Department of Earth and Ocean Sciences

Information for Majors and Minors

Geology students hiked to the bottom of the Grand Canyon, January 2011

Tufts University
http://eos.tufts.edu
Welcome to the Department of Earth and Ocean Sciences!

We are happy to welcome you into a program that offers exciting academic and intellectual challenges - our field uses all the sciences and mathematics to understand Earth processes, so there is something for everyone. This booklet is intended to give you some detail about what to expect as a major or minor in our department, and get you started thinking about your future in this interesting field.

The introductory courses you will take first are EOS 1 The Dynamic Earth and EOS 2 Environmental Geology. You can take either one first, as EOS 1 is not a prerequisite for EOS 2. Once you have completed at least one of these courses, you are ready to take one or more upper level courses that focus on some subdiscipline in Earth and Ocean Sciences. A faculty advisor will help you select the appropriate courses for your program (see p. 9).

The introductory courses may have large enrollments in the lectures (perhaps 60 to 75 students), but you will also be in a much smaller lab section. The upper level courses (those numbered above EOS 9) tend to have 6 to 20 students in them. You will get to know professors and your classmates well in these courses - there is plenty of individual attention and cooperative learning.

Part of the appeal of Earth and ocean sciences is that they apply biology, chemistry, physics, and mathematics in the study of the Earth systems. It is essential to have background in the supporting fields to understand their application to the study of processes operating on the Earth. Our students are required to take chemistry and physics, and are strongly encouraged to take calculus and biology.

One of the fascinating parts of this field is seeing how these other sciences can be used in solving geologic problems and explaining geologic phenomena. The sorting of sedimentary grains in stream flow, for example, can be described using mathematical and physical principles based on the size, shape, and density of the grains. Crystallization of molten rock either deep in the Earth or at the surface as lava flows can be explained using chemical models. Study of our Earth, its oceans, and even other planets integrates all the other sciences as we seek to explain and predict Earth processes.
Some of our courses are offered in alternate years. This requires careful planning on your part, in consultation with your advisor, to ensure that you are able to complete the requirements for either the Geology or the Geological Sciences major, or one of our Minor programs (Geology or Geoscience). The requirements for these programs are outlined below.

**Geological Sciences Major**

- EOS 1 *The Dynamic Earth*
- EOS 2 *Environmental Geology*
- EOS 11 *Mineralogy*
- EOS 22 *Structural Geology*

3 courses selected from
- EOS 12 *Igneous/Metamorphic Petrology*
- EOS 13 *Isotope Geochemistry*
- EOS 32 *Geomorphology*
- EOS 42 *Sedimentology & Stratigraphy*

1 course selected from
- EOS 131 *Groundwater*
- EOS 133 *Field Methods in Hydrogeology*

2 courses from above EOS 9 (or in related fields)

Plus:
- Math 32, Chem 1, and Physics 1 or 11
- 2 additional courses from Math 34, Chem 2, Physics 2 or 12, and an approved statistics course

**Geology Major**

- EOS 1 *The Dynamic Earth*
- EOS 2 *Environmental Geology*
- 8 more courses in EOS; up to 2 approved upper-level engineering courses may substitute for EOS courses, and up to 3 approved related fields courses may substitute, to a maximum of 4 substitute courses
- Chem 1
- Physics 11 (or 1)

**Geology Minor** *(for engineers only)*

- EOS 1 *The Dynamic Earth*
- EOS 2 *Environmental Geology*
- EOS 22 *Structural Geology*
  **or**
- EOS 32 *Geomorphology*
- EOS 131 *Groundwater*

An elective chosen from:
- EOS 22 *Structural Geology*
  **or**
- EOS 32 *Geomorphology*
- EOS 42 *Sedimentology & Stratigraphy*
- EOS 115 *Glacial/Quaternary Geology*
- EOS 132 *Groundwater Chemistry & Quality*
- EOS 133 *Field Methods in Hydrogeology*

**Geoscience Minor** *(for science, mathematics, or archeology majors only)*

- EOS 1 *The Dynamic Earth*
- EOS 2 *Environmental Geology*
- 3 EOS courses selected in consultation with EOS advisor

Descriptions of all these courses can be found at http://eos.tufts.edu

*On the way down the South Kaibab Trail, Grand Canyon*
Classes in Earth and Ocean Sciences

Our classes generally have a formal lecture component, but there are other more informal learning modes as well, especially in the lab meetings.

Examining thin sections (very thin slices of rock) using a petrographic microscope provides important data about a rock's mineral composition.

There is plenty of individual attention provided in the introductory geology lab meetings.

Students learn about element partitioning in molten rock through use of a delicious analog: M&Ms in many colors represent Si, Al, Fe, Na, etc. (The demonstration was eaten afterwards!)
Field Trips as part of your Major or Minor

The dynamic beaches of Cape Cod...
Pump testing a municipal aquifer...
Mineral collecting...
Mapping ancient glacial lake deltas...
Finding dinosaur tracks...

Our science is the study of the Earth - and field work is an essential part of the curriculum. In order to take advantage of the geologic setting in the northeastern U.S. we include required weekend field trips in some of our upper level courses. **Students must be prepared to commit a few weekends per semester for excursions.**

In EOS 1 and 2, field trips are scheduled during afternoon lab sessions where the geologic principles discussed in class are brought to life through landform analysis and rock outcrop interpretation. The upper level courses may have field trips during some afternoon labs as well, but there are also a few weekend field trips to more distant geologic locations in New England and New York State.

We notify students early in the semester about which weekends will have field trips for planning purposes. The expectation is that students will accommodate these field trips, given that they are so valuable in one’s geologic education and are the prelude to graduate study or a professional career in geology. This will require flexibility in scheduling jobs and studying, as well as foregoing sporting events or recreational activities.

Exposure to geology in the field is a wonderful way to enhance your understanding and appreciation of Earth processes. And the informality of field work always leads to getting to know your classmates and professors better - and they get to know you better as well.
Doing research in the Earth and Ocean Sciences

After you have had a few courses in EOS, you may find that your interests and those of one of the faculty intersect, and you would like to explore a research topic in greater depth. Our faculty are open to working with students and there have been many valuable collaborations. Some students have been hired to work with faculty over the summer, and such projects can turn into senior theses. You may approach a professor with an idea for a Summer Scholars project. Other students have done work during the academic year for credit. Students have become coauthors on papers or given talks or posters at regional, national, and international professional meetings.

Faculty research interests:
Anne Gardulski: stratigraphy, sedimentology, effects of climate and tectonics on sedimentary basins
Grant Garven: geohydrology, computer modeling of fluid flow in oil and gas systems, ore deposits
Molly McCanta: magma chemistry and dynamics, planetary geology
Jack Ridge: glacial geology, Quaternary history of the northeastern U.S., geomorphology
Jacob Benner: paleontology, paleoecology, trace fossils

Regardless of how such a project is structured or evolves, there are a few hints for setting up a useful and exciting collaboration. First, it is helpful for you to have some focused idea of what you would like to do, rather than just saying that you would like to “do research”. Is there a specific problem that appeals to you? A field area you have seen on field trips that brought questions to your mind? Sometimes faculty have specific projects on which they need help, and they will invite exceptional students to participate.
A 3-mile hike through a landscape of Jurassic sand dunes was the backdrop for the search for dinosaur trackways, in southern Utah.

Second, it is critical to realistically set aside time every day to pursue the work once a project is identified, and to set up a clear schedule for accomplishing tasks - e.g. experiments, field work, data analysis, and especially multiple drafts of the written results whether it is a report or a full thesis. One of the most common reasons for an unsatisfactory research experience is that students place it lower on their priority list - the math test coming up, or paper due in history, or hike on the weekend may seem more immediate and therefore the research work keeps being put off. You probably should not take more than 2 or 3 other courses in addition to the research credit, and don’t overextend yourself in extracurricular activities during these semesters.

Finally, take advantage of resources at the library for doing research - the web is not a rigorous research tool. Librarians are eager to help you learn how to use databases and organize information.

A self-directed or collaborative research project can be a terrific way to learn about some topic in depth and to develop problem-solving skills. It is also great preparation for graduate work and career paths that require the ability to see a multifaceted project through from beginning to end.
A few miscellaneous notes...

Going abroad:

Many Tufts students want to go abroad during their junior year. While this experience can be valuable, we encourage students to seriously consider how important this really is to them. There are some disadvantages to going abroad, including the fact that it may be difficult to find a school at which the EOS courses you need are being offered (given that many of our courses are offered in alternate years, this is an important planning consideration).

Also, at many European institutions, students don’t take just one course in Mineralogy, for example - they take Mineralogy for 2 or 3 years at different levels. So if you are only there for one semester or a year, you may not get the full course that you should have, or you may be over your head since other students have had much more preparatory material. Also, if you are away for the spring semester or, especially, for a year, when you return to Tufts in the fall of your senior year we do not know how you have progressed in your geo-sophistication at exactly the time that you are asking for letters of recommendation for graduate school or jobs. It is much easier to write an in-depth and meaningful letter for student whom we have seen grow continuously since their sophomore (or freshman) year.

However, there are advantages to studying elsewhere, including the possibility of finding courses in fields that we do not offer (e.g. geophysics, soil science). You also may be able to do field work in locations that are very different from New England. And of course, spending extended time in another country and culture is a memorable and educational experience.

Regardless of your decision about going abroad, it is important to realize that Earth science as a discipline is translatable to work anywhere in the world. Students often have the opportunity to live and do field work in places outside the U.S. while in graduate school, or to travel abroad for professional meetings and field trips. There are also employment opportunities outside North America that may be very appealing. The bottom line is that your junior year is not the last time you can travel. And subsequent travel may be even more meaningful after you have a degree in Earth and ocean sciences.

Groundwater hydrology field trip to Cape Cod to study contamination in the sand and gravel aquifer
Special Departmental Field Trips:

The Department of Earth and Ocean Sciences generally organizes one optional, extended field trip every year during either winter or spring break. These are fantastic opportunities to explore remote and beautiful geologic localities, including places in Arizona, New Mexico, and southern Utah.

The winter trip normally runs during the winters of even-odd years (e.g. 2006-07) from late December to mid-January. We visit 12-15 sites in Arizona and New Mexico, examining the geology of national parks and monuments, as well as other places, to a depth that tourists do not experience. Some locations that we have visited in the past include the Petrified Forest, Meteor Crater, Carlsbad Caverns, the Chiricahua Mountains, Bandelier cliff dwellings, and the Copper Queen mine in Bisbee, among others. We end the trip with a 3-day hike in the Grand Canyon, walking down through rocks representing nearly 2 billion years of Earth history. Students who have had EOS 1 and 2 and at least one upper level course are eligible to participate.

The spring break trip to southern Utah occurs in even years, and is open to any student who is taking Structural Geology or Sedimentology & Stratigraphy. We study the geology of Arches, Canyonlands, the San Juan River area, and a variety of other localities. This trip is a wonderful complement to the course work and provides first-hand experience with concepts that are covered in class.

Both of these trips are optional but are highly recommended. Not only are they great ways to expand your education, you tend to make fast friends on such close shared experiences and get to know the faculty well (and vice versa).

The trips require some financial contribution from students, but the Department underwrites a significant part of the cost. We make sure that no student passes up these opportunities because of financial need, so talk to Prof. Anne Gardulski if funding is a problem. We firmly believe that field work is the solid base of a geologic education.

Students exploring the large gypsum dunes at White Sands, NM

Canyonlands National Park in southern Utah is a great place to examine stratigraphy and learn about weathering and erosion processes that create fantastic landforms.
You are interested in Earth and Ocean Sciences - what next??

Once you have considered the various majors and minors in the Department of Earth and Ocean Sciences, the best thing to do is to talk to any of the professors for more information. Any of the faculty can serve as your academic advisor for either the Geology or the Geological Sciences major - just ask. Many students seek out the professor who taught their first introductory course to be their advisor, but any of us are happy to take on students as advisees.

If you are interested in the Geology or Geoscience minor, see Professor Anne Gardulski - she is the minors advisor.

Here are the faculty, and their email addresses:

Anne Gardulski   anne.gardulski@tufts.edu
Grant Garven     grant.garven@tufts.edu
Molly McCanta    molly.mccanta@tufts.edu
Jack Ridge (Chair) jack.ridge@tufts.edu
Jake Benner      jacob.benner@tufts.edu

The Departmental web site and links in there are also great resources for more information http://eos.tufts.edu
What is your future in Earth and Ocean Sciences?

Careers in the Earth sciences include an enormous array of jobs, from environmental engineering firms, to teaching, to planetary research institutes, to work at the geological surveys, and more. Developing awareness of the Earth as a closed, delicate, integrated system has led to renewed interest in problems such as the effects of groundwater contamination, climate change, soil degradation through intense agricultural policies, and natural hazards such as volcanic eruptions, tsunami, and landslides. The needs for energy in all its forms and for natural resources exploited in sensible ways will continue to rise in this world. And basic scientific research in the many fields in the sciences of the Earth and its systems can form a satisfying and rewarding career. Go to http://geology.tufts.edu/employment for much more information.

To maximize your options for a career in the Earth and ocean sciences, there are a few things you can do:

- take all the EOS courses you can fit into your schedule to establish a solid foundation in your major
- take supporting sciences courses to strengthen your background and scientific perspective - take the required Chemistry and Physics, and Mathematics, but go for some Biology as well, and upper level courses in these fields
- take every opportunity to do field work and go on field trips
- go to a high-quality field camp summer course after your junior or senior year
- undertake a research project, if possible
- plan to go to graduate school for at least a Masters degree (and a PhD is great for many careers - but you don’t have to do this all at once)
- join some of the professional geologic societies - for students, this is very inexpensive
- attend a regional or national professional geological or oceanographic society meeting

*relish this time in your life, when you can work in some beautiful places, and pursue a career where the Earth is your office!*
Students hiking into a canyon to study Triassic-age strata in northern Arizona for their research projects.