supervise and conduct research projects, including building and/or directing a research laboratory which can support physical analyses, computer and statistical analyses, and *in silico* simulations of geologic processes.
- Teach general geology and earth sciences courses in an area of expertise.
- Plan, develop, and teach undergraduate and graduate geology courses.

All Geology and Earth Science PhD program graduates will be highly competitive for securing leadership positions in at least one of the program's four focus areas with the following skillsets:

If these are not structured in the curriculum as concentrations, we won't include them here.
Graduates Earth history and paleobiology will be able to:

- Understand the history of life and biotic evolution
- Explore, find, collect, document and curate fossil specimens
- Apply principles of taxonomy and systematics
- Develop models of evolutionary morphology
- Conduct biostratigraphic analysis

Graduates in Climate and ocean evolution will be able to:

- Understand advanced principles of paleoclimatology and paleoceanography
- Measure sedimentary formations in the field and collect and analyze samples
- Carry out geochemical and micropaleontological analysis of sedimentary rocks
- Interpret geochemical and geophysical data to reconstruct past climate and past oceans

Graduates in Geological structure and solid-Earth processes will be able to:

- Understand advanced structural geology and plate tectonics
- Make 3-D measurements of rock formations in the field, and collect and analyze samples
- Utilize advanced principles of rock deformation and rock macro- and microstructures
- Characterize physical and mechanical properties of rocks
- Integrate structural and rock deformation concepts

Graduates in Geochemistry and geobiology will be able to:

- Understand advanced principles of geochemistry, paleontology and sedimentology
- Measure sedimentary formations in the field, identify fossils, and collect and analyze samples
- Carry out geochemical analysis of sedimentary rocks with field and lab instruments
- Integrate geochemical data with geobiological concepts

Relation to Existing Degree Programs (Degree, Certificate, Sub-area)

George Mason University's College of Science offers two degree programs that are related to the proposed program: 1) the PhD degree program in Climate Dynamics offered in the Department of Atmospheric, Oceanic, and Earth Sciences; and 2) the PhD degree program in Environmental Science and Public Policy offered in the Department of Environmental Science and Policy.

Both existing degree programs and the proposed degree program share related interests in ..... However, there are distinct differences in the purposes and program objectives. There are also distinct differences in the knowledge and skills of graduates.

The PhD degree program in Climate Dynamics is focused on how the atmosphere, ocean, and land surface work together to determine the climate. Students in this degree program use modern climate data to craft complex simulations of future climate to understand how the Earth's climate changes, and how well these changes can be predicted. Graduates will possess the knowledge, strategies, and skills required to. ... [please provide on the job skills]

The PhD degree program in Environmental Science and Public Policy is designed for graduates to contribute to the solution of complex environmental problems, which require the development

of knowledge and skills in the collection, analysis, and interpretation of scientific data, as well as in the integration of scientific understanding into the public policy process. Students in this degree are required to take a significant amount [how many courses?] of course work in public policy. Graduates will possess the knowledge, strategies, and skills required to. ... [please provide on the job skills]

Students in the proposed PhD degree program in Geology/Earth Sciences will focus primarily on ... The proposed program will provide a firm grounding in... Graduates will know to how to ...

Compromising Existing Degree Programs

The proposed PhD degree program in Geology/Earth Sciences will not threaten existing degree programs in the College of Science or degree programs at George Mason. The proposed degree program has a different scope from other programs and will attract students specifically interested in the solid earth and the oceans. No degree programs will be negatively impacted or close as the result of the initiation and operation of the proposed degree program.

Justification for the Proposed Program

Response to Current Needs

Need cited evidence to support the argument that the degree program is needed **at the PhD level.** Sources should be **quoted directly, not paraphrased**, and all quotes should be strategic to demonstrate that the discipline is calling for/expressing a need for more PhD graduates in the discipline. Do not string citations. SCHEV staff will not look at any citations that don't include quoted evidence. Quoted material must not more than 6-7 years old.

Each argument should be tied to the proposed degree program.

The proposed PhD Degree Program in Geology and Earth Sciences responds to the following needs for geologists and Earth scientists with advanced education and training: (1) understanding geological hazards, particularly those related to tectonics, land use, and coastal threats from rising sea level; (2) exploring for new mineral resources and solving materials science challenges; (3) investigating the history of climate change and global habitability; and (4) closing an alarming talent deficit in the geoscience workforce that has emerged over the past decade[1] [2].

The demand for experts in geology and Earth science is set to increase rapidly over the next decade as the world transitions away from the use of fossil fuel energy resources. Over the past 300+ years, geologists have played a major role in the exploration and production of energy from oil, gas and coal, enabling the rise of advanced technologies and amenities. Over the next 100+ years, geologists will be called upon once again to take part in the development of non-fossil fuel and renewable energy resources and energy storage systems in a worldwide effort to ameliorate

[1] Gonzales, L.M., Keane, C.M. (2010). Who will fill the geoscience workforce gap? *Environmental Science and Technology*, Vol. 44, pp. 550-555, https://doi.org/10.1021/es902234g
[2] American Geosciences Institute, Geoscience Workforce Projections, 2021-2029, Data Brief 2020-025; October 26, 2020, https://www.americangeosciences.org/geoscience-currents/geoscience-workforce-projections-2019-2029

climate change and protect global habitability.[3] To meet these societal needs, innovative investigation of unsolved problems in geology and Earth science is necessary. It is an all-hands-on-deck proposition that involves the full array of geology and Earth science disciplines.[4]

This is justifying the faculty and the curriculum, not the need for the degree program at the PhD level.

The faculty of the proposed PhD Degree Program in Geology and Earth Sciences specialize in the following subject matter areas: earth history, paleontology, paleobiology, climate and ocean evolution, geological structure, tectonics, mineralogy, soils, hydrogeology, igneous petrology, geomorphology, sedimentary geology, geochemistry, and geobiology.

These specializations will be leveraged to address three scientific themes to support current needs of government, industry and academia, and to correct a significant talent deficit in the geoscience workforce that has been developing over the past decade, described as follows.

Geology, Tectonics and Natural Disasters

Plate tectonics, the theory that the earth's surface is broken into a series of plates that move around over geologic time, is the theory that all of geology and earth science is built upon. Study in virtually all other subfields of geology is contingent on a thorough understanding of plate tectonics and its implications. As such, all students of geology at all levels from bachelor's to Master's and PhD degrees require instruction in this paradigmatic subject matter. Geology and tectonics also have a direct impact on the day-to-day lives of all people as well. Virtually all earthquakes, volcanic eruptions and associated phenomena, landslides and other natural disasters are all ultimately related to tectonic processes. These include mountain building, valley formation, river courses and transport of sediments. Tectonics, particularly mountain building, also deeply affects climate (see below) by interrupting the flow of air and moisture as it moves around the planet often causing both rain forests and deserts to form where they are. The most fundamental effect of plate tectonics is the positioning of the continents themselves relative to the oceans. This affects how ocean currents move about the planet, re-distributing heat from the sun and giving our climate system its basic form.

Both the U.S. Geological Survey (based in Reston, VA) and the Geology and Mineral Resources division of Virginia Energy (formerly known as Virginia Department of Mines, Minerals, and Energy) run programs that discover, assess and publish known geological hazards free to the business community and the general public. The data (particularly hazard maps) allow others to safely plan to put buildings, roads, waste disposal sites and more. PhD level geologists generally lead these hazard assessment teams, and job growth is expected in these areas in the future.[5]

[3] Siegel, D.I. (2020). The Future for Geoscience in the Context of Emerging Climate Disruption, 2019 GSA Presidential Address, *GSA Today*, Vol. 30, No. 2, https://doi.org/10.1130/GSAT19PrsAdrs.1.

[4] National Academies of Sciences, Engineering, and Medicine 2020. *A Vision for NSF Earth Sciences 2020-2030: Earth in Time*. Washington, DC: The National Academies Press. https://doi.org/10.17226/25761

[5] Association of Environmental & Engineering Geologists; What Does the Future Demand Look Like for Applied Geoscientists? https://www.aegweb.org/index.php?option=com_dailyplanetblog&view=entry&category=geology&id=10:what-does-the-future-demand-look-like-for-applied-geoscientists-

Climate Change, Coastlines, and Global Habitability

Global climate change caused by human activities is currently impacting and will continue to impact the atmosphere, climate system, oceans, and land.[6] These impacts will be felt by humans in different ways and to different degrees depending on where they live on the surface of the earth. Here in Virginia, as well as along the East Coast and Gulf Coast of the United States, significant sea level rise[7] due to melting of polar ice is likely to have significant impacts on human activities.[8] Virginia expects these impacts to cost billions of dollars.[9]

In the face of climate change, many geologists and Earth scientists have turned their attention to understanding past climate change and global habitability through study of the geological record.[10] This initiative is not just the purview of academia but is of great interest and concern to policymakers and governments charged with protecting their citizens and ensuring their prosperity and safety.[11] Preparation of experts to assess these changes, predict their impacts, and advise governmental bodies on possible courses of action is a focus of the proposed PhD degree at Mason.

One approach to help predict future impacts is to study the past conditions on Earth. Mason faculty currently study time periods in the past (e.g., the Eocene and Pliocene) when the world was warmer, much like what is predicted for Earth in the future. Paleoclimatology and paleontology tell us when it was warmer and/or wetter on the planet and how living things responded to the warm and wet climate. These studies are essential to interpret the future state of the Earth in response to predicted climate change. The National Academies of Sciences, Engineering, and Medicine has also advocated for more advanced training in these and other areas to address future needs. Provide quote that substantiates this claim?[12]

Critical Earth Resources

The current high global demand for minerals reflects the basic dependence of modern society on practically all natural occurring elements for products and technologies. Two linked challenges are involved in this demand: critical minerals exploration and materials science innovation.

[6] IPCC, 2021: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press. In Press.

[7] Ezer, T. and Atkinston, L. P. 2015. Sea level rise in Virginia–Causes, effects, and response. Virginia Journal of Science, 66(3), 355-369.

[8] Atkinston, L. P., Ezer, T. and Smith, E. 2013. Sea level rise and flooding risk in Virginia. Sea Grant Law and Policy Journal, 5(4), 3-14.

[9] Winter, A. 2019. Climate change could cost Va. coastal cities billions, experts warn Congress. Virginia Mercury. July 24, 2019. https://www.virginiamercury.com/2019/07/24/climate-change-could-cost-va-coastal-cities-billions-experts-warn-congress/

[10] Tierney, J.E., and 24 others (2020). Past climates inform our future. *Science*, Vol. 370, Issue 6517, eaay3701, https://www.science.org/doi/10.1126/science.aay3701 (visited January 17, 2022).

[11] The Intergovernmental Panel on Climate Change, https://www.ipcc.ch/about/ (visited January 17, 2022).

[12] National Academies of Sciences Engineering and Medicine. (2020). A Vision for NSF Earth Sciences 2020-2030: Earth in Time. Washington, DC: The National Academies Press.

Minerals in nature afford important "pre-processing" attributes in their concentration at formation of specific elements of interest for easy extraction. Critical minerals, of which there are currently 35,[13] are those minerals essential to existing and emerging technologies, renewable energy, and national security.[14] [15] In particular, the 2019 Federal Strategy to *Ensure Secure and Reliable Supplies of Critical Minerals* includes a call to action to "Grow the American Critical Minerals Workforce," to counteract a contraction in the domestic workforce when a significant expansion is needed.[16]

Materials science, while principally an engineering field, overlaps significantly with research on naturally occurring minerals and ores. The goal of materials science is to investigate physicochemical properties of raw materials, and to transform raw materials into engineered substances with specific properties for technological applications.[17] The field is crucial for ensuring the best processing and usage of critical minerals.

The top priority of the 2015 International Paris Agreement is the mitigation of greenhouse emissions and climate change,[18] which requires the research and development of clean, renewable energy production, and improved energy storage and delivery efficiency[19] [20]. Renewable energy from wind, solar and hydro resources relies on expertise from scientists with specialization areas in present-day Earth surface processes. Energy storage (battery) innovation requires knowledge of mineral resources, mining, processing, remediation and management,[21] and involve both critical minerals and materials science innovation.

This is about the faculty/program, not about the need for the degree program.
The proposed PhD program in Geology and Earth Science will contribute immediately to these priorities with an ongoing project in underground hydrogen storage involving a graduate student

[13] U.S. Department of the Interior, Final List of Critical Minerals 2018, *Federal Register*, Vol. 83, No. 97, pp. 23295-23295, https://www.govinfo.gov/content/pkg/FR-2018-05-18/pdf/2018-10667.pdf (visited January 17, 2022).
[14] Schulz, K. J., DeYoung, Jr., J.H., Seal II, R.R., Bradley, D.C., eds. (2017). Critical mineral resources of the United States - Economic and environmental geology and prospects for future supply: Chapter A, *USGS Professional Paper 1802*, https://pubs.er.usgs.gov/publication/pp1802 (visited January 16, 2022).
[15] U.S. Department of Energy (2021). *Critical Minerals and Materials: U.S. Department of Energy's Strategy to Support Domestic Critical Mineral and Material Supply Chains (FY 2021-FY 2031)*, https://www.energy.gov/sites/prod/files/2021/01/f82/DOE%20Critical%20Minerals%20and%20Materials%20Strategy_0.pdf (visited January 17, 2022).
[16] National Research Council (2013). *Emerging Workforce Trends in the U.S. Energy and Mining Industries: A Call to Action*. Washington, DC: The National Academies Press. https://doi.org/10.17226/18250 (visited January 17, 2022).
[17] National Academies of Sciences, Engineering, and Medicine (2019). *Frontiers of Materials Research: A Decadal Survey*. Washington, DC: The National Academies Press. https://doi.org/10.17226/25244 (visited January 17, 2022).
[18] The United Nations, The Paris Agreement, https://unfccc.int/sites/default/files/resource/parisagreement_publication.pdf (visited January 16, 2022).
[19] Gielen, D., Boshell, F., Saygin, D. (2016). Climate and energy challenges for materials science. *Nature Materials*, Vol. 15, pp. 117–120, https://www.nature.com/articles/nmat4545.pdf (visited January 16, 2022).
[20] National Research Council (2001). *Materials Research to Meet 21st Century Defense Needs: Interim Report*. Washington, DC, The National Academies Press, https://doi.org/10.17226/10056 (visited January 16, 2022).
[21] Arndt, N.T., Fontboté, L., Hedenquist, J.W., Kesler, S.E., Thompson, J.F.H., Wood, D.C. (2017). Future Global Mineral Resources, *Geochemical Perspectives*, Vol. 6, No. 1, pp. 1-171, https://www.geochemicalperspectives.org/wp-content/uploads/v6n1.pdf (visited January 16, 2022).

working in partnership with United States Geological Survey. The program will also acquire important new expertise in critical minerals and materials science with the department's plan to hire a tenure-stream faculty member with a specialization area in economic geology.[22]

The Geoscience Workforce Deficit

By 2009 there were already clear signs that there were not enough students graduating from geoscience programs to meet the needs of society[23]; in fact, this was identified as a serious problem facing the overall skilled technical workforce in the U.S.[24] [25]. An aggravating factor was that approximately 50% of geoscience professionals were identified to be within 10-15 years of retirement, i.e., in 2022 they would be retiring or preparing to retire.

While this is good news for PhD students training now to become geoscientists, there are not nearly enough students entering the workforce to fill the still growing deficit, which by 2029 is expected to represent 129,960 full time equivalent geoscientists out of a total of 482,726 available positions in the U.S., i.e., a 27% deficit.[26] Some of this shortfall may be alleviated by technological innovations such as artificial intelligence and machine learning. However, this is not a failsafe strategy, and renewed initiatives to reform and to increase geoscience education at all levels is essential for closing the workforce deficit.

Employment Demand

Graduates of the proposed PhD degree program in Geology and Earth Sciences will be qualifed to fill positions in government agencies such as the U.S. Geological Survey, state geological surveys, the Environmental Protection Agency, and the U.S. Department of the Interior. Graduates will be prepared to fill positions in industry as geologists to explore for mineral resources, fresh water, and fossil fuels including coal, oil, and gas. Graduates will also be prepared for positions in the environmental field to advise on projects to protect or restore the environment. Graduates will also be prepared for positions in higher education to perform research and to teach.

According to the Bureau of Labor Statistics (BLS), between 2020 and 2030 employment for geoscientists is expected to grow 7%, or "about as fast as the average for all occupations." The BLS goes on to say that the "need for energy, environmental protection, and responsible land and resource management is expected to spur demand for geoscientists."[27]

[22] George Mason University, *Atmospheric, Oceanic, and Earth Sciences Strategic Plan*, May 2021, p. 116.
[23] Gonzales, L.M., Keane, C.M. (2010). Who will fill the geoscience workforce gap? *Environmental Science and Technology,* Vol. 44, pp. 550-555, https://doi.org/10.1021/es902234g (visited January 17, 2022).
[24] National Academies of Sciences, Engineering, and Medicine (2017), *Building America's Skilled Technical Workforce*, Washington, D.C.: The National Academies Press, https://www.nap.edu/catalog/23472/building-americas-skilled-technical-workforce (visited January 17, 2022).
[25] National Science Board (2019), *The Skilled Technical Workforce: Crafting America's Science & Engineering Enterprise,* https://www.nsf.gov/nsb/publications/2019/nsb201923.pdf (visited January 17, 2022).
[26] American Geosciences Institute, *Geoscience Workforce Projections, 2019-2029*, Data Brief 2020-025; October 26, 2020, https://www.americangeosciences.org/geoscience-currents/geoscience-workforce-projections-2019-2029 (visited January 17, 2022).
[27] U.S. Bureau of Labor, Occupational Outlook Handbook, Accessed at: https://www.bls.gov/ooh/life-physical-and-social-science/geoscientists.htm#tab-6

According to the BLS, employment for Postsecondary teachers will grow at 12% between 2020 and 2030, “faster than the average of all occupations.” Specifically, growth for Earth science teachers, postsecondary is expected to grow 6%. The BLS notes: "The number of people attending postsecondary institutions is expected to grow over the projections decade. Students will continue to seek higher education to gain the knowledge and skills necessary to meet their career goals."[28]

The Virginia Employment Commission, Labor Market Information data projects approximately 4% growth for geoscientist and postsecondary teachers in the field between 2018 and 2028.

Labor Market Information: Virginia Employment Commission, 2018-2028 (10-Yr)

Occupation Title	Base Year Employment	Projected Employment	Total % change and #’s	Annual Change	Education
Geoscientists, Except Hydrologists and Geographers	344	360	4.65%, 16	2	Bachelor's degree
Atmospheric, Earth, Marine, and Space Sciences Teachers, Postsecondary	487	505	3.69%, 18	2	Not applicable

See Appendix E for job announcements (employment demand).

Duplication

One public institution in Virginia offers a degree program similar or related to the proposed degree program. Virginia Polytechnic Institute and State University (Virginia Tech), offers a PhD degree program in Geosciences that is similar to the proposed PhD degree program Geology and Earth Sciences.

Virginia Polytechnic Institute and State University (Virginia Tech)
Virginia Tech’s PhD degree program in Geosciences is a 90-credit degree program. The purpose of Virginia Tech’s degree program is to investigate earth processes at scales that range from atomic to planetary. The Virginia Tech degree program focuses on research in five (5) areas: solid earth; earth history and environments; water; earth materials; and hazards and resources. Virginia Tech’s degree program requires at least 30 credits of coursework, and at least 30 credits of research. A review of the Virginia Tech website and the Virginia Tech Graduate Catalog did not reveal information on core requirements for Virginia Tech’s PhD degree program.

Similarities
The Virginia Tech program includes two courses (GEOS 5014: Earth System History and

[28] U.S. Bureau of Labor, Occupational Outlook Handbook, Accessed at: https://www.bls.gov/ooh/Education-Training-and-Library/Postsecondary-teachers.htm#tab-6

GEOS 6604: Advanced Topics in Geochemistry) that are similar to core coursework in the proposed program (_____). The similarities between the list of Virginia Tech courses and the proposed program's coursework reflect the common topical areas of research and learning within the field of geology and Earth sciences. Both programs require a dissertation?

Differences

Virginia Tech's program includes focus areas in solid earth, earth history and environments, water, earth materials, and hazards and resources. The proposed degree program includes focus areas in Earth history and paleobiology, climate and ocean evolution, geological structure, tectonics and geomorphology, and geochemistry and geobiology. There is some overlap in these focus areas. Can you separate what is similar/what is different? Virginia Tech's degree program requires 18 more credits than the proposed degree program. Where are the extra courses coming from/focusing on? What do they have that the proposed program does not have?

The similarities between the list of Virginia Tech courses and the Mason courses reflect the generally recognized topical areas of research and learning withing Geology and Earth Sciences. The differences primarily represent the specific research interests of the different faculty at each institution. While both cover the breadth and depth of Geology and Earth Sciences, both offer alternative research and learning experiences for students.

Enrollments and graduation for a comparable degree program

Enrollment[29]	**Fall 2017**	**Fall 2018**	**Fall 2019**	**Fall 2020**	**Fall 2021**
Virginia Tech	38	40	37	37	N/A
Degrees Awarded[30]	**2017**	**2018**	**2019**	**2020**	**2021**
Virginia Tech	15	8	5	6	9

Student Demand

Evidence of student demand comes from three sources: 1) a survey of demand among Mason Department of Atmospheric, Oceanic, and Earth Sciences Geology Program current students, 2) a survey of demand among Mason Department of Atmospheric, Oceanic, and Earth Sciences Geology Program alumni, 3) a compilation of all requests for information on PhD graduate programs at Mason made to Geology Program faculty from June 2021 to June 2022.

Survey I: Current George Mason University Students

In January 2022, an email was sent to all current undergraduate and graduate students majoring in Geology in the Department of Atmospheric, Oceanic, and Earth Sciences asking them to participate in a brief online survey to determine student demand for the proposed PhD in Geology and Earth Sciences. Of the XX number the survey was sent to, 16 responded. Three of these students indicated that they were first or second year students, and were excluded from the survey results, leaving 13 respondents. Of those, 5 indicated they were extremely likely (1) and 4

[29] State Council of Higher Education for Virginia (SCHEV). *Fall Headcount Enrollment by Race/Ethnicity, Gender and Program Detail.* https://research.schev.edu/enrollment/E16_Report.asp

[30] State Council of Higher Education for Virginia (SCHEV). *C01A2: Completions, Program Detail*, https://research.schev.edu/Completions/C1Level2_Report.asp

indicated they were likely (4) to enroll in the proposed PhD in Geology and Earth Sciences if it were offered.

Survey II: George Mason University Alumni

In January 2022, am email was sent to alumni to participate in brief online survey to determine student demand for the proposed PhD program in Geology and Earth Sciences. This group included alumni who had graduated since 2012 with either an undergraduate or graduate degree in Geology. Of the XX number the survey was sent to, XX responded. Of those, XX indicated they were extremely likely (1) and XX indicated they were likely (XX) to enroll in the proposed PhD in Geology and Earth Sciences if it were offered.

Spontaneous Graduate Inquiries

The Department of Atmospheric, Oceanic, and Earth Sciences faculty compiled a list of all inquiries into graduate studies in the Geology program from June 2021 to June 2022. A total of XX inquiries were made. Of these, XX were exclusively regarding master's degree programs, XX were regarding either Master's degree programs or master's degree plus PhD programs, and XX were regarding PhD programs. These results indicate a strong demand from prospective students interested in pursuing doctoral degrees in Geology.

See Appendix F for the original survey to current students. Survey results follow the survey.
See Appendix G for the original alumni survey. Survey results follow the survey.
See Appendix H for the email inquiries from prospective students.

State Council of Higher Education for Virginia
Summary of Projected Enrollments in Proposed Program

Year 1		Year 2		Year 3		Year 4 **Target Year (2-year institutions)**			Year 5 **Target Year (4-year institutions)**		
2023 - 2024		2024 - 2025		2025 - 2026		2026 - 2027			2027 - 2028		
HDCT 4	FTES 3	HDCT 6	FTES 4	HDCT 8	FTES 6	HDCT 12	FTES 9	GRAD ____	HDCT 13	FTES 10	GRAD 4

Assumptions:
90 % Retention
100 % Full-time students
Full-time students: 9 credit hours per semester
Full-time students graduate in 4years

Projected Resource Needs for the Proposed Program

Resource Needs

George Mason University and the College of Science have the resources needed to initiate and sustain the proposed PhD in Geology and Earth Sciences. The College of Science will have the faculty, staff, equipment, space, and library resources to initiate and sustain the proposed program. The proposed program allocates 1.0 FTE of instructional effort for every 6.0 FTE of enrollment. The proposed program will therefore require approximately 0.75 FTE of instructional effort to initiate, rising to approximately 1.75 FTE by the target year 2027-28.

Full-time Faculty (For SCHEV purposes, this is defined as faculty devoting 50% or more of their teaching load to teaching core courses in the program)
Sample text: A faculty member currently teaching in the Department of Atmospheric, Oceanic, and Earth Sciences will serve as program director for the proposed program. The program director will be responsible for curriculum oversight, scheduling, marketing and recruitment strategy, and student satisfaction. The program director will devote XX FTE to teach core and required courses in the proposed program from its initiation through the target enrollment year.

One new faculty member will be hired to teach in the proposed program in the Fall 2023. Salary for the new hire is expected to be $200,000 with fringe of $50,000 for a total expense of $250,000. The new hire will devote 1.0 FTE to the proposed program.

The proposed program will require .50 FTE of full-time faculty effort to initiate, rising to 1.50 FTE in the target enrollment year.

Part-time Faculty
No part-time faculty will be utilized to initiate or sustain the proposed program.

Existing faculty members in the Department of Atmospheric, Oceanic, and Earth Sciences will devote a total of 1.25 FTE to teach core courses in the proposed program in the initial year and through the target enrollment year.

Adjunct Faculty
No adjunct faculty will be utilized to initiate or sustain the proposed program.

Graduate Assistants
The proposed degree program will provide four (4) students with graduate assistantships in the College of Science. Graduate assistants will assist with faculty members' research and teaching. In the initial year, the proposed program anticipates 7 enrolled graduate assistants. Graduate assistants are paid hourly at $40.00 hour, 10 hours a week for a total of $14,400. The total cost for the initial year will be $100,800. By the target enrollment year, a total of 20 graduate assistants will be supported for a total cost of $288,800.

Classified Positions
In the initiation year, a program manager will be hired to support the proposed program. This individual will be responsible for advising students on matriculation and class registration, using Banner and other university systems to schedule courses, and supporting other student needs related to coursework and graduation requirements. The program manager salary will be $55,000 with $25,000 in benefits for a total cost of $80,000.

Targeted Financial Aid
No targeted financial aid is required or designated to initiate and sustain the proposed program.

Equipment (including computers)
No new equipment (including computers) is required to initiate or sustain the proposed program. The College of Science has existing equipment (including computers) to provide the new hires.

Library
No new library resources will be needed to initiate and sustain the proposed degree program. The library has an adequate collection to support the proposed degree program. Resources include journals and publications. As a member of the Virtual Library of Virginia (VIVA), on-line access to journals is also available.

See Appendix I for library catalog holdings related to the proposed program.

Telecommunications
No new telecommunications are required to initiate or sustain the proposed program. For the new hires, existing telecommunications services and devices are available and will be utilized.

Space

No additional space is required to initiate or sustain the proposed program. The College of Science has adequate space for the new hires. Existing office space is available and will be utilized.

Other Resources
To advertise the proposed program, the College of Science will allocate funds from its marketing budget. It is estimated that approximately $50,000 will be spent on initial marketing of the proposed program to include paid digital marketing and social media.

Funds to Initiate and Operate the Degree Program
Figures provided in the table below will be compared to SCHEV funding estimates using the current base adequacy model. This comparison will serve as a reference for the estimated costs. If there are large discrepancies, SCHEV may request additional clarification to ensure the institution's assumptions are correct, or require modifications as a condition of approval.

Note: Institutions must use the recommended student-faculty ratio when estimating FTE enrollments and required faculty FTEs.

Cost and Funding Sources to Initiate and Operate the Program			
Informational Category		**Program Initiation Year 2023 - 2024**	**Program Full Enrollment Year[31] 2026 - 2027**
1.	Projected Enrollment (Headcount)	4	4
2.	Projected Enrollment (FTE)	3	3
3.	Projected Enrollment Headcount of In-State Students		
4.	Projected Enrollment Headcount of Out-of-State Students		
5.	Estimated Annual Tuition and E&G Fees for In-state Students in the Proposed Program	$	$
6.	Estimated Annual Tuition and E&G Fees for Out-of-State Students in the Proposed Program	$	$
7.	Projected Total Revenue from Tuition and E&G Fees Due to the Proposed Program	$	$
8.	Other Funding Sources Dedicated to the Proposed Program (e.g., grant, business entity, private sources)	$	$

[31] For the "Full Enrollment Year" use: for associate degrees, initiation year plus 1; for baccalaureate degrees, initiation plus 3; for masters degrees, initiation plus 2; for doctoral degrees, initiation plus 3.

Part V: Certification Statements

1. A request of any kind will be submitted to the General Assembly for funds to initiate and/or maintain the proposed degree program.

   Yes ☐
   No ☒

   If "Yes" is checked, include narrative text to describe: when the request will be made, how much will be requested, what the funds will be used for, and what will be done if the request is not fulfilled.

2. The proposed degree program is included in the institution's most recent six-year plan.

   Yes ☒
   No ☐

   If "No" is checked, include narrative text to explain why the program is being advanced at the present time despite not being included in the six-year plan.

3. The institution's governing board has been provided information regarding duplication (if applicable) and labor market projections as part of its approval action.

   Yes ☒
   No ☐

   If "No" is checked, include narrative text to explain why the governing board has not been provided the information.

The institution's Chief Academic Officer attests to the accuracy of the above statements

Mark R. Ginsberg, PhD
Name (Printed)

Signature Date

Appendices

Appendix A – Sample Plan of Study

Bachelor's Degree Entrance

Year	Fall Semester	Spring Semester
1	GEOL 541: Great Events in Earth History (3 credits)	GEOL 503: Geochemistry (3 credits)*
	GEOL 532: Paleoclimatology (3 credits)	GEOL 601: The Lithosphere (3 credits)
	GEOL 751: Geoscience in Academia* (2 credits)	GEOL 540: Modern Methods of Geology (3 credits)*
2	Restricted Elective (3 credits)	GEOL 565: Paleoceanography (3 credits)
	GEOL 536: Paleontology Seminar (2 credits)	Elective (3 credits)
	GEOL 996: Doctoral Reading and Research (3 credits)*	GEOL 792: Seminar in Earth Systems Science, Geology, Earth Science (1 credit)
3	GEOL 525: Modeling Earth Signals and Systems (3 credits)	Restricted Elective (3 credits)
	Elective (3 credits)	GEOL 720: Bayesian Methods in Geology and Earth Sciences* (3 credits)
	Restricted Elective (3 credits)	GEOL 792: Seminar in Earth Systems Science, Geology, Earth Science (1 credit)
4	Elective (3 credits)	Elective (3 credits)
	Elective (3 credits)	GEOL 998: Doctoral Dissertation Proposal (3 credits)*
5	GEOL 999: Doctoral Dissertation (6 credits)*	GEOL 999: Doctoral Dissertation (6 credits)*

Credit Hours – Year 1 – Fall Term	8
Credit Hours – Year 1 – Spring Term	9
Credit Hours – Year 2 – Fall Term	8
Credit Hours – Year 2 – Spring Term	7
Credit Hours – Year 3 – Fall Term	9
Credit Hours – Year 3 – Spring Term	7
Credit Hours – Year 4– Fall Term	6
Credit Hours – Year 4 – Spring Term	6
Credit Hours – Year 5 – Fall Term	6
Credit Hours – Year 5 – Spring Term	6
TOTAL CREDIT HOURS	**72**

Sample Plan of Study

Master's Degree Entrance

Year	Fall Semester	Spring Semester
1	GEOL 541: Great Events in Earth History (3 credits)	GEOL 601: The Lithosphere (3 credits)
	GEOL 540: Modern Methods of Geology (3 credits)	GEOL 503: Geochemistry (3 credits)
	Restricted Elective (3 credits)	GEOL 792: Seminar in Earth Systems Science, Geology, Earth Science (1 credit)
2	GEOL 525: Modeling Earth Signals and Systems (3 credits)	GEOL 532 Paleoclimatology (3 credits)
	GEOL 536: Paleontology Seminar (2 credits)	GEOL 999: Doctoral Dissertation (6 credits)*
	GEOL 998: Doctoral Dissertation Proposal (3 credits)*	
3	GEOL 792: Seminar in Earth Systems Science, Geology, Earth Science (1 credit)	GEOL 999: Doctoral Dissertation (6 credits)*
	GEOL 751: Geoscience in Academia* (2 credits)	
	Elective (3 credits)	

Credit Hours – Year 1 – Fall Term	9
Credit Hours – Year 1 – Spring Term	7
Credit Hours – Year 2 – Fall Term	8
Credit Hours – Year 2 – Spring Term	9
Credit Hours – Year 3 – Fall Term	6
Credit Hours – Year 3 – Spring Term	6
TOTAL CREDIT HOURS	**45 plus 27 waived credits = 72**

Appendix B – Course Descriptions

New courses are indicated with an asterisk.

Core Courses

GEOL 503: Geochemistry (3 credits)*
The course will begin with a discussion of the basic principles of thermodynamics and phase equilibrium. We will explore elements of aqueous geochemistry linked to redox, carbonates, mineral-fluid, and fluid-gas interactions. The role of geochemistry in understanding solid Earth processes would be studied through trace element and radiogenic isotope geochemistry. We will conclude with exploring elements of stable isotope geochemistry and how this is tied to climate research.

GEOL 525: Modeling Earth Signals and Systems (3 credits)
Provides instruction on time series analysis customized for Earth signals and systems such as climate, Earth-space orientation, earthquakes, geomagnetism, river flow, tides and many other time- dependent phenomena. Concepts including linear systems, filtering, spectrum estimation, harmonic analysis and hypothesis testing are applied to time series data sampled from natural processes to address a variety of scientific problems.

GEOL 532: Paleoclimatology (3 credits)
Explores the natural evolution of Earth's climate with the goal of providing a baseline for understanding present climate variability and future trends through increase knowledge of the physical, chemical, and biological processes that influence climate over the long-term.

GEOL 536: Paleontology Seminar (2 credits)
Paleontology Seminar presents topical research in paleontology and paleobiology in a structured discussion among graduate students and paleontology faculty. A theme for the seminar is chosen each semester the course is offered, tailored to the interests of the students.

GEOL 540: Modern Methods in Geology (3 credits)*
An introduction to common types of datasets (i.e. geologic map products, reflection seismic data, outcrop photogrammetry) that geologists use in the workforce (both public and private sector) to complement field-based and observational methods of geology (such as outcrop, core or sample descriptions). The class will focus on both learning about the applications of the various data types as well as developing skills in accessing, plotting, and making geologic interpretations of the data.

GEOL 541: Great Events in Earth History (3 credits)*
Through 4.5 billion years, Earth has undergone tumultuous changes, from the origin of life and atmospheric oxygenation, to mass extinction events and human evolution. In this seminar-style course, each week will involve an in-depth, student-led discussion on one ‘Great Event’ that helped shape the course of Earth history. The course is also focused on scientific literacy, with emphasis on reading the primary literature and writing/communicating effectively in a scientific setting.

Dissertation

GEOL 998: Doctoral Dissertation Proposal, repeat up to 24 credits (1-12 credits)*
Covers development of research proposal under guidance of dissertation director and doctoral committee. Proposal forms basis for climate dynamics doctoral dissertation.

GEOL 999: Doctoral Dissertation, repeat up to 24 credits (1-12 credits)*
Doctoral dissertation research under direction of dissertation advisor.

Restricted Electives

GEOL 500: Selected Topics in Modern Geology (1-3 credits)
Specialized topical course. Topic designated in class schedule.

GEOL 501: Selected Topics in Modern Geology (1-3 credits)
Specialized topical course. Topic designated in class schedule.

GEOL 504: Sedimentary Geology (4 credits)
Introduces sedimentation, sedimentary petrology, facies analysis, and stratigraphy.

GEOL 506: Soil Science (3 credits)
Explores the composition, classification, physical properties, and origin of soils.

GEOL 510: Advanced Structural Geology (3 credits)*
Advanced concepts in structural geology including, stress in the lithosphere, strain analysis, constitutive laws, balanced cross-section construction and restoration, and quantitative analysis of crystal-plastic deformation.

GEOL 512: Invertebrate Paleontology (4 credits)
Classification, evolutionary trends, and distribution of common invertebrate fossils.

GEOL 513: Hydrogeology (3 credits)
Geological and hydrologic factors controlling occurrence, distribution, movement, quality, and development of groundwater.

GEOL 521: Geology of Entergy Resources (3 credits)
Survey of global non-renewable and renewable energy resources. Topics include petroleum, natural gas, coal, nuclear, geothermal, solar, wind, and hydro power, and biofuels. Course discusses global production, usage, impacts and future prospects of these resources, and data capture, analysis and modeling of finite resources.

GEOL 534: Vertebrate Paleontology (4 credits)
Explores the evolution of vertebrates from the early Paleozoic to Recent. Covers systematics, anatomy, paleogeography, and ecology of extinct vertebrates. Discussions include fishes, early tetrapods and amniotes, dinosaurs, birds, and mammals. Lab portion includes paleontology techniques, analysis, and study of fossil specimens and casts.Notes: A weekend field trip is included.

GEOL 535: Quantitative Stratigraphy (3 credits)
Quantitative stratigraphy is a branch of geology that applies statistics to reconstruct the time sequence of geological events recorded in sedimentary strata. Methods of interpolation and error analysis used for defining stratigraphic boundaries and events, time scale estimation using integrated chronostratigraphy, and intercalibration are examined. Students receive advanced training in graphic correlation, constrained optimization, ranking and scaling, and dynamic programming.

GEOL 553: Field Mapping Techniques (3 credits)
Explores basic techniques for collecting, recording, and plotting spatial field data, including topographic maps, compass, transit, alidade, and global positioning systems. Field work and field based research project.

GEOL 563: Coastal Morphology/Processes (3 credits)
Investigates global coastal geomorphology and processes, with emphasis on U.S. Atlantic and Gulf coasts. Topics include plate tectonics; sea-level changes; sediment supply; impacts of waves, tides, storms; and human activities. Lecture and extended weekend field trips to U.S. mid-Atlantic coast.

GEOL 565: Paleoceanography (3 credits)
Investigates ocean evolution through geologic time. Earth's sediment archive provides proxy data on paleo-ocean chemistry, biology, geology, and physical properties. Class examines proxy reconstructions of oceanic conditions such as circulation, salinity, stratification, anoxia, and biogeochemistry. Discusses the history of ocean basins, with case studies from Precambrian to Holocene.

GEOL 601: The Lithosphere (3 credits)*
Global-scale overview of lithosphere, solid non-living Earth, materials, cycles, plate tectonic and geomorphic processes; and history, including interactions with and history of hydrosphere, atmosphere and biosphere, and methods of analysis.

GEOL 720: Bayesian Methods in Geology and Earth Science (3 credits)*
The focus of this course is the development of a broad and general tool set that can be applied to the student's own research. Case studies from geology and Earth science literature are a guide to learn about common pitfalls, explore strategies for data analysis, understand how to select the best model for the task at hand, and learn the importance of properly quantifying and reporting the level of confidence in one's conclusions.

GEOL 734: Paleobiology (3 credits)*
Paleobiology involves the ways that paleontologists study fossil organisms as living entities in ecological context. It also deals with large scale patterns in the fossil record and the relationships of those patterns to geologic events.

GEOL 741: Isotopes in Geology (3 credits)*
This course will cover how isotopes of various elements are used in geology. Topics include: determination the absolute ages of rocks and minerals; geochemical analyses and principles to

decipher the processes of formation of rocks and minerals, earth materials; radiogenic isotopic systematics for fingerprinting reservoir compositions, source of contaminants in the environment; assessing the accuracy and precision of geochemical analyses and datasets.

GEOL 751: Geoscience in Academia (2 credits)*
Geology in Academia prepares students for a career as a geoscientist in academia. It includes teaching and learning, pedagogy, research administration, and professional ethics.

GEOL 996: Doctoral Reading and Research*, repeat up to 24 credits (1-6 credits)
Reading and research on a specific topic in geology and earth sciences under the direction of a faculty member.

Appendix C – Faculty Curriculum Vitae (Abbreviated)

Include only those faculty who will teach core and required courses.

Paul Betka, PhD in Geology, 2013, University of Texas at Austin, Assistant Professor of Geology. Specialization Area: field and laboratory methods of structural geology.

Geoffrey Gilleaudeau, PhD in Geology, 2013, University of Tennessee, Assistant Professor of Geology. Specialization Area: chemical evolution of the ocean-atmosphere system.

Linda Hinnov, PhD in Geology, 1994, Johns Hopkins University, Professor of Geology. Specialization Area: analysis and modeling of Earth's past climate variations.

Giuseppina Mattietti, PhD in Geology, 2001, George Washington University, Associate Professor of Geology. Specialization area: petrology and volcanology.

Randolph McBride, PhD in Geology, 1995, Louisiana State University, Associate Professor. Specialization area: coastal geomorphology and processes.

Julia Nord, PhD in Geology, 1989, CUNY, New York, Professor of Geology and STEM Accelerator Faculty. Specialization Area: mineralogy and petrology.

Commented [MDU1]: Not slated to teach core courses.

Mark D. Uhen, PhD in Geology, 1996, University of Michigan, Associate Professor. Specialization Area: vertebrate paleontology and paleobiology.

Stacey Verardo, PhD in Geology, 1995, CUNY, New York, Professor of Geology. Specialization area: invertebrate paleontology and paleoclimatology.

New Hire: Geochemist, PhD, isotope geochemistry or aqueous geochemistry, Assistant, Associate or Full Professor. Specialization Area: paleoclimatology and marine chemistry.

Appendix D – Faculty Extramural Funding

Externally-funded Grants 2017-Present

Please format per sample document. Include only those faculty teaching core coursework.

Funded research for the past 5 years (2017-present) totals $5,493,519 and involves the following faculty members:

Rocio Caballero-Gill, Assistant Research Professor (total: $499,154)

- PI on Heising-Simons Foundation Grant # 2021-2803 (June 2021-May 2024): Leveraging the Geologic Record to Constrain Solar System Evolution, Earth-Moon Dynamics, Paleoclimate Change, and Geological Time, Project 6: The CycloCohort Program – An Early-Career Springboard for Inclusion, Diversity, Equity and Justice Focused Leadership in Geoscience & Astronomy; $499,154

Geoffrey Gilleaudeau, Assistant Professor (total: $686,238)

- PI on National Science Foundation Geobiology and Low-Temperature Geochemistry Grant (August 2020-July 2023): Collaborative Research: The rise and fall of the Neoproterozoic Era in Siberia: connections between tectonics, ocean chemistry, and biologic innovation; $361,062
- PI on American Chemical Society Petroleum Research Fund Grant (September 2020-August 2022): Redox gradients in Lower Mississippian black shales of North America: a test case for uranium isotope behavior; $55,000
- Co-I on NASA Exobiology Grant (September 2019-August 2022): Refining the geochemical toolkit for paleoredox reconstruction: uranium isotope behavior under suboxic, anoxic, and iron-rich conditions; $130,176
- NASA Postdoctoral Program Fellowship (February 2016-February 2018): $140,000

Linda Hinnov, Professor (total: $1,127,840 – not including the ICDP funding)

- PI on Heising-Simons Foundation Grant # 2021-2796 (June 2021-May 2024): Leveraging the Geologic Record to Constrain Solar System Evolution, Earth-Moon Dynamics, Paleoclimate Change, and Geological Time, Project 1b: Earth-Moon parameters and Solar System fundamental frequencies, Precambrian to present; $457,180
- Co-I on International Continental Drilling Program (ICDP) Grant (September 2015-December 2020): Integrated Understanding of the Early Jurassic Earth System and Timescale (JET); $1,500,000
- Co-I on International Continental Drilling Program (ICDP) Grant (March 2019): Deep Dust: Probing Continental Climate of the Late Paleozoic Icehouse-Greenhouse Transition Workshop; $77,810
- PI on National Science Foundation Earth-Life Transitions Program Grant (August 2013-July 2018): Collaborative Research: Investigating the biotic and paleoclimatic consequences of dust in the Late Paleozoic; $67,319
- PI on National Science Foundation Paleo Perspectives on Climate Change Program Grant (July 2013-August 2017): Collaborative Research: The relationship between multi-year

droughts in California, coupled ocean-atmosphere climate oscillations and climate forcing; $54,684
- PI on National Science Foundation Frontiers in Earth Systems Dynamics Program Grant (September 2011-August 2017): Open Earth Systems: Whole planet models for global processes and major events in Earth's history; $548,657 (divided between Johns Hopkins University and George Mason University)

Randolph McBride, Associate Professor (total: $187,509)
- Co-PI on Alexandria Renew Enterprises Grant (July 2020-June 2021): Survey of Micropollutants in Fluvial Sediments and Water from Hunting Creek and the Freshwater Tidal Potomac River; $94,795
- Co-PI on Alexandria Renew Enterprises Grant (2018): An Ecological Study of Hunting Creek 2018; $92,714

Julia Nord, Professor (total: $1,359,550 – all STEM education)
- PI on National Science Foundation Division of Undergraduate Education Grant (April 2021-March 2026): Supporting, Mentoring and Retaining New STEM Secondary Educators Through Major Transitions from Recruitment to Highly Effective Teacher; $1,199,552
- Co-PI on National Science Foundation Division of Undergraduate Education Grant (September 2015-August 2020): Collaborative Research: Scaling Undergraduate STEM Transformation and Institutional Networks for Engaged Dissemination; $159,998

Mark D. Uhen, Associate Professor (total: $1,633,228)
- PI (subcontractor) on National Science Foundation Integrative and Collaborative Education and Research Grant (September 2020-August 2023): EarthCube Data Capabilities: Solutions for Paleobotany: a web client hosting novel content and its integration with existing databases; $40,876
- PI on National Science Foundation Geoinformatics Grant (June 2020-May 2023): Collaborative Research: Geoinformatics: Facility: Paleobiology Database: Preserving and Presenting Ancient Data for Future Research; $666,472
- PI on Research Data Alliance USA Grant (March 2018-August 2018): Paleobiology Database Adoption of RDA Scalable Dynamic Data Citation Methodology; $35,000
- PI on National Science Foundation Integrative and Collaborative Education and Research (ICER) Grant (June 2015-May 2021): Collaborative Research: Leveraging "Big Data" to Explore Big Ideas: Utilizing the Paleobiology Database to Provide Hands-on Research Opportunities for Undergraduates; $202,699+$20,064 supplement
- PI on National Science Foundation Integrative and Collaborative Education and Research (ICER) Grant (November 2015-August 2018): EarthCube IA: Collaborative Proposal: ePANDDA: Enhancing Paleontological and Neontological Data Discovery API; $115,394
- PI on National Science Foundation Integrative and Collaborative Education and Research (ICER) Grant (September 2015-August 2018): EarthCube IA: Collaborative Proposal: Building Interoperable Cyberinfrastructure (CI) at the Interface between Paleogeoinformatics and Bioinformatics; $252,843

- Co-PI on National Science Foundation Integrative and Collaborative Education and Research (ICER) Grant (September 2013-August 2017): EarthCube RCN: C4P: Collaboration and Cyberinfrastructure for Paleogeosciences; $299,880

Appendix E –Employment Demand

Job ads need to be captured from website and sent as individual pdfs, not embedded in the proposal.

- 10 Job Ads are required. At least 6 must be from Virginia.
- Job announcements are not embedded in the proposal. Do not cut and paste text from the announcement into the proposal.
- Ads should be printed from the Internet or captured by PDF.
- Do not include the announcements as an image or screen capture.
- When printing job announcements, adjust print size for readability. SCHEV will not consider announcements that have small font and/or text that appears smeared/smudged.

Tips to print at the correct size:
Here are a few steps to ensure that the ads meet the 12 point font standard. Indeed was the best job search platform to use. I tried many others (Chronicle for Higher Education, Monster, Glassdoor, iHireEngineering, LinkedIn, etc.), but Indeed produced the best results.

- Create an Indeed account and save each ad to the My Jobs section.
- Go to Saved Jobs and click on the Job Title for the ad.
- Hit CTL Print
- Go to More Settings
- Scroll down to Scale
- Select Custom
- Increase the font size to 150 (will adjust size to minimum of 12 point)
- Print and Scan

Appendix F – Student Demand
Current Student Survey

Send pdf of original survey.
Send results of original survey.
These are not embedded in the proposal.

Appendix G – Student Demand
Alumni Survey

Appendix H – Prospective Student Inquiries

Appendix I – Library Resources

The Mason Library includes subscriptions to the following journals relevant to the proposed PhD program in Geology in Earth Sciences, as well as thousands of books both print and electronic for use by students. In addition, Mason Library includes subscriptions to finding and discovery aids like GeoRef and GeoScience World to enable discovery and access to articles in these journals and books.

AAPG Bulletin
American Mineralogist
Bulletin de la Société Géologique de France
Bulletin of Canadian Petroleum Geology
Bulletin of the Seismological Society of America
Canadian Journal of Earth Sciences
Clay Minerals
Clays and Clay Minerals
Earthquake Spectra
Economic Geology
Elements
Environmental & Engineering Geoscience
Environmental Geosciences
European Journal of Mineralogy
Exploration and Mining Geology
Geochemical Perspectives
Geochemistry: Exploration, Environment, Analysis
GeoArabia
Geological Magazine
Geology
Geophysics
Geosphere
GSA Bulletin
Interpretation
Italian Journal of Geoscience
Journal of Environmental & Engineering Geophysics
Journal of Foraminiferal Research
Journal of Micropalaeontology
Journal of Paleontology
Journal of Sedimentary Research
Journal of the Geological Society
Lithosphere
Micropaleontology
Mineralogical Magazine
PALAIOS
Paleobiology
Palynology
Petroleum Geoscience
Proceedings of the Yorkshire Geological Society
Quarterly Journal of Engineering Geology and Hydrogeology
Reviews in Mineralogy and Geochemistry
Rocky Mountain Geology
Russian Geology and Geophysics
Scottish Journal of Geology
SEG Discovery
Seismological Research Letters
South African Journal of Geology
The Canadian Mineralogist
The Leading Edge
The Seismic Record
Vadose Zone Journal
Journal of Metamorphic Geology
Permafrost and Periglacial Processes
Sedimentology
International Geology Review
Ore Geology Reviews
Sedimentary Geology
Lithosphere
Journal of Sedimentary Research
AAPG Bulletin
AAPG Memoir
AAPG methods in exploration
AAPG studies in geology
Abstracts with programs. Geological Society of America
Acta Geologica Polonica
Acta Micropalaeontologica Sinica
Acta Palaeobotanica (Krakow)
Acta Palaeontologica Polonica
Alcheringa
American Journal of Science

American Mineralogist
Annales de Paléontologie
Annales. Société géologique du Nord
Annals of Geophysics
Antarctic Science
Applied Geochemistry
Basin Research
Beiträge zur Hydrogeologie
Boreas
Bulletin de la Société Géologique de France
Bulletin of Volcanology
Bulletins of American paleontology
Canadian Journal of Earth Sciences
Canadian Mineralogist
Carbonates and Evaporites
Chemical Geology
Clay minerals
Computers & geosciences
Cretaceous Research
Developments in sedimentology
Earth
Earth and environmental science transactions of the Royal Society of Edinburgh
Earth and planetary science letters
Earth surface processes and landforms
Earthwise
Economic geology
Elements
Engineering geology
Environmental earth sciences
Environmental & engineering geoscience
Environmental geochemistry and health
Episodes
Erdwissenschaftliche Beiträge zum Naturschutz
Estonian journal of earth sciences
Estudios geologicos (Madrid)
European geologist
European journal of mineralogy
Exploration and mining geology
Facies
Fossil Record
GeoArabia
Geobios
Geochimica et cosmochimica acta
Geodiversitas
Geologia Croatica
Geologica acta
Geologica Belgica
Geologica Carpathica
Geological journal
Geological magazine
Geological Society of America bulletin
Geological Society engineering geology special publication (London)
Geological Society memoir (London)
Geological Society special publication (London)
Geological Society special report (London)
Geological Survey of Denmark and Greenland bulletin
Geology
Geology today
Geomagnetic bulletin. British Geological Survey
Geo-marine letters
Geophysics
Geotechnical and geological engineering
Géotechnique
GFF
Global and planetary change
Ground water
GSA today
Hydrogeology journal
International geology review
International journal of coal geology
International journal of earth sciences
International journal of rock mechanics and mining sciences
Irish journal of earth sciences
Island arc
Israel journal of earth sciences
Journal of African earth sciences
Journal of Asian earth sciences
Journal of foraminiferal research
Journal of gemmology
Journal of geochemical exploration
Journal of geodynamics
Journal of geology
Journal of Himalayan earth sciences
Journal of Iberian geology

Journal of metamorphic geology
Journal of micropalaeontology
Journal of paleontology
Journal of petroleum geology
Journal of petrology
Journal of Quaternary science
Journal of sedimentary research
Journal of South American earth sciences
Journal of structural geology
Journal of systematic palaeontology
Journal of the Geological Society (London)
Journal of the Geological Society of India
Journal of volcanology and geothermal research
Lethaia
Lithos
Lithosphere
Marine and petroleum geology
Marine geology
Marine geophysical researches
Marine micropaleontology
Materials world
Memoir. Geological Society of America
Memoir. Paleontological Society
Micropalaeontology
Mineral processing and extractive metallurgy
Mineralium deposita
Mineralogical magazine
Mining annual review
Mining journal
Mining magazine
Nature
Nature geoscience
Netherlands journal of geosciences
Oil and gas journal
Ore geology reviews
Organic geochemistry
Outcrop
Palaeobiodiversity and palaeoenvironments
Palaeogeography, palaeoclimatology, palaeoecology
Palaeontologia Polonica
Palaeontology
Palaeontology newsletter
Palaios
Paläontologische Zeitschrift
Paleobiology
Paleobios (Berkeley)
Paleontological research (Tokyo)
Paleontological Society papers
Petroleum geoscience
Petroleum review
Petroleum science. University of Petroleum, China
Philosophical transactions of the Royal Society of London
Planet Earth
Precambrian research
Proceedings of the Geologists' Association
Proceedings of the Ocean Drilling Program. Part B, Scientific results
Pure and applied geophysics
Quarterly journal of engineering geology and hydrogeology (London)
Quaternary International
Quaternary research
Quaternary science reviews
Reviews in engineering geology
Reviews in mineralogy and geochemistry
Revista geologica de America Central
Rivista italiana di paleontologia e stratigrafia
Rivista italiana di paleontologia e stratigrafia. Memoria
Rock mechanics and rock engineering
Scripta geologica
South African journal of geology
Spanish journal of palaeontology
Special paper. Geological Society of America
Special papers in palaeontology
Special publication. Cushman Foundation for Foraminiferal Research
Special publication. Geological Association of Canada, Mineral Deposits Division
Special publication. Geological Society of Australia
Special publication. Geological Survey of India

Special publication. Society of Economic Geologists
Stratigraphy
Swiss journal of geoscience
Techniques of water-resources investigations of the United States Geological Survey
Tectonophysics
Terra nova
Treatise on invertebrate paleontology
Undercurrent
U.S. Geological Survey bulletin
U.S. Geological Survey circular
U.S. Geological Survey professional paper