The Department of Earth and Space Sciences prepares students for careers in geoscience and geoscience education. The U.S. Bureau of Labor Statistics states that employment of geoscientists is projected to grow by 5% from 2010 to 2020, faster than the average for all occupations. The need for energy, environmental protection, and responsible land and resource management is projected to spur demand for geoscientists in the future. This geoscience degree prepares students for entry-level positions in such occupations and is also a strong foundation for people interested in pursuing advanced degrees. Geoscience is an integrated study of Earth, its geologic history, composition and structure, resources, natural hazards, atmosphere and oceans, and its environment in space. Geoscientists study such phenomena as earthquakes, landslides, floods, volcanoes, coastal erosion, and how these natural hazards impact humans. Geoscientists explore for mineral, energy, and water supplies. Geoscientists also attempt to make predictions about Earth’s future based on the past. Since most human activities are related to interaction with the physical components of Earth, geoscience plays a unique and essential role in today’s rapidly changing world. The Department of Earth and Space Sciences offers a bachelor of science degree program and a certification program in general science. The department also offers minors in astronomy, geology, earth science, and science education. All programs emphasize analytical skills and build on course work in mathematics, chemistry, physics, and statistics. Written and oral communication is emphasized in a majority of the course work.

• The B.S. in Geoscience program offers two areas of concentration that share a common core of geology courses. Students completing either concentration are prepared for careers as professional geoscientists and possess the educational requirements to seek licensure as certified professional geologists. The Geology Concentration (http://catalog.wcupa.edu/undergraduate/sciences-mathematics/earth-space-sciences/geoscience-bs-concentration-geology/) leads to occupations in managing and exploring for water, energy, and mineral resources; environmental protection, remediation, and management; mitigation of natural hazards; design of land development and management plans; geotechnical consulting; and research. Its curriculum emphasizes depth in the traditional disciplines of geology such as mineral and rock formation, paleontology, structural geology, geomorphology, and hydrogeology. The Earth Systems Concentration (http://catalog.wcupa.edu/undergraduate/sciences-mathematics/earth-space-sciences/geoscience-bs-concentration-earth-systems/) is intended for students who want a broader understanding of geoscience, astronomy, and human interactions with the environment. In addition to the geology core, students in this concentration take required courses in oceanography, meteorology, and astronomy. This concentration is excellent preparation for students pursuing careers in geoscience, the environmental industry, resource management, environmental law, or environmental policy.

• The certification program in General Science enables recipients to teach science in grades 6-9. The certification program meets all guidelines established by the National Council for Accreditation of Teacher Education (NCATE) and the Pennsylvania Department of Education (PDE).

All students must consult with their advisor regularly to ensure timely completion of the degree.

Programs

Majors

• B.S. in Geoscience - Earth Systems Concentration (http://catalog.wcupa.edu/undergraduate/sciences-mathematics/earth-space-sciences/geoscience-bs-concentration-earth-systems/)
  • Accelerated B.S. in Geoscience - Earth Systems Concentration to M.S. in Geoscience (http://catalog.wcupa.edu/undergraduate/sciences-mathematics/earth-space-sciences/geoscience-bs-concentration-earth-systems/)

• B.S. in Geoscience - Geology Concentration (http://catalog.wcupa.edu/undergraduate/sciences-mathematics/earth-space-sciences/geoscience-bs-concentration-geology/)

• Accelerated B.S. in Geoscience - Geology Concentration to M.S. in Geoscience (http://catalog.wcupa.edu/undergraduate/sciences-mathematics/earth-space-sciences/geoscience-bs-concentration-geology/)

Minors

• Astronomy (http://catalog.wcupa.edu/undergraduate/sciences-mathematics/earth-space-sciences/astronomy-minor/)

• Earth Science (http://catalog.wcupa.edu/undergraduate/sciences-mathematics/earth-space-sciences/earth-science-minor/)

• Geology (http://catalog.wcupa.edu/undergraduate/sciences-mathematics/earth-space-sciences/geology-minor/)

• Science Education (http://catalog.wcupa.edu/undergraduate/sciences-mathematics/earth-space-sciences/science-education-minor/)

Certification

• General Science (http://catalog.wcupa.edu/undergraduate/sciences-mathematics/earth-space-sciences/general-science-certification/)

Graduate Opportunities

See the graduate catalog for more information on the Earth and Space Sciences programs. (http://catalog.wcupa.edu/graduate/sciences-mathematics/earth-space-sciences/)

Policies

• See undergraduate admissions information. (http://catalog.wcupa.edu/general-information/admissions-enrollment/undergraduate-admissions/)

• See academic policies. (http://catalog.wcupa.edu/undergraduate/academic-policies-procedures/)

All undergraduate students are held to the academic policies and procedures outlined in the undergraduate catalog. Students are encouraged to review departmental handbooks for program tips, suggested course sequences, and explanations of procedures. When applicable, additional policies for specific department programs may be listed below.

Accelerated Program Policy

Refer to the Accelerated Programs page (http://catalog.wcupa.edu/undergraduate/accelerated-programs/) for more information.
Faculty

Professors
Richard M. Busch (rbusch@wcupa.edu) (1990)  
A.B., Franklin and Marshall College; M.A., Temple University; Ph.D., University of Pittsburgh  
Marc Gagné (mgagne@wcupa.edu) (1999)  
Assistant Chairperson, Earth and Space Sciences  
B.S., University of Montreal; Ph.D., University of Georgia  
Martin Helmke (mhelmke@wcupa.edu) (2005)  
B.S., Antioch College; Ph.D., Iowa State University  
Daria Nikitina (dnikitina@wcupa.edu) (2006)  
Graduate Coordinator, Earth and Space Sciences  
M.S., Moscow State University; Ph.D., University of Delaware  
Karen M. Schwarz (kschwarz@wcupa.edu) (2005)  
B.S., New Mexico Institute of Mining and Technology; Ph.D., Arizona State University  
Elizabeth Leann Srogi (lsrogi@wcupa.edu) (1991)  
B.S., Yale University; Ph.D., University of Pennsylvania  

Associate Professors
Howell Bosbyshell (hbosbyshell@wcupa.edu) (2011)  
Chairperson, Earth and Space Sciences  
B.S., West Chester University; Ph.D., Bryn Mawr College  
Joby Hilliker (jhilliker@wcupa.edu) (2004)  
B.S., M.S., Ph.D., Pennsylvania State University  
Yong Hoon Kim (ykim@wcupa.edu) (2016)  
B.S., M.S., Seoul National University, Korea; Ph.D., University of South Carolina  
Christopher Roemmele (croemmele@wcupa.edu) (2017)  
B.A., Franklin and Marshall; M.A., Kean University; Ph.D., Purdue University  

Instructor
Cynthia Hall (chall@wcupa.edu) (2008)  
B.S., Howard University; Ph.D., Georgia Institute of Technology  

Courses

ESC
ESC 199. Transfer Credits (Graduate). 1-10 Credits.  
Transfer Credits. Repeatable for Credit.  

ESL
ESL 199. Transfer Credits. 1 Credit.  
Transfer Credits. Repeatable for Credit.  

ESS
ESS 101. Introduction to Geology. 3 Credits.  
LEC (2), LAB (2)  
The earth's composition and history; the processes that occur on and within the earth.  
Gen Ed Attribute: Science Distributive Requirement.  
Distance education offering may be available.  
Typically offered in Fall, Spring & Summer.  

ESS 102. Humans and the Environment. 3 Credits.  
A study of the ability of humans to survive and maintain their life quality, considering the limited resources and recycling capacity of planet Earth. Note: Students completing ESS 102 may not take SCB 102 or ENV 102 for credit.  
Gen Ed Attribute: Interdisciplinary Requirement.  
Typically offered in Fall, Spring & Summer.  
Cross listed courses SCB 102, ENV 102, ESS 102.
ESS 301. Environmental Geochemistry. 3 Credits.
An introduction to principles and applications of geochemistry to geologic systems, including surface and ground waters, soils, and rocks.
Pre/Co requisites: ESS 301 requires prerequisites of CHE 103 and ESS 101.
Typically offered in Spring.

ESS 302. Mineralogy. 3 Credits.
LEC (2), LAB (2)
In-depth survey of the formation, identification, classification, and uses of minerals. Principles of symmetry, crystallography, crystal chemistry, and optical mineralogy. Laboratory and field examination and analysis of minerals.
Pre/Co requisites: ESS 302 requires prerequisites of ESS 101 and ESS 204 and CHE 103.
Typically offered in Fall.

ESS 307. Geology of the Solar System. 3 Credits.
The geology, origin, evolution, and properties of planets, comets, asteroids, moons, and meteorites.
Typically offered in Spring.

ESS 311. Introduction to Astronomy. 3 Credits.
LEC (0), LAB (0)
An introduction to astronomy and astrophysics. Topics include celestial mechanics, the properties of light, matter and energy, the formation of stars and planets, stellar evolution, galaxies, and cosmology. Two hours of lecture and two hours of lab.
Pre/Co requisites: ESS 311 requires a prerequisite of MAT 115 or MAT 131 or MAT 143 or MAT 161.
Typically offered in Fall.

ESS 321. Geometrics. 3 Credits.
Application of computational and statistical methods to geologic problems. Geologic sampling, data comparisons in environmental, petrologic, paleontologic, and geochemical problems.
Typically offered in Fall.

ESS 323. Gen'1 Geol Field Studies of SE Pennsylvania. 3 Credits.
Occurrence, relationships, and geologic history of the rocks, minerals, and soils of this area, studied at representative locations.
Pre/Co requisites: ESS 323 requires prerequisite of ESS 302.
Typically offered in Summer.

ESS 330. Introduction to Oceanography. 3 Credits.
LEC (2), LAB (2)
A survey of our present knowledge of the waters and floors of the oceans.
Pre/Co requisites: ESS 330 requires prerequisite of ESS 101.
Typically offered in Fall & Spring.

ESS 331. Introduction to Paleontology. 3 Credits.
LEC (2), LAB (2)
Identification and study of common fossils in order to understand their life processes and geologic significance.
Gen Ed Attribute: Writing Emphasis.
Typically offered in Spring.

ESS 332. Advanced Oceanography. 3 Credits.
An advanced course in oceanography covering marine resources, oceanographic literature, animal-sediment relationships, field techniques, estuaries, salt marshes, sea level changes, and pollution.
Pre/Co requisites: ESS 332 requires prerequisite of ESS 330.
Typically offered in Spring.

ESS 336. Environmental Geology. 3 Credits.
The application of geological information to human problems encountered in natural phenomena, such as flooding, earthquakes, coastal hazards, and man-made concerns, including waste disposal, land use, and global change.
Pre/Co requisites: ESS 336 requires prerequisite of ESS 101.
Typically offered in Spring.

ESS 343. Geomorphology. 3 Credits.
Constructional and degradational forces that have shaped present landforms and are constantly reshaping and modifying landforms. Interpretation of geologic and topographic maps; field studies.
Pre/Co requisites: ESS 343 requires prerequisites of ESS 101 and ESS 204.
Typically offered in Spring.

ESS 344. Geomorphology II. 3 Credits.
A continuation of the study of earth surface processes. Interpretation of topographic maps and air photos.
Pre/Co requisites: ESS 344 requires a prerequisite of ESS 343.

ESS 347. Earth & Space Science Seminar. 1 Credit.
One credit weekly seminar featuring guest lectures by Geoscience professionals, prominent scientists, faculty and students. Students will read professional literature, attend and participate in the lecture, and write a summary and/or analysis of each seminar.
Typically offered in Fall.
Repeatable for Credit.

ESS 348. International Geology Field Studies. 3 Credits.
Field investigations of selected country’s physical environments focusing on geology and natural resources in relationship to cultural traditions, lifestyle and sustainability. Case studies of human adaptation to local and global environmental challenges will be considered. Two hours of lecture and two hours of lab.
Pre/Co requisites: ESS 348 requires prerequisite ESS 101 or ESS 102 or permission of instructor.
Repeatable for Credit.

ESS 355. Intermediate Astronomy. 3 Credits.
LEC (2), LAB (2)
An analytical and qualitative analysis of selected astronomical phenomena. Topics include telescope optics (including photographic and photovoltaic attachments), lunar and planetary orbits, stellar motions and magnitudes, galactic classifications, and distances. Two hours of lecture and two hours of lab.
Pre/Co requisites: ESS 355 requires prerequisite of ESS 111.

ESS 362. History of Astronomy. 3 Credits.
Development of astronomical theories from the ancient Greeks until the 20th century.
Pre/Co requisites: ESS 362 requires prerequisite of ESS 111.

ESS 370. Introduction to Meteorology. 3 Credits.
LEC (2), LAB (2)
A study of the principles governing the earth’s atmosphere and how these principles determine weather conditions.
Pre/Co requisites: ESS 370 requires a prerequisite of MAT 115 or MAT 143 or MAT 131 or MAT 161.
Typically offered in Fall.

ESS 371. Advanced Meteorology. 3 Credits.
A continuation of the study of the principles governing the earth’s atmosphere and how these principles determine weather conditions.
Pre/Co requisites: ESS 371 requires prerequisite of ESS 370.
Typically offered in Spring.

ESS 394. Geology of Northwestern National Parks. 4 Credits.
This course includes a field trip to the national parks in South Dakota, Wyoming, Montana, Idaho, northern Utah, and Colorado. The purpose of the course is to look at the geologic features of the national parks in these states and to develop an appreciation of the geology and geologic history of the region.
Consent: Permission of the Department required to add.

ESS 405. Igneous and Metamorphic Petrology. 3 Credits.
LEC (2), LAB (2)
Theories of the formation of igneous and metamorphic rocks based on field occurrence, physical properties, geochemistry, thermodynamics, and petrography. Classification and identification of rocks. Laboratory and field examination of rocks.
Pre/Co requisites: ESS 405 requires prerequisites of ESS 201 and ESS 302.
Typically offered in Spring.

ESS 420. Structural Geology. 3 Credits.
LEC (2), LAB (2)
Determination of the sequential development and the forces involved in the various structural features of the earth.
Pre/Co requisites: ESS 420 requires prerequisites of ESS 201 and ESS 302.
Typically offered in Spring.
**ESS 435. Remote Sensing. 3 Credits.**

LEC (1), LAB (2)

An introduction to the science and technology of remote sensing and the applications of remote sensing data to geology, oceanography, meteorology, and the environment. Includes a discussion of the history and principles of remote sensing; fundamentals of electromagnetic radiation; theory and types of active and passive remote sensing systems; fundamentals of image interpretation; digital analysis of LANDSAT and AVHRR data; operation of environmental satellites; and future imaging systems.

Typically offered in Spring.

**ESS 439. Hydrogeology. 3 Credits.**

LEC (2), LAB (2)

This applied course covers aquifer flow systems, well hydraulics, water resources, advective contaminant transport, groundwater flow modeling, and sustainable management of groundwater resources. Students considering employment in the environmental industry as professional geologists are encouraged to complete this course.

Pre / Co requisites: ESS 439 requires prerequisites of ESS 101, and PHY 130 or PHY 170.

Typically offered in Spring.

**ESS 442. Geophysics. 3 Credits.**

Gravitational, magnetic, seismic (refraction and reflection), and electrical properties of rocks and minerals in the earth. Physical principles of the earth; geophysics in relation to economic deposits.

Pre / Co requisites: ESS 442 requires prerequisites of PHY 140 or PHY 180 and MAT 162.

**ESS 447. Earth and Space Science Seminar. 1 Credit.**

A one credit weekly seminar featuring guest lectures by Geoscience professionals, prominent scientists, faculty and students. Each week students will read professional literature, attend and participate in the lecture, and write a summary and/or analysis of each seminar.

Pre / Co requisites: ESS 447 requires prerequisite of ESS 347 or department consent.

Typically offered in Fall.

Repeatable for Credit.

**ESS 450. Sedimentation & Stratigraphy. 3 Credits.**

LEC (2), LAB (2)

LAB, LEC Class, laboratory, and field studies of sediments, sedimentary rocks, depositional processes and environments, and diagenesis. Description, mapping, and correlation of strata to infer temporal-spatial relationships, locate resources, and interpret Earth history.

Pre / Co requisites: ESS 450 requires prerequisites: ESS 301, 302, 331 and 343.

Typically offered in Fall.

**ESS 460. Internship. 1-18 Credits.**

Contact department for more information about this course.

Repeatable for Credit.

**ESS 480. Special Problems. 1-3 Credits.**

Reports on special topics and current developments in the earth and space sciences.

Repeatable for Credit.

**ESS 490. Fundamentals of Soils. 3 Credits.**

LEC (2), LAB (2)

Soil properties, classification, and genesis from geologic, agricultural, and engineering perspectives. Topics include pedology, soil physics, geotechnical engineering, erosion, septic systems, soil contamination, and remediation.

Pre / Co requisites: ESS 490 requires prerequisite of ESS 101.

Typically offered in Fall.

**ESS 491. Independent Studies. 1-3 Credits.**

Contact department for more information about this course.

Repeatable for Credit.

**ESS 499. The Professional Geoscientist. 3 Credits.**

This is the Geoscience Capstone course, which will serve as a culminating experience in which students will synthesize geoscience knowledge and interests that have been acquired, and along with the development of research skills, apply these skills in preparation of a geoscience research prospectus as an artifact for entry into a graduate program or career. Students will orally present and defend a research prospectus as well as related geoscience content and research topics of interest. Students will also develop competency in leading and partaking in whole and small group discussions and performing scenario-based and topic-based activities.

Pre / Co requisites: ESS 499 requires a prerequisite of 90 credits earned overall, of which 18 must come from ESS.

Gen Ed Attribute: Speaking Emphasis.

Typically offered in Fall & Spring.