

Curricular Affairs Committee of the Faculty Senate

MEMO

To: Faculty Senate
From: Colby Kervick and Stephen Everse, Co-Chairs of the Faculty Senate
Date: January 11 2024
Re: Approval of a proposal for a new **B.S. Major in Geosciences** by the Department of Geography and Geosciences in the College of Arts and Sciences

Using an electronic ballot that closed on January 11th 2024, the CAC unanimously approved a proposal for a new **B.S. Major in Geosciences** submitted by the Department of Geography and Geosciences in the College of Arts and Sciences, specifically: Julia Perdrial, Keith Klepeis, Laura Webb, Nicolas Perdrial, Beverly Wemple, Lesley-Ann L. Dupigny-Giroux, and Shelly A. Rayback. If approved by the Faculty Senate and the Board of Trustees, the start date will be the fall 2024 semester.

Program Description and Rationale

Our well-being on Earth depends on solving the most pressing issues of our time that include degrading air and water quality, climate change, increasing energy demand, threat of natural and human hazards, and the decline of life-sustaining geosystem services. To address these complex, and highly interrelated challenges across time and land scales, modern geosciences investigate the past, understand and measure the present, and make predictions about the future behavior of our planet and other planetary bodies. As an interdisciplinary field of study, geosciences take a systems lens to investigate the interconnectedness of the Earth layers including atmosphere, hydrosphere, biosphere, and geosphere and includes how living things, including humans, interact with the Earth and other planetary systems.

The geosciences B.S. offers students the opportunity to select courses across a variety of geosciences offerings to study the Earth and other planetary bodies in an interdisciplinary setting and within a system understanding. The new geosciences B.S. will fill a gap in STEM education at UVM as a result of the termination of the Geology Department and Geology major by expanding upon our understanding of the interconnectedness of all Earth's layers as a system, including its geo-resources and the thin layer where life flourishes. This major will combine classroom-based education with hands-on field and lab experiences that integrate the application of course content to real research experiences in the context of the liberal arts and other STEM fields.

Philosophical Goals Statement

The goals of the proposed program are to address fundamental and applied geosciences questions regarding Earth's transitions over space and time and related societal challenges. Combining cutting-edge research with high impact educational experiences through an innovative, learning outcome-based curriculum, the proposals provide students with opportunities to discover and develop relevant geosciences knowledge and skills. The program will offer students a broad geosciences foundation with the flexibility for specialized study and practical experiences and will integrate research with education to promote excellence in both. This approach will support students in their pursuit of their professional goals in an ever-evolving job market in alignment with the liberal arts mission of College of Arts and Sciences and the land grant mission of UVM.

The goals of the B.S. are to:

- build knowledge and skills in the breadth of the discipline that encompasses the interconnectedness of the geosphere, hydrosphere, cryosphere, biosphere and atmosphere in the context of the holistic liberal arts perspective.
- offer in-depth education in specialized subdisciplines in alignment with other STEM fields.
- develop hands-on skills in lab, field, and data analyses in preparation for an ever-changing job market.
- empower learners of all identities including learners that have been traditionally excluded from STEM fields, including students of color, students with disabilities, and LGBTQ+ students.

B. Program level learning outcomes.

The major will offer breadth in the discipline with options in specialized studies in one or more subdisciplines that accommodate student interest. Further, geosciences contribute a systems lens to STEM education; therefore, systems thinking is a key learning outcome for geosciences students. Further, the students will critically engage with the environmental, social, and economic challenges and the colonial history of geosciences. Building skills around written and oral communication, as well as skills in generating and analyzing data in a variety of situations will prepare geosciences students for the job market.

Upon completion of the B.S. degree, students will be able to:

1. Demonstrate familiarity with the discipline's foundational theories and models and demonstrate a deeper comprehension of several subfields in the Geosciences.
2. Articulate the interconnectedness of atmosphere, biosphere, hydrosphere, and lithosphere and interpret significance of relevant processes across time and space.
3. Critically engage with the connections between geosciences and environmental, social, and economic challenges in the coupled human-natural environment.
4. Communicate the relevance of geosciences in relation to other science fields to multiple audiences through oral and written communication.
5. Demonstrate competence with observation, analysis, experimentation, and hypothesis testing in relation with Earth systems thinking and integrate and assess representations of data of multiple types and/or origins.

Justification and Evidence for Demand

The proponents of the B.S. in Geosciences identified demand and needs at the department, college, University and local/regional/state levels.

Geosciences not only fills the gap created by the deactivation of the geology major (B.S., B.A.) and minor but, expands beyond the original mission of the geology program through intentional integration of all layers of the Earth (geosphere, hydrosphere, cryosphere, biosphere, and atmosphere) and other planetary bodies. This includes investigating relevant processes across a broad range of time-scales and landscape-scales using an Earth systems lens, and the generation of knowledge and skills linked to a variety of technologies to respond to shifts in the behavior of our planet across time and space.

Since the merger of Geography and Geology in 2022 Department of Geology and Geosciences has received weekly inquiries and requests about geosciences offerings from both prospective students and current students, respectively. During Admitted Student Days in spring 2023, several families signaled strong interest in a geosciences program, despite the fact that there is no advertising for geosciences in larger ASD events. To meet the demand of currently matriculated students, they have developed a streamlined process for students to declare an Individually Designed Major and Minor (IDM) in geosciences. Currently, five students are working on the application for the major. However, the number of IDM students does not reflect the true level of interest. Indeed, many students, predominantly first-years, have indicated they want to wait and see if the geosciences program will appear in the catalogue.

The proposed Geosciences program can also support local and regional needs related to the assessment and management of water and mineral resources, surface, and groundwater pollution (including PFAS, nitrates, phosphorous, and radioactivity), bedrock aquifers, landslide and erosion hazards, soils and forest health, and

many other issues linked to climate change. The geosciences program is in a unique position to help address these needs because of the expertise of its faculty and through the many partnerships they have with national and state agencies. The Geosciences faculty involvement with state agencies are synergistic and involve research collaborations, personnel exchanges, internships and undergraduate student mentor programs, and educational workshops. Student involvement in these activities provides on-the-job training, field experiences, professional development, participation at professional meetings, and material for research projects and Senior theses. The state receives outstanding applied research that would not be forthcoming without UVM student participation. These collaborations and partnerships directly serve both UVM and Vermont by helping UVM achieve its mission of advancing the economic and social well-being of Vermonters, including by helping to mitigate and to prepare for the effects of climate change.

Relationship to Existing Programs

This program is housed in the Department of Geography and Geosciences in the College of Arts and Sciences. No other units are involved in meeting the core requirements for this program. However, courses offered in other departments, programs, and units are possible as electives and ancillary courses. One way that the proposed B.S. in Geosciences major relates to several programs in the same department or college or to other programs in the University is through these electives and ancillary courses. Further, the geosciences program has direct relationships with other important programs that investigate different spatial scales of physical and human interactions (e.g., Geography, ENVS), and which focus applied aspects of ecosystem processes at shorter timescales (ENSC). The geosciences major will complement these offerings through courses on Earth and other planetary bodies including Earth systems interactions of hydrosphere, cryosphere, biosphere, and atmosphere, across geologic time and landscape scales. As such, geosciences will also support other majors, for example the Earth sciences concentration in the teacher education program in the College of Education and Social Studies. Additionally, many students majoring in Environmental Engineering take courses in geoscience as electives.

The proponents have provided clear distinctions between the proposed program and existing programs in the same department, college or in other colleges.

Within CAS

Within the University of Vermont's College of Arts and Sciences, the launching of the major in geosciences supports the goals of a liberal arts education where "students experience the connectedness and accessibility of a small liberal arts college within a high caliber public research institution." The geosciences program also aligns with the college's mission, i.e. "The College of Arts and Sciences at the University of Vermont welcomes difference, values collaboration, encourages debate, and stands for integrity, service, and academic excellence. We are dedicated to the rigorous pursuit, understanding, and dissemination of knowledge through the process of discovery, the creation of art, and the practice of teaching. We provide an integrated and engaging multidisciplinary experience that generates creativity, critical thought, effective communication, and a practiced commitment to serve the pressing needs of society and the natural world."

Below is a list of programs in CAS which are related to this proposed B.S. in Geosciences.

Geography: this program shares a common root word, geo, and also highlights the application of spatialized thinking in social and natural environments, from local to global scales of analysis. Geography is composed of both physical and human geography, and while physical geography shares some aspects with the geosciences, the geosciences program includes deep time (i.e., the longer timescales that impact deeper Earth layers) and a connection to the core concepts underlying the investigations of all Earth layers and other planetary bodies. Because this major would be co-housed with geography in the Department of Geography and Geosciences, the proponents also envision it satisfying unmet demand voiced by geography students during past program reviews, in which students have articulated a desire for more natural-science focused course work and the opportunity for a B.S. degree. Both the B.A. and B.S. tracks in geosciences provide this pathway to meet articulated student demand.

Geospatial Technology Minor (GST): This is a cross-college minor that includes multiple courses taught by geoscience faculty. This minor includes coursework in GIS, remote sensing, computer programming and data analysis. While there is overlap in the available courses between the GST minor and the proposed geosciences major, the geosciences major is constructed very flexibly so as to allow a student to complete the GST minor and a rigorous geosciences major without exceeding the allowable 3 credits of overlap (double dip) between a major and minor.

Environmental Studies (Major and Minor): Environmental studies is (like geosciences) interdisciplinary and emphasizes a systems lens, but at timescales that are adapted to the living world (typically decades) and with the explicit focus on environmental sustainability and justice. The geosciences major is complementary in this context as all Earth's layers and their interconnectedness are considered and contribute knowledge and skills across larger timescales and depths to understand, predict and mitigate shifts in our planet's behavior and other planetary bodies. The course offerings of the geosciences program are complementary and will be available to students of the ENV5 program.

Outside of CAS

UVM's land grant mission includes the mandate to empower individuals to advance the economic and social well-being of this nation and of the State of Vermont through discovery of knowledge, innovation, and the education of critical thinkers for leadership roles. In support of this mission the proposed B.S in Geosciences can help educate future leaders in systems thinking across these multiple scales and to be transdisciplinary in their problem-solving capacities. The geosciences program will complement and enhance existing programs at UVM through our emphasis on an Earth systems lens and by incorporating knowledge and skills from sub disciplines that investigate the geosphere, hydrosphere, cryosphere, biosphere and atmosphere. Such systems thinking is necessary to address the most pressing issues of our time (degrading air and water quality, climate change, increasing energy demand, threat of natural and human hazards, and the decline of life-sustaining geosystem and ecosystem services) which is complex and highly interrelated across a wide range of scales and disciplines.

Below is a list of programs outside of CAS which are related to this proposed B.S. in Geosciences.

Environmental Sciences (Major): Environmental sciences is also an interdisciplinary program that emphasizes a systems lens, but typically at timescales that are adapted to the living world. The science of the environment does not typically extend below layers of living things and, with exception of the environmental Geology concentration, excludes the explicit study of rocks or the Earth and other planetary bodies, but instead focusses on the ecosystem context in shallow Earth layers including vegetation and soil. The geosciences program is complementary in this context as all Earth's layers and their interconnectedness are considered and contribute knowledge and skills across larger timescales and depths to understand, predict and mitigate shifts in our planet's behavior and other planetary bodies. This way, the course offerings of the geosciences program are complementary and will be available to students of the ENSC program. Indeed, in the past, geology courses were an important contribution to these programs and geosciences offerings will be available in this collaborative and synergistic setting.

Curriculum

The proposed curriculum was adequately described and presented in a way that clearly links programmatic concepts and skills to learning outcomes and curriculum structure (foundation, core, electives) as well as their relationship to the CCC. The proposed **B.S.** requires at least 43 credits in major courses, plus at least 15 credits in ancillary courses.

The curriculum is structured to offer breadth, depth and flexibility to capture the interest of diverse students and requirements of an ever-changing job market. The curriculum is based on cutting edge research in geosciences education and work with core competencies and skills, which are encompassed by program level LO's to enable assessment. It is structured such that all students have instruction in foundational courses (intro level) which ensures the same level of preparation and opens mid-level courses. Further, the categories in core courses ensure that students receive instruction across the breadth of our discipline, even for cases when

students have highly specialized interests. The requirement of minimum 9 credits in advanced course work further ensures depth. The course list shows multiple course offerings in each category (breadth) as well as choices of several advanced courses in each category (depth).

Foundation courses (introductory level, 10 credits):

All students will take 3 introductory courses that introduce the breadth of the discipline and providing important context for midlevel courses:

Core courses (intermediate and advanced level, minimum 21 credits):

At the intermediate and advanced level, students are required to take core courses in each of the following 4 categories that emphasize the interconnectedness of Earth layers and processes.

- Earth and Planetary Materials
- Land-Surface Processes & Interactions
- Atmospheric and climatological processes
- Practice Requirement

Electives (up to 12 credits):

Flexibility is also built into the proposed program through the possibility of applying electives (up to 12 credits) in courses with numbers of 2000 and above. These can be additional geosciences courses and/or courses from select departments and units, such as courses with the prefixes ASTR, BIOL, CEE, CHEM, CS, ENSC, ENVS, GEOG, NR, STAT, PHYS, or PSS. This flexibility offers students the chance to combine integrated geosciences courses with courses in related disciplines in the spirit of a truly interdisciplinary and integrated field of study.

Ancillary courses (minimum 20 credits):

The guidelines for ancillary courses reflect the combination of flexibility with guardrails: all B.S. students are required to take calculus I and II or statistics, chemistry, and physics. They further have the option to apply astronomy, biology, computer science, or additional statistics courses to the required minimum of 20 credits in ancillary courses. The proponents will offer guidance on decisions on ancillary courses, as certain coursework that might be required for graduate school admissions down the line. However, the proponents intentionally refrain from requesting the same prerequisites for all students, because “trajectories, interests and career choices are highly variable.”

At least 43 credits in major courses, plus at least 20 credits in ancillary courses, including:

FOUNDATIONS. 10 credits.

GEOL 1400	Environmental Geology	4
or GEOL 1025	or Topics In: LASP Seminar	
GEOG 1200	Weather, Climate & Landscapes	3
GEOL 1100	Earth through time	3

CORE COURSES. At least 21 credits.

LEVEL REQUIREMENTS.

At least 9 additional credits from the Core Courses 9-21
Subfields lists at the 4000-level or higher in GEOL
and/or the 3000-level or higher in GEOG, in any
combination

Up to 11 additional credits from the Core Courses 0-12
Subfields lists at the 2000-level or 3000-level in
GEOL and/or the 2000-level in GEOG, in any
combination

SUBFIELD REQUIREMENTS. Select at least 1 course/3 credits from each of the following subfields; a single course can be counted in more than one subfield.

Earth and Planetary Materials. GEOL 2105, 2110, 2605, 3515, 4105, 4110, 4510

Land-Surface Processes and Interactions. GEOG2205, 2250, 2715, 3230, 3250, 3410
GEOL2105, 2110, 2405, 2410, 3405, 4405
Atmospheric and Climatological Processes. GEOG2230, 2250, 2715, 3230, 3250, 3520
GEOL2405, 3405
Practice Requirement. GEOG2510, 2520, 3505, 3520
GEOL2105, 3405, 3515, 3993, 3995, 4105, 4405, 4510, 4525

ELECTIVES. At least 12 credits.

At least 12 additional credits from the following: 12
GEOL numbered 2105 to 2990, or 3000 to 3990, or 4000 to 4990
GEOG numbered 2205 to 2715, GEOG 3230, GEOG 3250, GEOG 3505, or GEOL 3520
ASTR, BIOL, CEE, CHEM, CS, ENSC, ENVS, NR, STAT, PHYS, or PSS numbered 2000 to 2989
ASTR, BIOL, CEE, CHEM, CS, ENSC, ENVS, NR, STAT, PHYS, or PSS numbered 3000 to 3989
ASTR, BIOL, CEE, CHEM, CS, ENSC, ENVS, NR, STAT, PHYS, or PSS numbered 4000 to 4989

ANCILLARY REQUIREMENTS. At least 20 credits.

CALCULUS I. Choose 1 of the following: 3-4
MATH 1212 Fundamentals of Calculus I
MATH 1234 Calculus I
STATISTICS OR CALCULUS II. Choose 1 of the 3-4
following:
STAT 1410 Basic Statistical Methods (recommended)
MATH 1224 Fundamentals of Calculus II
MATH 1242 Transitional Calculus
MATH 1248 Calculus II
CHEMISTRY. Choose 1 of the following options: 3-8
Option A (strongly recommended):
CHEM 1400 and CHEM 1450

Other Considerations

The proposal specifies restrictions on ineligible majors/minors.

The proposal presented ample evidence of multiple viable pathways /curriculum design that students with varying interests can complete the B.S. major in 4 years.

The proposal listed all existing courses that will contribute to the proposed B.S. program. There is no anticipated negative effect on enrollment since the geosciences program fills a gap created by the termination of the geology program.

The proposal also listed new course name/numbering changes and the faculty responsible for submitting those changes.

Admission Requirements and Process

Anyone in the College of Arts and Science can declare geosciences as a major. Students from other colleges at UVM may also declare a geosciences major if they are willing to enroll as a dual degree student and complete College of Arts and Sciences requirements. In order to graduate with the geosciences major, students will have to maintain a GPA of 2.0 or better.

Anticipated Enrollment and Impact on Current Programs

It is predicted that there will be about 30 majors in the first year with increasing numbers as the program becomes more widely known through work by the Admissions Office and ASVD, the department and college websites, the course catalogue, and through serendipitous encounters with the courses linked to students' need to fulfill Catamount Core requirements.

Advising

The program director will serve as advisor. In the beginning, the director will offer trainings in advising for geosciences faculty and College of Arts and Sciences advisers, after which advising will be shared equally by all geosciences faculty. As per common practices in the Department of Geography and Geoscience, students will be offered group advising sessions each semester before registration. This offering will be in addition to individual advising appointments.

Assessment Plan

A clear and thorough plan has been presented. It will be overseen by the director.

Staffing Plan, Resource Requirements, and Budget

The program will have a director who will be responsible for typical tasks such as coordinating meetings, advising, admitted student days, outreach, and program assessment. This position is compensated with a stipend and course release to allow time for administrative responsibilities.

The following faculty in the Department of Geography and Geosciences will be participating:

- Julia Perdrial,
- Keith Klepeis,
- Laura Webb,
- Nicolas Perdrial,
- Beverley Wemple,
- Lesley-Ann L. Dupigny-Giroux, and
- Shelly Rayback.

Confirmation has been made that all necessary resources are available from the previous Geology program and the Geography program. No additional resources will be necessary.

First-year costs of the program will be supported by the department's operating budget and previously approved course fees. Current faculty will teach courses listed in the geoscience's curriculum. Graduate students, supported by faculty grants and the Graduate College, will provide additional support.

Costs for the first five years of the program will be supported by the operating budget, approved course fees, and current faculty and GTA'S.

Evidence of Support

The proponents engaged with chairs of programs that are closely related and/or involved through ancillary courses. Evidence of support was provided by the following:

Programs that are closely aligned

- Geography – Shelly Addison Rayback <srayback@uvm.edu>, <Jennifer.Pontius@uvm.edu>
- Geospatial Technology Minor – Gillian Galford <gillian.galford@uvm.edu>
- ENVS – Cheryl Morse <Cheryl.Morse@uvm.edu>
- ENSC – Jennifer Pontius <Jennifer.Pontius@uvm.edu>

Departments involved through ancillary or possible elective courses

- Department of Chemistry - Matthias Brewer <Matthias.Brewer@uvm.edu>
- Department of Physics – Randall Headrick <Rheadrick@uvm.edu>
- Department of Mathematics and Statistics – Jianke Yang <Jianke.Yang@uvm.edu>
- Department of Civil and Environmental Engineering – Mandar Dewoolkar <mdewoolk@uvm.edu>

- Department of Biology – Bryan Ballif <bballif@uvm.edu>
- Department of Plant and Soil Science – Terence Bradshaw <Terence.Bradshaw@uvm.edu>
- Additionally, the Geosciences will support the Earth Sciences concentration for Teacher education (secondary education grades 7-12) B.S.Ed. in the College of Education and Social Services.

Summary

The proposed B.S in Geosciences will be valuable additions to UVM. The proposed curriculum offers breadth, depth and flexibility while recognizing the interconnectedness of the interactions of the Earth and other planetary systems with living things will be examined through a systems lens. These suit the missions of UVM and the College of Arts and Sciences. .