

Earth Science

The Wiess School of Natural Sciences

Chair

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Degrees Offered: B.A., B.S., M.A., Ph.D.

All undergraduate majors in earth science take a 4 -course core sequence, typically in the sophomore and junior years, on earth processes, materials, observations, and history. Majors also take introductory courses in mathematics, chemistry, and in many cases, physics and biology.

The selection of upper-division courses and additional science courses depends on which major, B.A. or B.S., and, for the B.S. major, which of five tracks are chosen by the student: geology, geochemistry, geophysics, environmental earth science, or a track designed by the student subject to the approval of the department undergraduate adviser. The program of study typically includes experience with analytical equipment, computer systems, and fieldwork.

The B.S. in earth science degree should be chosen by students planning a career or further study in earth science or a related field. The B.A. in earth science degree has fewer requirements and might be a good choice for students planning a career or further study to which earth science is incidental.

For general university requirements, see Graduation Requirements (pages 20–23).

Degree Requirements for B.S. in Earth Science

For general university requirements, see Graduation Requirements (pages 20–23). B.S. majors must also complete the “Additional Requirements” for one track (described below).

The following courses are required for all tracks:

MATH 101/102 <i>Single Variable Calculus I and II</i>	ESCI 321 <i>Earth System Evolution and Cycles</i>
CHEM 121/122 or 151/152 <i>General Chemistry I and II with lab</i>	ESCI 322 <i>Earth Chemistry and Materials</i>
PHYS 101/102 or 111/112 <i>Introductory Physics I and II with lab</i>	ESCI 323 <i>Earth Structure and Deformation with lab</i>
	ESCI 324 <i>Earth's Interior</i>

Additional Requirements for the Geology Track

The following courses are required:

MATH 211 *Ordinary Differential Equations and Linear Algebra*
 ESCI 334 *Geological and Geophysical Techniques*
 ESCI 390 *Field Camp*

Choose one of the following courses:

COMP 110 *Computation in Natural Science*
 CAAM 210 *Introduction to Engineering Computation (FORTRAN)*
 CAAM 211 *Introduction to Engineering Computation (C)*
 COMP 210 *Principles of Computing and Programming*

Choose one of the following courses:

ESCI 412 *Advanced Petrology*
 ESCI 430 *Principles of Trace-Element and Isotope Geochemistry*

Choose one of the following courses:

ESCI 427 *Sequence Stratigraphy*
 ESCI 521 *Seminar in Applied Micropaleontology*

Choose one of the following courses:

ESCI 504 *Siliciclastic Depositional Systems*
 ESCI 506 *Carbonate Depositional Systems*
 ESCI 421 *Paleoceanography*

Choose one of the following courses:

ESCI 446 *Solid Earth Geophysics*
 ESCI 442 *Exploration Geophysics I*

Choose one of the following courses:

ESCI 463 *Advance Structural Geology*
 ESCI 428 *Geologic Interpretation of Reflection Seismic Profiles*
 ESCI 464 *Global Tectonics*

Additional Requirements for the Geochemistry Track

The following courses are required:

- BIOS 201 *Introductory Biology I*
- A 6 hour field-based course or equivalent, approved by the department undergraduate adviser.

Choose 9 hours from the following:

ESCI 412 *Advanced Petrology*
 ESCI 421 *Paleoceanography*
 ESCI 458 *Thermodynamics/Kinetics for Geoscientists*
 ESCI 203 *Biogeochemistry*
 ESCI 430 *Principles of Trace-Element and Isotope Geochemistry*

Choose 9 hours from the following:

All upper division ESCI courses
 CEVE 401 *Introduction to Environmental Chemistry*
 CEVE 403 *Principles of Environmental Engineering*
 CEVE 434 *Chemical Transport and Fate in the Environment*
 CEVE 532 *Physical-Chemical Processes in Environmental Engineering*

CEVE 534 *Transport Phenomena and Environmental Modeling*
 CEVE 550 *Environmental Organic Chemistry*
 BIOS 202 *Introductory Biology*
 BIOS 211 *Introductory Lab Module in Biological Science*
 CHEM 211/212 *Organic Chemistry*
 CHEM 311/312 *Physical Chemistry*
 CHEM 415 *Chemical Kinetics and Dynamics*

CHEM 495 *Transition Metal Chemistry*
 MATH 211 *Ordinary Differential Equations and Linear Algebra*
 MATH 212 *Multivariable Calculus*
 COMP 110 *Computation Science and Engineering*
 CAAM 210/211 *Introduction to Engineering Computation*
 COMP 210 *Introduction to Principles of Scientific Computing*

Additional Requirements for the Geophysics Track

The following courses are required:

- MATH 211 *Ordinary Differential Equations and Linear Algebra*
- MATH 212 *Multivariable Calculus*
- PHYS 201 *Waves and Optics*
- PHYS 231 *Elementary Physics Lab II*

In addition, the student must complete a field experience, equivalent to 6 semester hours, approved by the department undergraduate advisor.

Choose one of the following courses:

- COMP 110 *Computation in Natural Science*
- CAAM 210 *Introduction to Engineering Computation (FORTRAN)*
- CAAM 211 *Introduction to Engineering Computation (C)*
- COMP 210 *Principles of Computing and Programming*

Choose 6 hours from the following:

ESCI 440 <i>Geophysical Data Analysis: Digital Signal Processing</i>	ESCI 454 <i>Geographic Information Science</i>
ESCI 441 <i>Geophysical Data Analysis: Inverse Theory</i>	ESCI 461 <i>Seismology I</i>
ESCI 442 <i>Exploration Geophysics I</i>	ESCI 462 <i>Tectonophysics</i>
ESCI 444 <i>Exploration Geophysics II</i>	ESCI 464 <i>Global Tectonics</i>
ESCI 450 <i>Remote Sensing</i>	ESCI 532 <i>Advanced Global Tectonics</i>
	ESCI 542 <i>Seismology II</i>

Choose 6 hours from the immediately preceding or following lists:

- Any 3- or 4- hour course in ESCI with a number between 411 and 475, except for research and special studies
- Any 300- or 400-level MATH, CAAM, OR PHYS class
- CHEM 311 *Physical Chemistry*
- CEVE 412 *Hydrology & Watershed Analysis*

Additional Requirements for the Environmental Earth Science Track

The following courses are required:

- MATH 211 *Ordinary Differential Equations and Linear Algebra*
- BIOS 201 *Introductory Biology I*

Choose one of the following courses:

- COMP 110 *Computation in Natural Science*
- CAAM 210 *Introduction to Engineering Computation (FORTRAN)*
- CAAM 211 *Introduction to Engineering Computation (C)*
- COMP 210 *Principles of Computing and Programming*

Choose 14 hours from the following, including at least two courses in ESCI:

ESCI 451 <i>Analysis of Environmental Data</i>	CEVE 434 <i>Chemical Transport and Fate in the Environment</i>
ESCI 353 <i>Environmental Geochemistry</i>	CEVE 412 <i>Hydrogeology and Watershed Analysis</i>
ESCI 442 <i>Exploration Geophysics</i>	CEVE 401 <i>Environmental Chemistry</i>
ESCI 454 <i>Geographic Information Science</i>	CHEM 211 <i>Organic Chemistry</i>
ESCI 463 <i>Advanced Structural Geology I</i>	CHEM 311 <i>Physical Chemistry</i>
ESCI 504 <i>Clastics</i>	CHEM 360 <i>Inorganic Chemistry</i>
ESCI 506 <i>Carbonates</i>	PHYS 201 <i>Waves and Optics</i>
ESCI 568 <i>Paleoclimates and Human Response</i>	PHYS 231 <i>Elementary Physics Lab II</i>
CEVE 306 <i>Global Environmental Law and Sustainable Development</i>	BIOS 202 <i>Introductory Biology II</i>

Additional Requirements for the Self-Designed Track

The department recognizes the interdisciplinary nature of modern earth science and the opportunity for students to specialize in nontraditional and emerging fields. Therefore, students can design their own specialty track, normally in close consultation with one faculty member and followed by approval from the department undergraduate adviser. In addition to required earth science courses and related courses, these tracks will generally comprise 15 additional hours that target a coherent theme from an approved list of 300- or higher-level courses, from inside or outside the department. Interested students are expected to submit a statement of rationale by the beginning of their third year.

Choose 9 hours from the following:

BIOS 201 <i>Introductory Biology I</i>	CHEM 311/312 <i>Physical Chemistry I and II</i>
COMP 110 <i>Computation in Natural Science</i>	MATH 211 <i>Ordinary Differential Equations and Linear Algebra</i>
CAAM 210 <i>Introduction to Engineering Computation (FORTRAN)</i>	MATH 212 <i>Multivariable Calculus</i>
CAAM 211 <i>Introduction to Engineering Computation (C)</i>	PHYS 201 <i>Waves and Optics</i>
COMP 210 <i>Principles of Computing and Programming</i>	PHYS 203 <i>Atmosphere, Weather, and Climate</i>

- Complete a field experience, equivalent to 4 semester hours, approved by the department undergraduate adviser.
- Choose 15 hours of additional courses numbered 300 or higher targeting a coherent theme selected with approval of the department undergraduate adviser.

Degree Requirements for B.A. in Earth Science

For general university requirements, see Graduation Requirements (pages 20–23). The following courses are required:

MATH 101/102 *Single Variable
Calculus I and II*

CHEM 121/122 or 151/152 *General
Chemistry I and II with lab*

ESCI 321 *Earth System Evolution and
Cycles*

ESCI 322 *Earth Chemistry and Materi-
als*

ESCI 323 *Earth Structure and Deforma-
tion with lab*

ESCI 324 *Earth's Interior*

ESCI 334 *Geological and Geophysical
Techniques*

Choose 6 hours from the following:
BIOL 201/202 *Introductory Biology I
and II*

BIOL 211, 213 *Biology Lab Modules*

MATH 211 *Differential Equations*

PHYS 101/102 or 125/126 *Introductory
Physics*

COMP 110 *Computation in Natural
Science* or CAAM 210 *Introduction
to Engineering Computation*

(FORTRAN) or CAAM 211

Introduction to Engineering

Computation (C) or COMP 210

*Principles of Computing and
Programming*

- Choose four upper division ESCI courses, approved by the department undergraduate advisor.
- Choose 6 hours in science and engineering (including ESCI) courses at the 200 level or above approved by the department undergraduate advisor.

Undergraduate Independent Research

The department encourages, but does not require, earth science undergraduate majors to pursue independent supervised research in ESCI 481 *Research in Earth Science*. See also Honors Programs (page 34).

Degree Requirements for M.A. and Ph.D. in Earth Science

All incoming students should have a strong background in physics, chemistry, and mathematics and should have, or should acquire, a broad grounding in fundamental earth science. The department encourages applications from well-qualified students with degrees in the other sciences and mathematics. For general university requirements, see Graduate Degrees (pages 65–70). The requirements for the M.A. and Ph.D. in earth science are similar, but the Ph.D. demands a significantly higher level of knowledge, research skills, and scholarly independence. Most students need at least two years beyond the bachelor's degree to complete the M.A. and at least two years beyond the M.A. degree for the Ph.D.

Candidates determine, with their major professor and advisory committee, a course of study following the *Guidelines for Advanced Degrees in the Department of Earth Science* distributed to all incoming students. For both degrees, candidates must:

- Complete 20 semester hours of course work at the 400 level and above (or other approved courses), not including research hours
- Pass a written preliminary exam
- Maintain a grade point average of 3.00 (B) or better
- Prepare a written thesis
- Produce a publishable thesis that represents an original contribution to science
- Defend the research and conclusions of the thesis in an oral examination

Students of exceptional ability with a bachelor's degree and department approval may work directly toward the Ph.D., in which case the course of study is equivalent to that required for both degrees; performance on the examinations and the thesis, however, should be at the level required for the Ph.D.

Because the graduate programs require full-time study and close interaction with faculty and fellow students, the department discourages students from holding full (or nearly full) time jobs outside the university. Outside employment must be approved by the chair.

See ESCI in the Courses of Instruction section.