

# Geosciences

## Undergraduate Student Handbook

### 2011-2012

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## INTRODUCTION

The most critical questions for any young person to ask when considering college is "What shall I study and what is the best school for me?" These questions are, of course, more easily asked than answered. This small handbook has been prepared to help provide some insight into the nature of the geosciences in general, and into the undergraduate program at Virginia Tech specifically. It is a mere outline of a complex and constantly changing science. Hence, if you are interested in pursuing a career in the geosciences, and are not a student at Tech, we suggest that you visit our campus to see our facilities and to talk with our students and faculty. We are eager to recruit talented young people into our diverse science, but more importantly, we want to help each of you find the field for which you are best suited.

Instruction and research in geosciences offer broad and diverse curricula directed toward developing a fundamental understanding of the earth's materials and properties, its dynamic processes, and their societal implications. Programs in geology, geochemistry, and geophysics offer a learning environment that provides opportunities in resources (oil and gas, water, minerals), exploration, production, and management, as well as environmental, hydrogeologic, and geologic hazards studies. The program also provides excellent preparation for graduate studies in nearly all aspects of the Geosciences. Surface, and subsurface mapping, non-invasive imaging, as well as material and geologic analyses, form the background for a diverse and interdisciplinary learning environment. Qualified geoscientists have important societal responsibilities in finding, exploiting, and managing earth resources as well as in the recognition and mitigation of geologic hazards. In conjunction with the school of Education in the College of Liberal Arts and Human Sciences, the Department of Geosciences also prepares students who wish to become earth science teachers in public schools.

The Department of Geosciences is housed in the entire central section of Derring Hall. Dr. Kenneth A. Eriksson is the department chair. The mailing address is: Department of Geosciences, 4044 Derring Hall, Virginia Tech, Blacksburg, VA 24061; Telephone: (540) 231-8824; Fax: (540) 231-3386; E-mail: [geosciences@vt.edu](mailto:geosciences@vt.edu). We invite you to visit at any time, but recommend calling ahead first, so that we are able to schedule an appointment for you with the most appropriate individuals. We also encourage you to browse our homepage at <http://www.geos.vt.edu/>.

### What is Geoscience and Why Study It?

**Geo** is derived from Greek for earth; hence, in its broadest form, geology is the study of the earth and all aspects of its composition, history, and active processes. Although there are now a great many sub disciplines and areas of specialization, the geosciences program at Virginia Tech offers three basic major undergraduate options: geology, geochemistry, and geophysics. They involve the study of earth materials, earth processes, earth structure, and earth history. The differences lie primarily in the means of observation, and in the approaches and tools they use. Geologists rely primarily on direct observations (e.g., examining the minerals, observing the folds and faults, measuring the thickness of rock sequences and identifying fossils). Geochemists examine earth materials and systems in terms of the distributions of chemical elements and compounds and model the geochemical cycles in which these move. Geophysicists rely primarily on indirect

observation through the use of magnetic, electrical, and seismic measurements (e.g., mapping and imaging the subsurface using seismic, electrical, gravity, and magnetic data).

The undergraduate earth science education option provides students with a broad earth science curriculum that meets the earth science content area goals for secondary earth science teaching.

All four fields complement one another and often overlap.

## Geosciences at Virginia Tech

The geosciences today involve the most sophisticated techniques of physics, chemistry, biology, geotechnical studies, and materials science, and their applications to the study of natural processes and systems. Research topics are diverse; for example, experimental and theoretical examination of the polymerization of silicate magmas, the discovery and evolution of mineral resources, and computerized seismic topography of the earth to image the earth's interior structures. In the broadest sense, a geoscientist's laboratory is the earth itself, but the realms of study may range from the distribution of atoms on mineral surfaces, to the high mountains of western North America to mid-ocean ridges where ore deposits are forming, to modern limestone reefs, to the waters flowing in aquifers, to computer modeling systems.

For example research in the Department of Geosciences at Virginia Tech covers as wide a spectrum as that in any university in the United States. Experimental laboratories can simulate the temperature and pressure conditions that exist kilometers deep in the earth, allowing detailed examination of the fine-scale details of crystallization of rocks and minerals. The geophysics research group uses sophisticated computer analysis of seismic data to characterize subsurface structures for resource exploration, environmental monitoring and control, and earthquake mechanisms; they produce and use "CAT scans" of subsurface geologic structures. Research on igneous and metamorphic rocks and ores ranges from examination and micro chemical analysis of small parts of individual mineral grains using electron microscopy and electron probe microanalyses, to isotopic analysis of rocks and minerals and the spectroscopic characterization of fluids in the deep crust of the earth. Mineralogical research includes X-ray crystallography and *ab initio* quantum mechanical modeling of mineral structures and reaction mechanisms. Structural geology studies range from characterizing the megascale plate tectonic processes that have shaped the Himalayan and other mountains to analyzing the deformation mechanisms within individual mineral grains in folded and faulted rocks using optical and electron microscopy. Research in hydrogeology includes studies on groundwater flow in porous and fractured rocks, aquifer mechanics, storage and recharge processes, and transport of contaminants in groundwater. Sedimentologic-sequence stratigraphic studies at Tech span Phanerozoic, Proterozoic and Archean sedimentary rocks and attempt to understand global tectonic, eustatic and climatic controls on depositional systems, as well as their porosity/diagenetic evolution. The geobiology and paleobiology group analyzes the fossil record of microbes, plants, and animals in order to reconstruct the evolutionary and ecological history of the biosphere and to understand the interactions between biological and geological processes in the geological past.

## ACADEMICS

### Undergraduate Curriculum

The Department of Geosciences offers four undergraduate options—geology, geochemistry, geophysics, and earth science education: each of which is briefly described below and the specific course requirements are summarized on one of the attached check sheets.

The attached pages detail the requirements to complete a Bachelor of Sciences Degree in Geosciences for the department, the college, and the university. Note the College of Science requirements match or exceed those of the university core. Each student should read this information in the University Catalog under the “Academic” section.

### Undergraduate Advising

Ms. Connie Lowe, student program coordinator is the academic advisor for the department. Her office is located in 4050 Derring Hall. She will help in the selection of major courses and in finding solutions to academic problems. Your faculty advisor will help in identifying career options. The student is encouraged to meet regularly with his/her advisor to take maximum advantage of the help available.

#### *Student Responsibility*

The student is responsible for knowing and observing the regulations in the Undergraduate Course Catalog at <<http://www.undergradcatalog.registrar.vt.edu/>>. The responsibility for verification of information and completion of degree requirements rest with the student.

#### *Advisor Responsibility*

The advisor shares the responsibility for developing an advising partnership with the undergraduate student.

#### *Geology Option*

The undergraduate geology option is designed to provide a background for the student to go on to graduate school or to enter the job market with a B.S. degree. The required geology courses include geoscience fundamentals, physical geology, earth and life through time, geoscience field observations, mineralogy, structural geology, elementary geophysics, paleontology, igneous and metamorphic petrography, sedimentary/stratigraphy, and all corresponding laboratories, a summer field course, senior seminar and several elective courses. The courses are sequenced to increase the students’ depths and breadth in the geosciences. Geologists rely heavily upon the collateral sciences; hence, geology majors must also take one year each of chemistry, biology, and physics with their corresponding laboratories. Because the acquisition and processing of geological data often requires mathematical methods, geology students are also required to take mathematic courses through calculus and statistics. They are also urged to take a course in computer science and to make as much use of computers as possible to increase computer

literacy. For course information see the attached “check sheet” or <http://www.geos.vt.edu/currentstudents/checksheets/>.

### *Geochemistry Option*

The undergraduate geochemistry option is designed for those students who have a special interest in the chemical aspects of the earth and its materials. It is intended that many students will move on from this program to more advanced graduate training in one or more of the specific disciplines of geochemistry, but the program is also sufficiently flexible that a course of study can be constructed to prepare the student for technical geochemical employment at the bachelor's level. The required geology courses include geoscience fundamentals, physical geology, earth and life through time, resources geology, geoscience field observation, mineralogy, structural geology, elementary geophysics, paleontology, igneous and metamorphic petrography, sedimentation/stratigraphy, environmental geochemistry, and all corresponding laboratories, a research project and senior seminar. Because the acquisition and processing of geological data requires mathematical methods, geochemistry students also must take mathematic courses through calculus and statistics. Students in this option take a year each of physics and chemistry with the corresponding laboratories, and choose an additional 10 hours of chemistry courses. The student elect at least 12 hours of upper level courses from a broad choice of scientific, mathematical or engineering disciplines across the university completes the program. For course information see the attached “check sheet” or [http://www.geos.vt.edu/currentstudents/checksheets](http://www.geos.vt.edu/currentstudents/checksheets/) >.

### *Geophysics Option*

The undergraduate geophysics curriculum prepares students for professional employment and for continued study in graduate school. The required courses in the Department of Geosciences include geoscience fundamentals, physical geology, earth and life through time, geoscience field observation, mineralogy, structure, sedimentation/stratigraphy, igneous and metamorphic petrography, paleontology, senior seminar, and upper level geophysics courses including seismic stratigraphy, potential field methods, seismology, and earthquake seismology and all corresponding laboratories. Because the acquisition and processing of data requires mathematical methods, geophysics students also must take mathematic courses through calculus and statistics. In addition, a computer language course, one year each of physics and chemistry with corresponding laboratories are required. Additional science courses must be selected from a list of geoscience, physics, and math courses. For course information see the attached “check sheet” or [http://www.geos.vt.edu/currentstudents/checksheets](http://www.geos.vt.edu/currentstudents/checksheets/) >

### *Earth Science Education Option*

The undergraduate earth science education option provides students with a broad earth science curriculum that meets the earth science content area goals for secondary earth science teaching. *Certification for earth science teaching is not provided in this program.* Information about teaching certification in Virginia can be obtained from the Department of Teaching and Learning at [http://www.soe.vt.edu/elementaryed/maed\\_eled.html](http://www.soe.vt.edu/elementaryed/maed_eled.html) The courses required to complete a B.S. degree in the Department of Geosciences under [http://www.geos.vt.edu/currentstudents/checksheets](http://www.geos.vt.edu/currentstudents/checksheets/) > the earth science education option

include geoscience fundamentals, physical geology with the corresponding laboratory, earth and life through time, geoscience field observations, resources and the environment with the corresponding laboratory, mineralogy, structural geology, elementary geophysics, paleontology, igneous and metamorphic rocks, sedimentology and stratigraphy, astronomy with the corresponding laboratory, meteorology, oceanography, senior seminar and several elective courses. The science courses are sequenced to increase student understanding of both the breadth and depth of what makes up the Earth sciences. Because the Earth sciences rely upon the collateral sciences, Earth science education majors must also take one year each of chemistry, biology, and physics with the corresponding laboratory. Because the acquisition and manipulation of data commonly requires mathematical, statistical and/or computational methods, earth science education students are also required to take mathematic, statistic and computer science application courses. Further, to appreciate the history, methods and assumptions of the scientific methodologies used to study the earth, students must also take a one-year course on the history of science. For specific course information, please see the attached “check sheet” or at <http://www.geos.vt.edu/currentstudents/checksheets> >

### *Geology Minor*

The department of Geosciences offers a minor in geology for students who wish to develop a working knowledge of geology but who are majoring in other disciplines. In order to minor in geology, a student must take: physical geology and earth and life through time lectures and their corresponding laboratories, plus 12 credit hours of geoscience courses at the three and/or four thousand level and have a minimum GPA of 2.0. For specific course information, please see <http://www.geos.vt.edu/currentstudents/checksheets> >

### *Foreign Language Requirement*

#### **College of Science Foreign Language Requirement:**

The requirement may be fulfilled by successful completion of one of the following:

1. The third year (level III) of one foreign language in high school.
2. Take equivalent of an 1106 foreign language at an accredited university or community college.

Note: A student who has not completed two (2) units of a single foreign language in high school must earn six (6) semester hours of college level credit in a foreign language (i.e., both 1105 and 1106). These six hours are in addition to the 120 hours required for graduation.

3. Credit by examination for a foreign language. The credit by exam option is available only to student who have gained knowledge of a foreign language without the benefit for formal training.
4. Students whose native language is not English may be exempted from the foreign language through demonstrating satisfactory knowledge of the foreign language as prescribed by the Department of Foreign Languages. (No credit is granted).

## *Field Camp*

The Department of Geosciences requires that undergraduate majors in the geology option complete a six-semester credit-hour summer field camp before they graduate. This requirement is normally fulfilled in the summer following either the junior or senior year, although the department recommends it be done as early as possible because there may be opportunities for grant-funded undergraduate research assistantships that require field camp attendance as prior experience.

Virginia Tech does not currently offer its own field camp, so each student must select a suitable six-semester credit-hour summer field camp from among the many offered at other universities. Many of our majors have attended field camps in the western United States, but there are other field camps overseas that the department has direct experience with. Students are reminded that they should check with the departmental field camp advisor (Dr. Richard Law) before applying for dean's approval for the camp they have chosen. The department maintains a current list of available camps on-line at (<http://www.geol.vt.edu/courses/fieldcamp.html>). Students are also encouraged to file applications late in the fall term or during winter break, especially for the more popular camps, because most camps fill their rosters on a "first-come, first-served" basis.

There is only one field camp originating in Virginia (James Madison's camp run in Ireland) and students should be aware that attendance at field camps outside Virginia might involve substantial expense for tuition, fees and travel. *Because the university has no direct connection with any field camps, Virginia Tech financial aid does not cover these expenses.* Some field camps may provide scholarship assistance, and other opportunities for aid through professional societies or other institutions may be available.

## Progress Toward Degree

All Geoscience students will be monitored for Progress Toward Degree. Existing university rules require both overall GPA and in-major GPA be 2.0 or above for graduation. The university recognizes that it becomes very difficult to meet this graduation requirement if the GPA is too low earlier in the degree. For this reason, the university enforces, through probation and suspension, an overall 2.0 at all times.

For similar reasons, we require all majors to maintain an in-major GPA (GEOS courses only) of at least 2.0 at all times.

Any Geosciences major whose in-major GPA falls below 2.0 at the end of any semester will have one semester of probation to bring the GPA to or above 2.0. Failure to do so will result in blocking of the student's registration by the department. Students who anticipate not being able to raise their GPA to a satisfactory level at the end of the probationary semester must promptly discuss the situation with their academic advisor and may be asked to change to a more suitable major.

## Transferring into Geology, Geochemistry, Geophysics, or Earth Sciences

Many students who major in geology, geochemistry, geophysics or earth sciences have begun their academic studies in other departments or other schools. Transferring into one of the geoscience options is relatively simple if the student has a satisfactory background, including a minimum overall QCA of 2.0. However, transferring between majors after the beginning of the second year often means that a student cannot graduate in four years. Because each situation is unique, it is necessary for any student considering transferring to geology, geochemistry, and geophysics or earth science options to discuss their specific program with a course advisor. Therefore, prior to the initiation of any transfer action, a student should contact the Student Information Office, 4050 Derring Hall (231-8824).

## Transfer of Course Credit from Other Schools

The transfer of course credit (when grades are “C” or above) from one university to another is relatively routine for many courses if it is possible to identify specific correlative courses at Virginia Tech. If no correlative course exists at Virginia Tech, credit will generally be transferred but only as meeting general elective course requirements. The transfer of course credits from community colleges is handled in a similar manner but is limited to a maximum of 60 credits. The transfer website is at <http://www.registrar.vt.edu/tranguide/index.html>. Once students are enrolled at Virginia Tech, it is highly recommended that they discuss any anticipated transfer credits with their advisors before taking the courses at another school in order to insure that the transfer will be accepted. The University requires that 18 of the last 45 credit hours be taken in residence at Virginia Tech regardless of the number of credits transferred into the student’s degree program. NOTE: Grades do not transfer.

## Freshman Computer Requirements

The department of Geosciences does not have a platform or a format preference. It does not require software beyond the University baseline Requirement. You may check the computer requirement homepage for more information. <http://www.compreq.vt.edu/>

## FINANCIAL ASSISTANCE

The Department has numerous endowed accounts that are used for scholarships and research funding each year, as well as several scholarships from industry, are available to undergraduate majors in the geosciences. Detailed information can be obtained at the Student Information Office in 4050 Derring Hall.

## EMPLOYMENT OUTLOOK

A wide variety of industrial, governmental, and educational institutions employ geoscientists. These include the oil and mining industries, engineering and environmental consulting firms, highway departments, state geologic surveys, water resource agencies, the Forest Service and other conservation agencies, the U.S. Geological Survey, State Geological Surveys, natural



history museums, and colleges and universities. Bachelor degree recipients in geology are most frequently employed as field assistants (a lot of geologic work goes on out-of-doors) or as laboratory technicians. It is emphasized, however, that an MS degree is generally regarded as the minimum qualification for many professional career paths in the Geosciences.

Virginia Tech has an excellent record for employment of its geology, geochemistry, geophysics, and earth science graduates, approximately one-third of who are women. We have placed graduates in the oil industry, with federal and state geological surveys, with consulting and service firms, and in academic positions. Currently there is a rapid growth in the demand for geosciences expertise in water resources, petroleum and environmental areas.

## **FACILITIES AND SERVICES**

### The Geosciences Library

Books and journals are located on the 4th floor of Newman Library. Maps and air photos are located on the 1<sup>st</sup> floor of the main library.

### The Museum of Geosciences

The Museum of Geosciences enhances the undergraduate education as well as supporting public outreach and research. With over 13,000 minerals, the museum also has programs for K-12 students and teachers. The museum is open during the week (8:30 - 4) and some minerals may be checked out for projects connected with your classes or for outreach programs. Sigma Gamma Epsilon runs an outreach program to schools that are supported by the museum. Volunteer positions are also possible.

### Computer Support Facilities

In order to assist the University in supporting lecture and lab activities, the department maintains several computers labs in various locations throughout Derring Hall.

All faculty, staff and students at Virginia Tech have e-mail accounts on the Virginia Tech server. There is no charge for this service. The server can be accessed from the internet or through the Virginia Tech modem pool. Each student is assigned a PID (Personal Identification), but before this can be used, the student must activate PID upon admission. This is accomplished using [a web-accessible procedure called PIDTool](#).

Students have access to the Hokie SPA, a program that allows monitoring of your address, class schedule, grades, student account, award and refund letters. You must have an activated PID in order to use this valuable service.

### Seminars

Weekly seminars are generally held at 4:00 pm in 4069 on Friday with refreshments at 3:45. Most speakers are from other universities, industry or governmental organizations. Undergraduates are **strongly encouraged** to attend. A list of speakers is available in Derring 4042 or on <http://www.geos.vt.edu/news/>.

## **PROFESSIONAL DEVELOPMENT**

### Geology Club

This society, managed by undergraduates, organizes several functions each year for geology students and faculty. The club sponsors several seminars and information programs each semester, including discussion sessions on interviewing, professional standards, and career development. The club also runs field trips to selected localities and schedules topical lectures during the academic year, including a field camp informational evening in October each year.

### Geophysical Society of Virginia Tech

The organization's goal is to promote the use of geophysical tools for the earth scientist and to assist students at Virginia Tech in their research that involves geophysics. The society has sponsored lunchtime seminars, raised funds for the purchase of geophysical software and hardware, and sponsored students at geophysical conferences. All students with an interest in geophysics are encouraged to join.

### Sigma Gamma Epsilon

The organization is an honor society for the earth scientist. Members must have an interest in the earth sciences, have taken at least 12 semester hours of earth science courses, maintain a 3.00 GPA in the Earth sciences and maintain a 2.67 GPA overall. The group activities include hikes, field trips, community service and an educational outreach program.