Earth Science

The Wiess School of Natural Sciences

Chair
Alan Levander

Professors
John B. Anderson
André W. Droxler
Richard G. Gordon
Dale S. Sawyer

Associate Professors
Gerald R. Dickens
Adrian Lenardic
Andreas Luttge
Julia Morgan
Colin A. Zelt

Assistant Professors
Rajdeep Dasgupta
Brandon Dugan
Helge Gonnerman
Cin-Ty Lee
Caroline Masiello
Fenglin Niu

Adjunct Professors
K. K. Bissada
Stephen H. Danbom
Jeffrey J. Dravis
Paul M. Harris
Thomas A. Jones
Stephen J. Mackwell
W. C. Rusty Riese
Juan Antonio Simo
John C. Van Wagoner
Fred M. Weaver

Adjunct Associate Professor
Vitor Abreu
David L. Olgaard

Adjunct Assistant Professors
Alan D. Brandon
Patrick J. McGovern
Christian A. Noll
Stephanie S. Shipp
Julia S. Wellner
Yitian Xiao

Earth Science Research Scientists
Rolf Arvidson
Glen Snyder

Earth Science Lecturers
Vitor Abreu
Stephen H. Danbom
Alison T. Henning
W.C. Rusty Riese

Earth Science Postdoctoral Research Associates
William Hockaday
Tobias Hoeink
Peter Luffi
Meghan Miller
Bing Shen

Earth Science Joint Appointments (with Chemistry)
Andreas Luttge

ESCI Degrees Offered: BA, BS, MS, PhD

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 a course in geological field techniques and 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, BA or BS, and, for the BS major, which of 5 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 advisor. The program of study typically includes experience with analytical equipment, computer systems, and fieldwork.

The BS in earth science degree should be chosen by students planning a career or further study in earth science or a related field. The BA 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.
Degree Requirements for BS in Earth Science

For general university requirements, see Graduation Requirements (pages 16–19).
BS majors also must complete the “Additional Requirements” for one track (described below).

The following courses are required for all tracks:
MATH 101/102 Single Variable Calculus I and II
CHEM 121/122 or 151/152 General Chemistry I and II with lab
PHYS 101/102 or 111/112 Introductory Physics I and II with lab

ESCI 321 Earth System Evolution and Cycles
ESCI 322 Earth Chemistry and Materials
ESCI 323 Earth Structure and Deformation with lab
ESCI 324 Earth’s Interior
ESCI 334 Geological and Geophysical Techniques

Additional Requirements for the Geology Track

The following courses are required:
MATH 211 Ordinary Differential Equations and Linear Algebra
ESCI 390 Geology Field Camp
ESCI 442 Exploration Geophysics I

Choose one of the following courses:
COMP 110 Computation in Natural Science
CAAM 210 Introduction to Engineering Computation
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 Paleogeography

Choose one of the following courses:
ESCI 418 Quantitative Hydrogeology
ESCI 463 Advanced 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
ESCI 390 Geology Field Camp or
ESCI 391 Earth Science Field Experience

Choose 9 hours from the following:
ESCI 340 Global Biogeochemical Cycles
ESCI 412 Advanced Petrology
ESCI 421 Paleogeography
ESCI 425 Organic Geochemistry
ESCI 458 Thermodynamics/Kinetics for Geoscientists
ESCI 203 Biogeochemistry

ESCI 430 Principles of Trace-Element and Isotope Geochemistry

Choose 8 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

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The following courses are required for all tracks:
MATH 101/102 Single Variable Calculus I and II
CHEM 121/122 or 151/152 General Chemistry I and II with lab
PHYS 101/102 or 111/112 Introductory Physics I and II with lab

ESCI 321 Earth System Evolution and Cycles
ESCI 322 Earth Chemistry and Materials
ESCI 323 Earth Structure and Deformation with lab
ESCI 324 Earth’s Interior
ESCI 334 Geological and Geophysical Techniques

Additional Requirements for the Geology Track

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MATH 211 Ordinary Differential Equations and Linear Algebra
ESCI 390 Geology Field Camp
ESCI 442 Exploration Geophysics I

Choose one of the following courses:
COMP 110 Computation in Natural Science
CAAM 210 Introduction to Engineering Computation
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 Paleogeography

Choose one of the following courses:
ESCI 418 Quantitative Hydrogeology
ESCI 463 Advanced 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
ESCI 390 Geology Field Camp or
ESCI 391 Earth Science Field Experience

Choose 9 hours from the following:
ESCI 340 Global Biogeochemical Cycles
ESCI 412 Advanced Petrology
ESCI 421 Paleogeography
ESCI 425 Organic Geochemistry
ESCI 458 Thermodynamics/Kinetics for Geoscientists
ESCI 203 Biogeochemistry

ESCI 430 Principles of Trace-Element and Isotope Geochemistry

Choose 8 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

**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
- ESCI 390 Geology Field Camp or ESCI 391 Earth Science Field Experience

Choose one of the following courses:
- COMP 110 Computation in Natural Science
- CAAM 210 Introduction to Engineering Computation
- COMP 210 Principles of Computing and Programming

Choose 6 hours from the following:
- ESCI 418 Quantitative Hydrogeology
- ESCI 440 Geophysical Data Analysis: Digital Signal Processing

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

**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
- COMP 210 Principles of Computing and Programming

Choose 11 hours from the following, including at least two courses in ESCI:
- ESCI 340 Global Biogeochemical Cycles
- ESCI 345 Organic Geochemistry
- ESCI 353 Environmental Geochemistry
- ESCI 354 Analysis of Environmental Data
- ESCI 401 Remote Sensing
- ESCI 444 Exploration Geophysics I
- ESCI 445 Exploration Geophysics II
- ESCI 454 Geographic Information Science
- ESCI 461 Seismology I
- ESCI 462 Tectonophysics
- ESCI 463 Advanced Structural Geology I
- ESCI 464 Advanced Global Tectonics
- ESCI 465 Global Tectonics
- ESCI 504 Clastics
- ESCI 506 Carbonates
- ESCI 568 Paleoclimates and Human Response
- CEVE 306 Global Environmental Law and Sustainable Development
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 Materials

**ESCI 323** Earth Structure and Deformation with lab

Choose 6 hours from the following:

**BIOL 201/202** Introductory Biology I and II

**BIOL 211, 213** Biology Lab Modules

Choose 9 hours from the following:

**BIOL 201/202** Introductory Biology I and II

**COMP 110** Computation in Natural Science

**CAAM 210** Introduction to Engineering Computation

**COMP 210** Principles of Computing and Programming

**CHEM 311/312** Physical Chemistry I and II

**MATH 211** Ordinary Differential Equations and Linear Algebra

Choose 12 hours of additional courses numbered 300 or higher targeting a coherent theme selected with approval of the department undergraduate advisor.

**CEVE 434** Chemical Transport and Fate in the Environment

**CEVE 412** Hydrogeology and Watershed Analysis

**CEVE 401** Environmental Chemistry

**CHEM 211** Organic Chemistry

**CHEM 311** Physical Chemistry

**CHEM 360** Inorganic Chemistry

**PHYS 201** Waves and Optics

**PHYS 231** Elementary Physics Lab II

**BIOS 202** Introductory Biology II

**MATH 212** Multivariable Calculus

**PHYS 201** Waves and Optics

**PHYS 203** Atmosphere, Weather, and Climate

**ESCI 390** Geology Field Camp or

**ESCI 391** Earth Science Field Experience

degree requirements for BA in Earth Science

For general university requirements, see Graduation Requirements (pages 16–19).

**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 Materials

**ESCI 323** Earth Structure and Deformation 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

Choose 4 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 28).

Degree Requirements for MS and PhD 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 61–62). The requirements for the MS and PhD in earth science are similar, but the PhD demands a significantly higher level of knowledge, research skills, and scholarly independence. Most students need at least 2 years beyond the bachelor’s degree to complete the MS and at least 2 years beyond the MS degree for the PhD.

Candidates determine, with their major professor and thesis 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 PhD, 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 PhD. 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.