Department of Geosciences

[0030] Information and Departmental Plan of Study

The intellectual excitement of modern geosciences is fueled by our exploration of the dynamic forces and delicate balances that mold our planet and have rendered it conducive to life for much of its history. Our landscape is continually reshaped by the movement of cold continents atop the hot, viscous mantle, and our lives are altered by the earthquakes and volcanic eruptions that attend their collision. Rocks that cover the Earth's surface sink to great depths and transform under enormous temperatures and pressures, perhaps to be uplifted as mountains and exposed to future generations by the forces of erosion. The ocean and atmosphere engage in a continuous and complex dialogue that controls the Earth's climate. Chemical reactions operating within microorganisms and on a variety of mineral and other natural surfaces are integrated into large geochemical fluxes, which distribute the resources needed for life, and life in turn alters these fluxes. This process operates within the framework of biological evolution, in which diverse organisms appear, evolve, and vanish, sometimes leaving a transfigured world in their wake. All of these processes influence our daily lives in profound and surprising ways.

Many of the great challenges to humanity, today and in the future, involve processes that are studied by Earth scientists, leading to a rapidly increasing role for the field in issues of environmental regulation and public policy. A background in the Earth sciences is an essential component of contemporary education. Practicing geoscientists study nature both in the field and in the lab. To an ever-increasing degree, they must quantify observations with the aim of not only describing the past but also predicting the future of our planet, often with the aid of rigorous laboratory and field experiments and intensive computation and modeling. The diversity of processes that characterize the Earth as a whole requires the geosciences to be an extraordinarily interdisciplinary field with direct connections to mathematics, physics, chemistry, biology and computer science. As a result of these connections, the geosciences frequently draw students from many backgrounds. Many of our most successful graduates begin their undergraduate careers in subjects ranging from physics to English. The Department of Geosciences welcomes this intellectual variety, and our undergraduate program allows flexibility while stressing the importance of a sound understanding of the basic sciences.

[0050] Prerequisites

All concentrators are required to take both GEO 202 and GEO 203, or one of these and one of the GEO FRS courses. Students with adequate preparation may proceed directly to GEO 300 level courses with the consent of their GEO advisor, but this cannot substitute for one of the 8 upper level geoscience courses. Other introductory geosciences courses, such as GEO 102 103, 107 and 197 [formerly 297] are intended primarily for non-science majors and are not ideal for students anticipating in majoring in geosciences.
[0080] General Requirements

The following courses are required for graduation (with at most one PDF). AP credit may be used to place into a more advanced math or science course, but it does not provide credit toward the Geoscience concentration.

Mathematics: MAT 104 or one higher level math class. MAT 201 and 202 are recommended for some upper-level courses but are not required for the concentration.

Biology, Chemistry, Physics and Computer Science: Two introductory or one advanced course from two of these four departments. Introductory courses include EEB 211, 214, 215, 306, 308, 309 or 321; CHM 201 and 202 (or 207); PHY 103 and 104; COS 126 and 226 (or 323), 333.

Students interested in graduate school are encouraged to take more than these minimum basic science requirements.

[0090] Departmental Requirements

Concentrators are required to take eight upper-level geosciences courses (300 level or higher) with a breadth requirement of one course from at least two tracks (no PDF).

Two upper-level courses (300 level or higher and not counted toward the General Requirements listed above) in CEE, CHE, CHM, COS, EEB, MAE, MAT, MOL or PHY may be substituted for two of the eight required geosciences courses. Examples of advanced courses that can substitute for two introductory courses include CHM 215, 303+304, 305, 306; PHY 205, 207, 208. Subsequent to completion of the introductory course requirement, one GEO 200-level course can replace one 300-level course.

Students are urged to consult with the departmental representative or their junior or senior advisor before choosing departmental courses outside geosciences. In general, the department is flexible with course selections and requirements; however, we must ensure a degree of coherency in the curriculum of each student.

Junior Colloquium. This is a weekly luncheon meeting, convened during the fall term, to acquaint juniors with research and career opportunities. This is mandatory for all geosciences majors (including those in the geological engineering program).

[0120] Program of Study
A set of informal programs (tracks) of study is designed to help students interested in different areas of geosciences, and to provide basic course plans that allow students to develop a strong foundation in those areas. These areas of focus include:

*Geology and Geophysics (GPG).* This track focuses on the structure and evolution of the Earth as a physical system, by theory, experiment, fieldwork, and numerical simulation. The emphasis is on geological processes of global relevance and the history of Earth and life in the rock record. The quantitative concepts and techniques covered in class are also relevant to applied sciences and industry.

*Ocean, Atmosphere, and Climate (OAC).* This track specializes in the study of the coupled ocean and atmosphere system as it interacts with life to set the physical and chemical conditions of the Earth's surface. Students with backgrounds in subjects as diverse as chemistry, biology, physics, public policy and economics with an interest in climate and global environmental conditions will find this track a challenging and relevant addition to their coursework.

*Environmental Biogeochemistry (EBG).* This track focuses on the understanding of chemical and biological processes modifying the Earth's surface (atmosphere, soils, sediments, oceans) and how their interactions alter the behavior of elements or molecules responsible for different environmental processes, such as climate change, and the transport and bioaccumulation of anthropogenic contaminants.

*Certificate Programs.* The department offers a certificate program in geological engineering in collaboration with the Department of Civil and Environmental Engineering, which is described in the entry for the Program in Geological Engineering. The department also cooperates in the certificate programs in environmental studies, materials science and engineering, planets and life, and teacher preparation. Several geosciences courses fulfill the requirements of these certificate programs.

All students considering a concentration in the department should see the departmental representative. They are encouraged to consult as soon as possible, even as first-year students, to aid in the design of a course of study. The department offers an open house in both the fall and spring terms to introduce prospective students to departmental courses, faculty, students, and research interests.

For full details, see the department's [website](#).  

**Junior Advisors**

Each Geosciences junior is assigned an advisor, who is a faculty member and part of the Undergraduate Work Committee (UWC). Students are expected to regularly meet their advisors for discussions on curriculum, course selection, choice of junior research paper topics, study abroad plans etc. Once the courses are selected in consultation with your advisor, turn in your signed fall and spring course worksheet to the undergraduate coordinator. Any course changes
should also be discussed and approved by your advisor or the undergraduate chair. You will be informed who your Geosciences advisors are at the beginning of each academic year.

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[0170] Independent Work

**Junior Independent Work**

All juniors are required to conduct independent research both in the Fall and Spring semesters. Students are required to submit a written report of their JIR at the end of both the fall and the spring semester. In addition, students will present their JIR to the department as an oral presentation in the fall semester and as a poster presentation in the spring semester. Although the Geoengineers are not required to conduct JIR, some Geoengineers have done JIRs anyway, conducting independent research in Geosciences or Engineering and receiving course credit.

Different research topics are available in any given year and listed in the “Shopping Guide”, which students obtain from the undergraduate coordinator. Students are encouraged to consult with their faculty advisor for suggestions regarding the selection of the JIR project. If students have other exciting ideas for possible JIR projects, they are encouraged to consult their faculty advisor to discuss the feasibility of these projects.

JIR projects for both the fall and spring terms typically involve literature reviews, data collection (i.e., fieldwork, laboratory analysis and/or data mining), and original data analysis. A student may choose to work on the same topic for the full year, or on two different topics, but the fall semester JIR must stand alone as a full project and will be judged on its own merits. ALL JIR work MUST include original data and/or original analysis. A literature review by itself does not qualify for a JIR project. Many opportunities for collecting data are available, either through the student's own efforts (including geological field work, experiments conducted in any of the several laboratories in the department, and computer simulations), or by accessing databases made available by and for the scientific community at large. The department and the faculty advisor can provide the necessary funding to conduct this independent research. The final grade for both fall and spring independent research is decided based on the quality of the research, written report, and the oral presentation of the student.

**Senior Independent Work**

The senior research thesis project involves a much more in-depth study in the chosen topic and is a full year effort. Students should therefore budget their time accordingly. Each Geosciences senior will choose an appropriate faculty member as senior thesis advisor in consultation with the Departmental advisor and the faculty members that shore the student’s interests. The student is expected to conduct research in the advisor’s laboratory and work closely with the advisor and/or graduate students.

The Department publishes a “Shopping Guide”, which lists research topics that the Geosciences faculty members are currently pursuing. The *Shopping Guide* is a good starting point to identify
a list of topics and Research Advisors from which a student can select a topic and advisor for their senior independent research in consultation with the Departmental Advisor and faculty members. If a student is interested in pursuing a topic that is not part of the *Shopping Guide*, he/she is encouraged to approach their departmental advisor to discuss the feasibility of conducting the research either under the supervision of a faculty member in the Department or in another department in the University. Many students select their projects early in consultation with the faculty advisor, and begin the research during the summer preceding the senior year. The department and the faculty advisor usually provide the necessary funds to conduct the independent research.

The Department requires that students submit a thesis proposal and several interim research progress reports, including the fall semester progress report, a rough draft of the thesis for feedback and the final thesis. The goal of these interim reports is to facilitate timely advisor-student feedback, help minimize the unavoidable thesis rush at the end of the year and to ensure that the final product of the thesis is of the highest quality. In addition to writing the thesis, all students give an poster presentation to the faculty and students of the Geosciences department. The grade for the thesis is based on the quality of the research, written report, and the poster presentation.

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**Senior Departmental Examination**

The comprehensive examination in the department consists of an oral examination based on the senior thesis and related topics.

**Grading and Honors**

**Senior Thesis:** You will be graded on 1) your thesis research plus written report and 2) oral presentation plus answers to questions.

- **Thesis Grade:**
  1. *Research:* quality, originality and commitment to doing the best possible lab-, field- or model-based research. Ability to interpret results. Grade determined by your advisor.
  3. *Oral presentation:* based on quality and clarity of presentation in lecture and illustrations and facility in answering questions by pertaining to research results. Grade determined by the entire faculty.

The final thesis grade will be set only after a meeting of the faculty to discuss and rank all theses. In general an A on a senior thesis means that the work and write-up submitted has sufficient merit to be published in a peer-reviewed journal. The final thesis grade is reported to the Registrar and appears on your transcript.

**Academic Honors:**
The Department awards academic honors (Honors, High Honors, Highest Honors) based on a combination of factors, including the overall grade point average (GPA) departmental GPA, Junior Papers and Senior Thesis. To compute the departmental GPA all grades from required classes for the particular majors track are used. If the student has taken more than the required courses, then the courses with the highest grades that satisfy the concentration and breadth requirements are used in the calculation. For the Senior Thesis and Junior Research papers the assigned grades will be used. In addition to grades, dedication to research, academic participation and the overall impressions made by the student on the faculty are taken into consideration in honors calculation. To assure that the quality of honors remains consistent from year to year the faculty compares student achievements with those from previous years.

Guidelines to calculating Honors:

- Overall GPA 20%
- Difficulty and relevance of course load 10%
- Departmental GPA including outside classes required for majors 30%
- Junior Independent Research paper #1 7.5%
- Junior Independent Research paper #2 7.5%
- Senior Thesis & oral defense 25%

[0230] Preparation for Graduate Study

Specialization in any one of the Earth sciences today requires graduate study. Students interested in pursuing graduate studies in any of the tracks are encouraged to take advanced chemistry, physics, mathematics, and biology courses. More specific information on graduate education can be obtained from the departmental representative or other faculty members.

[0250] Additional Information [category header will not show]

Field Programs. Since experience in field geology is an important aspect of professional training, students are encouraged to take a course in field methods in geology and oceanography.

Geological Field Camp. Many of our students take the YBRA (Yellowstone-Bighorn Research Association) field course in Red Lodge, Montana, after their sophomore or junior year. Other students choose to work with a faculty member (e.g., Maloof, Schoene, Onstott, and Keller) or a graduate student in the field, and may conduct independent research for junior or senior independent research as part of this opportunity. Geosciences facilitates student enrollment in these field opportunities by providing financial aid.

Experience at Sea. Students interested in ocean studies can participate in ongoing studies at sea or at the Bermuda Biological Station. The department tries to make available opportunities to interested undergraduates, particularly to those electing the OAC and EBG tracks, to participate in an oceanographic cruise at some time during their undergraduate years.
Information on other opportunities for field experience is made available annually. The student should consult the departmental representative if interested in participating in field programs.

**Financial Assistance**

Grants for fieldwork in geology are available through the Tony Conway '36 Memorial Scholarship Fund. Grants for field and museum studies and research in natural history during the summer are available to students of high scholastic standing from the John Boyd '43 Memorial Fund and the Glenn L. Jepsen '27 Fund. Grants are available from the Erling Dorf ’33 Fund for field work and the field course. The Howard T. Vaum Jr. ’78 Fund supports studies in geological engineering in a field study program. Grants for environmental studies are available from the Princeton Environmental Institute (PEI). Students wishing assistance from any of these funds should present a proposal (two pages of research description) by February 15 to the departmental representative.

Funds are available from time to time for qualified undergraduates to serve as research assistants to faculty members during the regular academic session as well as during the summer months. In some instances summer employment for qualified students can be arranged with governmental, commercial, or academic field parties.