# Earth Sciences

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## Faculty

Ilya N. Bindeman, professor (stable isotope geochemistry, volcanology). BS, 1988, Moscow; PhD, 1998, Chicago. (2004)

Edward B. Davis, associate professor (vertebrate paleontology). BS, 1999, Tennessee, Knoxville; PhD, 2005, California, Berkeley. (2013)

Rebecca J. Dorsey, professor (sedimentology, basin analysis). BS, 1983, Vermont; MA, 1986, PhD, 1989, Princeton. (1997)

Josef Dufek, professor (volcanology). BS, 2000, Chicago; MS, 2004, PhD, 2006, Washington (Seattle). (2017)

Thomas Giachetti, assistant professor (volcanology). MS, 2006, PhD, 2010, Université Blaise Pascal, Clermont-Ferrand. (2015)

Emilie Hooft Toomey, associate professor (marine geophysics). BSc, 1990, Trinity College, Toronto; PhD, 1997, Massachusetts Institute of Technology and Woods Hole Oceanographic Institution. (1999)

Samantha Hopkins, associate professor (paleontology). See **Robert Donald Clark Honors College**.

Eugene D. Humphreys, professor (seismology, regional tectonics). BS, 1974, MS, 1978, California, Riverside; PhD, 1985, California Institute of Technology. (1985)

Qusheng Jin, associate professor (biogeoscience). BS, 1994, Nanjing; MS, 1997, Chinese Academy of Sciences; PhD, 2003, Illinois, Urbana-Champaign. (2005)

A. Dana Johnston, professor (experimental petrology, geochemistry). BS, 1976, Bates; MS, 1978, PhD, 1983, Minnesota. (1986)

Leif A. Karlstrom, assistant professor (volcanology, geomorphology, fluid mechanics). BS, 2006, Oregon; PhD, 2011, California, Berkeley. (2011)

Diego Melgar, assistant professor (earthquake seismology, tsunamis, geodetic imaging). BEng., 2009, Universidad Nacional Autonoma de Mexico; MS, 2010, PhD, 2014, Scripps College. (2017)

Marli B. Miller, senior instructor (structural geology). BA, 1982, Colorado College; MS, 1987, PhD, 1992, Washington (Seattle). (1997)

Matthew Polizzotto, associate professor (soil and environmental hydrogeochemistry). BS, BA, 2001, Rochester; PhD, 2007, Stanford. (2016)

Mark H. Reed, professor (mineral deposits, aqueous geochemistry). BA, 1971, Carleton; MS, 1974, PhD, 1977, California, Berkeley. (1979)

Alan W. Rempel, professor (geomechanics and applied mathematics). BASc, 1991, MSc, 1995, British Columbia; PhD, 2001, Cambridge. (2004)

Gregory J. Retallack, professor (paleobotany, paleosols). BA, 1973, Macquarie; PhD, 1978, New England University, Australia. (1981)

Joshua J. Roering, professor (surface processes, geomorphology). BS, 1994, MS, 1995, Stanford; PhD, 2000, California, Berkeley. (2000)

Valerie Sahakian, assistant professor (tectonics, ground seismology, marine geophysics). BS, 2009, Rhode Island; MS, 2010, PhD, 2015, Scripps College. (2018)

David A. Sutherland, associate professor (physical oceanography). BA, 2001, North Carolina, Wilmington; PhD, 2008, Massachusetts Institute of Technology and Woods Hole Oceanographic Institution. (2011)

Amanda M. Thomas, associate professor (earthquake seismology and fault mechanics). BS, 2007, Georgia Institute of Technology; PhD, 2012, California, Berkeley. (2015)

Douglas R. Toomey, professor (seismology, tectonics, midocean ridges). BS, 1981, Pennsylvania State; PhD, 1987, Massachusetts Institute of Technology and Woods Hole Oceanographic Institution. (1990)

Paul J. Wallace, professor (igneous petrology, volcanology, geochemistry). BS, 1986, George Washington University; PhD, 1991, California, Berkeley. (2001)

James M. Watkins, associate professor (experimental petrology, geochemistry, volcanology). BS, 2005, Wisconsin, Eau Claire; PhD, 2010, Cailfornia, Berkeley. (2012)

Ray J. Weldon, professor (neotectonics, structural and quaternary geology). BA, 1977, Pomona; PhD, 1986, California Institute of Technology. (1987)

## Research Staff

Dennis K. Fletcher, research assistant. BS, 1996, Oregon. (2006)

Leland O'Driscoll, seismic field technician. PhD, 2012, Oregon (2015)

Sara Meyer, field technician. BS, 2010, California, Santa Cruz; IT specialist certification, 2015, Alaska, Fairbanks. (2017)

James Palandri, research associate. PhD, 2000, Oregon. (2001)

Lucy Walsh, research assistant. MS, 2012, Oregon. (2017)

## Emeriti

M. Allan Kays, professor emeritus. BA, 1956, Southern Illinois; MA, 1958, PhD, 1960, Washington (St. Louis). (1961)

Alexander R. McBirney, professor emeritus. BS, 1946, United States Military Academy, West Point; PhD, 1961, California, Berkeley. (1965)

William N. Orr, professor emeritus. BS, 1961, Oklahoma; MA, 1963, California, Riverside and Los Angeles; PhD, 1967, Michigan State. (1967)

Jack M. Rice, professor emeritus. AB, 1970, Dartmouth College; MS, 1972, PhD, 1975, Washington (Seattle). (1977)

Norman M. Savage, professor emeritus. BSc, 1959, Bristol; PhD, 1968, Sydney. (1971)

Harve S. Waff, professor emeritus. BS, 1962, William and Mary; MS, 1966, PhD, 1970, Oregon. (1978)

Daniel Weill, professor emeritus. BA, 1956, Cornell; MS, 1958, Illinois; PhD, 1962, California, Berkeley. (2002)

*The date in parentheses at the end of each entry is the first year on the University of Oregon faculty.*

- **Bachelor of Arts: Geology Track**
- **Bachelor of Arts: Geophysics Track**
- **Bachelor of Arts: Environmental Geoscience Track**
- **Bachelor of Arts: Paleontology Track**
- **Bachelor of Science: Geology Track**
- **Bachelor of Science: Geophysics Track**
- **Bachelor of Science: Environmental Geoscience Track**
- **Bachelor of Science: Paleontology Track**
- **Minor**

# Undergraduate Studies

The undergraduate program in the Department of Earth Sciences provides an understanding of the materials that constitute the earth and the processes that have shaped the earth from deep in its interior to the surface environment—geology. Geology applies all the basic sciences—biology, chemistry, mathematics, and physics—to understanding earth processes in the historical context of geologic time. It is a science that explores problems by combining field investigations with laboratory experiments and theoretical studies.

Geology also addresses many natural hazards—earthquakes, flooding, and volcanic eruptions—that affect humans. It addresses the impact of humans on the earth's surface environment, where we pollute rivers and ground water, cause rapid erosion and landslides, or attempt to re-engineer rivers and shorelines.

## Preparation

High school students planning to major in geological sciences should include in their high school program as much mathematics and science (physics, chemistry, biology, or earth science) as possible.

Students who transfer to the department after two years of college work elsewhere should have completed a year of general chemistry, a year of general physics, and two quarters or a semester of calculus. A year of general geology with laboratory is recommended.

## Careers

Students with a degree in earth sciences are qualified for employment in a broad range of careers: geotechnical and environmental consultants; K–12 school teachers (with an additional teaching certificate); laboratory technicians; professional geologists, geophysicists, or geochemists; and positions in the petroleum and mining industries or in state and federal agencies such as the United States Geological Survey or the Environmental Protection Agency. The current climate for employment in the earth sciences is good. Geoscience jobs require skills in critical thinking and problem solving, quantitative analysis, oral and written communication, and team work. The Department of Earth Sciences curriculum emphasizes these skills.

## Geological Sciences Curriculum

The Department of Earth Sciences offers a bachelor of science (BS) or a bachelor of arts (BA) degree with a major in earth sciences.

## Major Tracks

Earth science is an unusually broad subject. It addresses everything from the chemical processes that make rocks and minerals to the physics behind plate tectonics and the travel of earthquake waves through the planet. It explores the history of the evolution of life revealed in fossils, and it probes the earth processes that affect how humans can survive on the surface of the planet. To address this breadth, the department offers four curricular tracks for a major in earth sciences: geology, geophysics, environmental geoscience, and paleontology.

All of the tracks require a common core of general chemistry, calculus, general geology, and physics, except that paleontology- and environmental geoscience–track students may take two terms of biology in place of two terms of physics. Beyond the core, each track requires certain additional courses and a selection of electives.

## Undergraduate Research

As many as 4 credits of research can be counted toward electives in any of the tracks. To receive such credit, students must

- submit a short letter, approved by the faculty research advisor and addressed to the head undergraduate advisor in earth sciences, stating the nature of the research and asserting that there is faculty supervision
- submit a final written report to the faculty advisor describing the results of the research

Students may earn credit in this category by registering for any of the following:

| Code | Title | Credits |
|---|---|---|
| GEOL 401 | Research: [Topic] | 1-21 |
| GEOL 406 | Field Studies: [Topic] | 1-6 |
| GEOL 408 | Laboratory Projects: [Topic] | 1-6 |

Students who complete an honors thesis may not apply this option toward elective credits.

## Grade Options and Standards

Undergraduate majors must take for letter grades (the pass/no pass option is not acceptable) all the courses required in their degree program. Required courses must be completed with grades of C– or better. Exceptions for honors students are noted under Honors in Earth Sciences.

# Bachelor of Arts: Geology Track

| Code | Title | Credits |
|---|---|---|
| **Core Courses** | | |
| GEOL 101<br>& GEOL 102<br>& GEOL 103 | Exploring Planet Earth<br>and Exploring Earth's Environment<br>and Exploring Earth History [1] | 12 |
| or GEOL 201<br>& GEOL 202<br>& GEOL 203 | Dynamic Planet Earth<br>and Earth's Surface and Environment<br>and History of Life | |
| PHYS 201–202 | General Physics | 8 |
| or PHYS 251<br>& PHYS 252 | Foundations of Physics I<br>and Foundations of Physics I | |
| CH 221–222 | General Chemistry | 8 |

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|---|---|---|
| or CH 224H–225H | Honors General Chemistry | |
| MATH 251–252 | Calculus I-II | 8 |
| GEOL 315 | Earth Physics | 4 |
| GEOL 316 | Introduction to Hydrogeology | 4 |
| GEOL 318 | Introduction to Field Methods | 3 |
| GEOL 363 | Computational Tools for Earth Sciences | 4 |
| GEOL 418 | Earth and Environmental Data Analysis | 4 |
| or MATH 253 | Calculus III | |
| or MATH 343 | Statistical Models and Methods | |
| or MATH 425 | Statistical Methods I | |
| **Additional Requirements** | | |
| GEOL 331 | Mineralogy | 5 |
| GEOL 332 | Introduction to Petrology | 5 |
| GEOL 334 | Sedimentology and Stratigraphy | 4 |
| GEOL 350 & GEOL 351 & GEOL 352 | Structural Geology and Structural Geology Problems and Structural Geology Laboratory and Field | 5 |
| GEOL 406 | Field Studies: [Topic] | 12 |
| **Electives** | | |
| See Electives table for choices | | 20 |
| Total Credits | | 106 |

[1] The 200-level sequence is recommended for majors; however, the 100-level sequence may be substituted if the courses are passed with grades of mid-B or better.

## Electives

| Code | Title | Credits |
|---|---|---|
| **Biology** | | |
| Courses numbered 306 or higher | | |
| **Chemistry** | | |
| CH 223 | General Chemistry III | 4 |
| CH 226H | Advanced General Chemistry III | 4 |
| CH 227–229 | General Chemistry Laboratory | 6 |
| or CH 237–239 | Advanced General Chemistry Laboratory | |
| CH 331 | Organic Chemistry I | 4 |
| CH 335 | Organic Chemistry II | 4 |
| CH 336 | Organic Chemistry III | 4 |
| CH 411–413 | Physical Chemistry | 12 |
| CH 431–433 | Inorganic Chemistry | 12 |
| CH 444 | Chemical Thermodynamics | 4 |
| CH 445 | Statistical Mechanics | 4 |
| **Computer and Information Science** | | |
| CIS 210–212 | Computer Science I-III | 12 |
| CIS 315 | Intermediate Algorithms | 4 |
| **Geography** | | |
| GEOG 321 | Climatology | 4 |
| GEOG 322 | Geomorphology | 4 |
| GEOG 323 | Biogeography | 4 |
| GEOG 360 | Watershed Science and Policy | 4 |
| GEOG 361 | Global Environmental Change | 4 |
| GEOG 421 | Advanced Climatology: [Topic] | 4 |
| GEOG 423 | Advanced Biogeography: [Topic] | 4 |
| GEOG 425 | Hydrology and Water Resources | 4 |
| GEOG 427 | Fluvial Geomorphology | 4 |
| GEOG 430 | Long-Term Environmental Change | 4 |
| GEOG 481–482 | GIScience I-II | 8 |
| GEOG 485–486 | Remote Sensing I-II | 8 |
| GEOG 491 | Advanced Geographic Information Systems | 4 |
| GEOG 495 | Geographic Data Analysis | 4 |
| **Earth Sciences** | | |
| Select from GEOL 304–310 | | 4 |
| GEOL 353 | Geologic Hazards | 4 |
| GEOL 363 | Computational Tools for Earth Sciences | 2 |
| GEOL 401 | Research: [Topic] | 1-21 |
| GEOL 403 | Thesis | 1-6 |
| GEOL 410 | Experimental Course: [Topic] | 5 |
| GEOL 407 | Seminar: [Topic] (Current Topics in Geology) [1] | 3 |
| Courses higher than 410 | | |
| **Mathematics** | | |
| MATH 256 | Introduction to Differential Equations | 4 |
| MATH 281–282 | Several-Variable Calculus I-II | 8 |
| MATH 341–342 | Elementary Linear Algebra | 8 |
| MATH 411–412 | Functions of a Complex Variable I-II | 8 |
| MATH 420 | Ordinary Differential Equations | 4 |
| MATH 421–422 | Partial Differential Equations: Fourier Analysis I-II | 8 |
| MATH 425–426 | Statistical Methods I-II | 8 |
| **Physics** | | |
| PHYS 203 | General Physics | 4 |
| or PHYS 253 | Foundations of Physics I | |
| PHYS 204–206 | Introductory Physics Laboratory | 6 |
| PHYS 290 | Foundations of Physics Laboratory | 1 |
| PHYS 351–353 | Foundations of Physics II | 12 |
| PHYS 411–413 | Mechanics, Electricity, and Magnetism | 12 |

[1] Pass/no pass

## Bachelor of Science: Geology Track

| Code | Title | Credits |
|---|---|---|
| **Core Courses** | | |
| GEOL 101 & GEOL 102 & GEOL 103 | Exploring Planet Earth and Exploring Earth's Environment and Exploring Earth History [1] | 12 |
| or GEOL 201 & GEOL 202 & GEOL 203 | Dynamic Planet Earth and Earth's Surface and Environment and History of Life | |
| PHYS 201–202 | General Physics | 8 |
| or PHYS 251 & PHYS 252 | Foundations of Physics I and Foundations of Physics I | |
| CH 221–222 | General Chemistry | 8 |
| or CH 224H–225H | Honors General Chemistry | |

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|---|---|---|
| MATH 251–252 | Calculus I-II | 8 |
| GEOL 315 | Earth Physics | 4 |
| GEOL 316 | Introduction to Hydrogeology | 4 |
| GEOL 318 | Introduction to Field Methods | 3 |
| GEOL 363 | Computational Tools for Earth Sciences | 4 |
| GEOL 418 | Earth and Environmental Data Analysis | 4 |
| or MATH 253 | Calculus III | |
| or MATH 343 | Statistical Models and Methods | |
| or MATH 425 | Statistical Methods I | |
| **Additional Requirements** | | |
| GEOL 331 | Mineralogy | 5 |
| GEOL 332 | Introduction to Petrology | 5 |
| GEOL 334 | Sedimentology and Stratigraphy | 4 |
| GEOL 350 & GEOL 351 & GEOL 352 | Structural Geology and Structural Geology Problems and Structural Geology Laboratory and Field | 5 |
| GEOL 406 | Field Studies: [Topic] | 12 |
| **Electives** | | |
| See Electives table for choices | | 20 |
| Total Credits | | 106 |

[1] The 200-level sequence is recommended for majors; however, the 100-level sequence may be substituted if the courses are passed with grades of mid-B or better.

## Electives

| Code | Title | Credits |
|---|---|---|
| **Biology** | | |
| Courses numbered 306 or higher | | |
| **Chemistry** | | |
| CH 223 | General Chemistry III | 4 |
| CH 226H | Advanced General Chemistry III | 4 |
| CH 227–229 | General Chemistry Laboratory | 6 |
| or CH 237–239 | Advanced General Chemistry Laboratory | |
| CH 331 | Organic Chemistry I | 4 |
| CH 335 | Organic Chemistry II | 4 |
| CH 336 | Organic Chemistry III | 4 |
| CH 411–413 | Physical Chemistry | 12 |
| CH 431–433 | Inorganic Chemistry | 12 |
| CH 444 | Chemical Thermodynamics | 4 |
| CH 445 | Statistical Mechanics | 4 |
| **Computer and Information Science** | | |
| CIS 210–212 | Computer Science I-III | 12 |
| CIS 315 | Intermediate Algorithms | 4 |
| **Geography** | | |
| GEOG 321 | Climatology | 4 |
| GEOG 322 | Geomorphology | 4 |
| GEOG 323 | Biogeography | 4 |
| GEOG 360 | Watershed Science and Policy | 4 |
| GEOG 361 | Global Environmental Change | 4 |
| GEOG 421 | Advanced Climatology: [Topic] | 4 |
| GEOG 423 | Advanced Biogeography: [Topic] | 4 |
| GEOG 425 | Hydrology and Water Resources | 4 |
| GEOG 427 | Fluvial Geomorphology | 4 |
| GEOG 430 | Long-Term Environmental Change | 4 |
| GEOG 481–482 | GIScience I-II | 8 |
| GEOG 485–486 | Remote Sensing I-II | 8 |
| GEOG 491 | Advanced Geographic Information Systems | 4 |
| GEOG 495 | Geographic Data Analysis | 4 |
| **Earth Sciences** | | |
| Select from GEOL 304–310 | | 4 |
| GEOL 353 | Geologic Hazards | 4 |
| GEOL 363 | Computational Tools for Earth Sciences | 2 |
| GEOL 401 | Research: [Topic] | 1-21 |
| GEOL 403 | Thesis | 1-6 |
| GEOL 410 | Experimental Course: [Topic] | 5 |
| GEOL 407 | Seminar: [Topic] (Current Topics in Geology) [1] | 3 |
| Courses higher than 410 | | |
| **Mathematics** | | |
| MATH 256 | Introduction to Differential Equations | 4 |
| MATH 281–282 | Several-Variable Calculus I-II | 8 |
| MATH 341–342 | Elementary Linear Algebra | 8 |
| MATH 411–412 | Functions of a Complex Variable I-II | 8 |
| MATH 420 | Ordinary Differential Equations | 4 |
| MATH 421–422 | Partial Differential Equations: Fourier Analysis I-II | 8 |
| MATH 425–426 | Statistical Methods I-II | 8 |
| **Physics** | | |
| PHYS 203 | General Physics | 4 |
| or PHYS 253 | Foundations of Physics I | |
| PHYS 204–206 | Introductory Physics Laboratory | 6 |
| PHYS 290 | Foundations of Physics Laboratory | 1 |
| PHYS 351–353 | Foundations of Physics II | 12 |
| PHYS 411–413 | Mechanics, Electricity, and Magnetism | 12 |

[1] Pass/no pass

## Bachelor of Arts: Geophysics Track

| Code | Title | Credits |
|---|---|---|
| GEOL 315 | Earth Physics | 4 |
| GEOL 363 | Computational Tools for Earth Sciences | 4 |
| or CIS 122 | Introduction to Programming and Problem Solving | |
| CH 221–222 | General Chemistry | 8 |
| or CH 224H–225H | Honors General Chemistry | |
| MATH 251–253 | Calculus I-III | 12 |
| PHYS 251–253 | Foundations of Physics I | 12 |
| **Additional Requirements** | | |
| Select two from the following: | | 7-8 |
| GEOL 441 | Hillslope Geomorphology | |
| GEOL 451 | Hydrogeology | |
| GEOL 452 | Neotectonics and Quaternary Geology | |
| GEOL 453 | Tectonics | |

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|---|---|---|
| GEOL 454 | Fluid Dynamics | |
| GEOL 462 | Environmental Geomechanics | |
| GEOL 463 | Computational Earth Science | |
| GEOL 466 | Geodynamics | |
| GEOL 467 | Fault Mechanics | |
| GEOL 468 | Introduction to Seismology | |
| GEOL 455 | Mechanical Earth | 4 |
| MATH 281–282 & MATH 256 | Several-Variable Calculus I-II and Introduction to Differential Equations | 12 |
| PHYS 351–353 | Foundations of Physics II | 12 |
| or PHYS 411–413 | Mechanics, Electricity, and Magnetism | |
| **Electives** | | |
| See Electives table for choices | | 16 |
| Total Credits | | 91-92 |

[1] The 200-level sequence is recommended for majors; however, the 100-level sequence may be substituted if the courses are passed with grades of mid-B or better.

## Electives

| Code | Title | Credits |
|---|---|---|
| **Chemistry** | | |
| CH 223 | General Chemistry III | 4 |
| CH 226H | Advanced General Chemistry III | 4 |
| CH 411 | Physical Chemistry | 4 |
| **Earth Sciences** | | |
| Select from GEOL 101–310 | | 8 |
| GEOL 311 | Earth Materials | 5 |
| GEOL 316 | Introduction to Hydrogeology | 4 |
| GEOL 318 | Introduction to Field Methods | 3 |
| GEOL 334 | Sedimentology and Stratigraphy | 4 |
| GEOL 350 | Structural Geology | 3 |
| GEOL 351 | Structural Geology Problems | 1 |
| GEOL 352 | Structural Geology Laboratory and Field | 1 |
| GEOL 353 | Geologic Hazards | 4 |
| GEOL 363 | Computational Tools for Earth Sciences | 2 |
| GEOL 401 | Research: [Topic] | 1-21 |
| GEOL 403 | Thesis | 1-6 |
| GEOL 407 | Seminar: [Topic] (Current Topics in Geology) [1] | 1-5 |
| Courses numbered 408 or higher | | |
| **Mathematics** | | |
| MATH 341–342 | Elementary Linear Algebra | 8 |
| or MATH 421–422 | Partial Differential Equations: Fourier Analysis I-II | |

[1] Pass/no pass

## Bachelor of Science: Geophysics Track

| Code | Title | Credits |
|---|---|---|
| GEOL 101 & GEOL 102 & GEOL 103 | Exploring Planet Earth and Exploring Earth's Environment and Exploring Earth History [1] | 12 |
| or GEOL 201 & GEOL 202 & GEOL 203 | Dynamic Planet Earth and Earth's Surface and Environment and History of Life | |
| GEOL 315 | Earth Physics | 4 |
| GEOL 318 | Introduction to Field Methods | 3 |
| CH 221–222 | General Chemistry | 8 |
| or CH 224H–225H | Honors General Chemistry | |
| MATH 251–253 | Calculus I-III | 12 |
| PHYS 251–253 | Foundations of Physics I | 12 |
| **Additional Requirements** | | |
| Select two of the following: | | 7-8 |
| GEOL 441 | Hillslope Geomorphology | |
| GEOL 451 | Hydrogeology | |
| GEOL 452 | Neotectonics and Quaternary Geology | |
| GEOL 453 | Tectonics | |
| GEOL 454 | Fluid Dynamics | |
| GEOL 462 | Environmental Geomechanics | |
| GEOL 463 | Computational Earth Science | |
| GEOL 466 | Geodynamics | |
| GEOL 467 | Fault Mechanics | |
| GEOL 468 | Introduction to Seismology | |
| GEOL 455 | Mechanical Earth | 4 |
| MATH 281–282 & MATH 256 | Several-Variable Calculus I-II and Introduction to Differential Equations | 12 |
| PHYS 351–353 | Foundations of Physics II | 12 |
| or PHYS 411–413 | Mechanics, Electricity, and Magnetism | |
| **Electives** | | |
| See Electives table for choices | | 16 |
| Total Credits | | 102-103 |

[1] The 200-level sequence is recommended for majors; however, the 100-level sequence may be substituted if the courses are passed with grades of mid-B or better.

## Electives

| Code | Title | Credits |
|---|---|---|
| **Chemistry** | | |
| CH 223 | General Chemistry III | 4 |
| CH 226H | Advanced General Chemistry III | 4 |
| CH 411 | Physical Chemistry | 4 |
| **Earth Sciences** | | |
| Select from GEOL 101–310 | | 8 |
| GEOL 311 | Earth Materials | 5 |
| GEOL 316 | Introduction to Hydrogeology | 4 |
| GEOL 318 | Introduction to Field Methods | 3 |
| GEOL 334 | Sedimentology and Stratigraphy | 4 |
| GEOL 350 | Structural Geology | 3 |
| GEOL 351 | Structural Geology Problems | 1 |
| GEOL 352 | Structural Geology Laboratory and Field | 1 |
| GEOL 353 | Geologic Hazards | 4 |
| GEOL 363 | Computational Tools for Earth Sciences | 2 |
| GEOL 401 | Research: [Topic] | 1-21 |

| | | |
|---|---|---|
| GEOL 403 | Thesis | 1-6 |
| GEOL 407 | Seminar: [Topic] (Current Topics in Geology) [1] | 1-5 |
| Courses numbered 408 or higher | | |
| **Mathematics** | | |
| MATH 341–342 | Elementary Linear Algebra | 8 |
| or MATH 421–422 | Partial Differential Equations: Fourier Analysis I-II | |

[1] Pass/no pass

## Bachelor of Arts: Environmental Geoscience Track

| Code | Title | Credits |
|---|---|---|
| **Core Requirements (60 or 65 credits)** | | |
| GEOL 101 & GEOL 102 & GEOL 103 | Exploring Planet Earth and Exploring Earth's Environment and Exploring Earth History [1] | 12 |
| or GEOL 201 & GEOL 202 & GEOL 203 | Dynamic Planet Earth and Earth's Surface and Environment and History of Life | |
| GEOL 311 | Earth Materials | 5 |
| or GEOL 331 & GEOL 332 | Mineralogy and Introduction to Petrology | |
| GEOL 315 | Earth Physics | 4 |
| GEOL 316 | Introduction to Hydrogeology | 4 |
| GEOL 318 | Introduction to Field Methods | 3 |
| GEOL 363 | Computational Tools for Earth Sciences | 2 |
| or CIS 122 | Introduction to Programming and Problem Solving | |
| PHYS 201 & PHYS 202 | General Physics and General Physics | 8 |
| or PHYS 251 & PHYS 252 | Foundations of Physics I and Foundations of Physics I | |
| CH 221–222 | General Chemistry | 8 |
| or CH 224H & CH 225H | Advanced General Chemistry I and Advanced General Chemistry II | |
| MATH 251–252 | Calculus I-II | 8 |
| or MATH 246 & MATH 247 | Calculus for the Biological Sciences I and Calculus for the Biological Sciences II | |
| GEOL 418 | Earth and Environmental Data Analysis | 4 |
| or MATH 253 | Calculus III | |
| or MATH 343 | Statistical Models and Methods | |
| or MATH 425 | Statistical Methods I | |
| **Electives** | | |
| See Electives table for choices | | 44 |
| Total Credits | | 102 |

[1] The 200-level sequence is recommended for majors; however, the 100-level sequence may be substituted if the courses are passed with grades of mid-B or better.

## Electives

| Code | Title | Credits |
|---|---|---|
| **Group A** | | 24 |
| GEOL 310 | Earth Resources and the Environment | |
| GEOL 334 | Sedimentology and Stratigraphy | |
| GEOL 353 | Geologic Hazards | |
| GEOL 410 | Experimental Course: [Topic] (Physical Oceanography; Soil and Environmental Chemistry) | |
| GEOL 438 | Geobiology | |
| GEOL 441 | Hillslope Geomorphology | |
| GEOL 451 | Hydrogeology | |
| GEOL 455 | Mechanical Earth | |
| GEOL 462 | Environmental Geomechanics | |
| ENVS 477 | Soil Science | |
| **Group B** | | 20 |
| Group A elective courses beyond 24 credits | | |
| GEOL 304–308, 350–352, 406, 407 | | |
| GEOL 410 and above if not taken as a Group A elective | | |
| BI 212–214, 306 and above | | |
| CH 223, 226, 227–229, 237–239, 331 and above | | |
| CIS 210–212 | | |
| ENVS 350, 465 | | |
| GEOG 321, 322, 323, 360, 361, 421, 423, 425, 427, 430, 433, 481, 482, 485, 486, 490, 491, 494, 495 | | |
| MATH 256, 281, 282, 341, 342, 411, 412, 420–422 | | |

## Bachelor of Science: Environmental Geoscience Track

| Code | Title | Credits |
|---|---|---|
| **Core Requirements (60 or 65 credits)** | | |
| GEOL 101 & GEOL 102 & GEOL 103 | Exploring Planet Earth and Exploring Earth's Environment and Exploring Earth History [1] | 12 |
| or GEOL 201 & GEOL 202 & GEOL 203 | Dynamic Planet Earth and Earth's Surface and Environment and History of Life | |
| GEOL 311 | Earth Materials | 5 |
| or GEOL 331 & GEOL 332 | Mineralogy and Introduction to Petrology | |
| GEOL 315 | Earth Physics | 4 |
| GEOL 316 | Introduction to Hydrogeology | 4 |
| GEOL 318 | Introduction to Field Methods | 3 |
| CIS 122 | Introduction to Programming and Problem Solving | 4 |
| PHYS 201 & PHYS 202 | General Physics and General Physics | 8 |
| or PHYS 251 & PHYS 252 | Foundations of Physics I and Foundations of Physics I | |
| CH 221–222 | General Chemistry | 8 |
| or CH 224H & CH 225H | Advanced General Chemistry I and Advanced General Chemistry II | |
| MATH 251–252 | Calculus I-II | 8 |
| or MATH 246 & MATH 247 | Calculus for the Biological Sciences I and Calculus for the Biological Sciences II | |
| GEOL 418 | Earth and Environmental Data Analysis | 4 |
| or MATH 253 | Calculus III | |
| or MATH 343 | Statistical Models and Methods | |

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|---|---|---|
| or MATH 425 | Statistical Methods I | |
| **Electives** | | |
| See Electives table for choices | | 44 |
| Total Credits | | 104 |

## Electives

| Code | Title | Credits |
|---|---|---|
| **Group A** | | 24 |
| GEOL 310 | Earth Resources and the Environment | |
| GEOL 334 | Sedimentology and Stratigraphy | |
| GEOL 353 | Geologic Hazards | |
| GEOL 410 | Experimental Course: [Topic] (Physical Oceanography; Soil and Environmental Chemistry) | |
| GEOL 438 | Geobiology | |
| GEOL 441 | Hillslope Geomorphology | |
| GEOL 451 | Hydrogeology | |
| GEOL 455 | Mechanical Earth | |
| GEOL 462 | Environmental Geomechanics | |
| ENVS 477 | Soil Science | |
| **Group B** | | 20 |
| GEOL 304 | The Fossil Record | |
| GEOL 305 | Dinosaurs | |
| GEOL 306 | Volcanoes and Earthquakes | |
| GEOL 307 | Oceanography | |
| GEOL 308 | Geology of Oregon and the Pacific Northwest | |
| GEOL 350 | Structural Geology | |
| GEOL 351 | Structural Geology Problems | |
| GEOL 352 | Structural Geology Laboratory and Field | |
| GEOL 406 | Field Studies: [Topic] | |
| GEOL 407 | Seminar: [Topic] | |
| GEOL 410 and above if not taken as a Group A elective | | |

1 The 200-level sequence is recommended for majors; however, the 100-level sequence may be substituted if the courses are passed with grades of mid-B or better.

2 May include courses numbered 304-310.

## Bachelor of Arts: Paleontology Track

| Code | Title | Credits |
|---|---|---|
| GEOL 101 & GEOL 102 & GEOL 103 | Exploring Planet Earth and Exploring Earth's Environment and Exploring Earth History [1] | 12 |
| or GEOL 201 & GEOL 202 & GEOL 203 | Dynamic Planet Earth and Earth's Surface and Environment and History of Life | |
| GEOL 311 | Earth Materials | 5-10 |
| or GEOL 331 & GEOL 332 | Mineralogy and Introduction to Petrology | |
| GEOL 315 | Earth Physics | 4 |
| or GEOL 316 | Introduction to Hydrogeology | |
| GEOL 318 | Introduction to Field Methods | 3 |
| GEOL 363 | Computational Tools for Earth Sciences | 4 |
| or CIS 122 | Introduction to Programming and Problem Solving | |
| GEOL 418 | Earth and Environmental Data Analysis | 4 |
| or MATH 253 | Calculus III | |
| or MATH 343 | Statistical Models and Methods | |
| or MATH 425 | Statistical Methods I | |
| BI 211 | General Biology I: Cells | 4 |
| BI 212 | General Biology II: Organisms | 4 |
| or BI 213 | General Biology III: Populations | |
| CH 221–222 | General Chemistry | 8 |
| or CH 224H & CH 225H | Advanced General Chemistry I and Advanced General Chemistry II | |
| MATH 246–247 | Calculus for the Biological Sciences I-II | 8 |
| or MATH 251–252 | Calculus I-II | |
| PHYS 201 | General Physics | 4 |
| or PHYS 251 | Foundations of Physics I | |
| **Additional Requirements** | | |
| GEOL 334 | Sedimentology and Stratigraphy | 4 |
| GEOL 350 & GEOL 351 & GEOL 352 | Structural Geology and Structural Geology Problems and Structural Geology Laboratory and Field | 5 |
| GEOL 406 | Field Studies: [Topic] | 12 |
| Select two of the following: | | 8 |
| GEOL 433 | Paleobotany | |
| GEOL 434 | Vertebrate Paleontology | |
| GEOL 435 | Paleopedology | |
| **Electives** | | |
| See Electives table for choices | | 16 |
| Total Credits | | 105-110 |

1 The 200-level sequence is recommended for majors; however, the 100-level sequence may be substituted if the courses are passed with grades of mid-B or better.

## Electives

| Code | Title | Credits |
|---|---|---|
| **Anthropology** | | |
| ANTH 361 | Human Evolution | 4 |
| ANTH 366 | Human Osteology Laboratory | 4 |
| ANTH 462 | Primate Evolution | 4 |
| ANTH 466 | Primate Feeding and Nutrition | 4 |
| ANTH 467 | Paleoecology and Human Evolution | 4 |
| ANTH 468 | Evolutionary Theory | 4 |
| ANTH 471 | Zooarchaeology: [Topic] | 4 |
| ANTH 479 | Taphonomy: Bones, Bugs, and Burials | 4 |
| **Biology** | | |
| Courses numbered 306 or higher | | |
| **Chemistry** | | |
| CH 227–229 | General Chemistry Laboratory | 6 |
| or CH 237–239 | Advanced General Chemistry Laboratory | |
| CH 223 | General Chemistry III | 4 |
| CH 331 | Organic Chemistry I | 4 |

| | | |
|---|---|---|
| CH 335 | Organic Chemistry II | 4 |
| CH 336 | Organic Chemistry III | 4 |
| CH 411–413 | Physical Chemistry | 12 |
| CH 431–433 | Inorganic Chemistry | 12 |
| CH 444 | Chemical Thermodynamics | 4 |
| CH 445 | Statistical Mechanics | 4 |
| **Computer and Information Science** | | |
| CIS 210–212 | Computer Science I-III | 12 |
| CIS 315 | Intermediate Algorithms | 4 |
| **Geography** | | |
| GEOG 321 | Climatology | 4 |
| GEOG 322 | Geomorphology | 4 |
| GEOG 323 | Biogeography | 4 |
| GEOG 360 | Watershed Science and Policy | 4 |
| GEOG 361 | Global Environmental Change | 4 |
| GEOG 421 | Advanced Climatology: [Topic] | 4 |
| GEOG 423 | Advanced Biogeography: [Topic] | 4 |
| GEOG 425 | Hydrology and Water Resources | 4 |
| GEOG 427 | Fluvial Geomorphology | 4 |
| GEOG 430 | Long-Term Environmental Change | 4 |
| GEOG 481–482 | GIScience I-II | 8 |
| GEOG 495 | Geographic Data Analysis | 4 |
| **Earth Sciences** | | |
| GEOL 315 | Earth Physics | 4 |
| GEOL 316 | Introduction to Hydrogeology | 4 |
| GEOL 353 | Geologic Hazards | 4 |
| GEOL 401 | Research: [Topic] | 1-21 |
| GEOL 403 | Thesis | 1-6 |
| GEOL 410 | Experimental Course: [Topic] | 5 |
| GEOL 407 | Seminar: [Topic] [1] | 3 |
| Courses higher than 410 [2] | | |
| **Mathematics** | | |
| MATH 256 | Introduction to Differential Equations | 4 |
| MATH 281–282 | Several-Variable Calculus I-II | 8 |
| MATH 341–342 | Elementary Linear Algebra | 8 |
| MATH 411–412 | Functions of a Complex Variable I-II | 8 |
| MATH 420 | Ordinary Differential Equations | 4 |
| MATH 425–426 | Statistical Methods I-II | 8 |
| **Physics** | | |
| PHYS 202 | General Physics | 4 |
| PHYS 203 | General Physics | 4 |
| PHYS 204 | Introductory Physics Laboratory | 2 |
| PHYS 205 | Introductory Physics Laboratory | 2 |
| PHYS 206 | Introductory Physics Laboratory | 2 |
| PHYS 253 | Foundations of Physics I | 4 |
| PHYS 290 | Foundations of Physics Laboratory | 1 |
| PHYS 351–353 | Foundations of Physics II | 12 |
| PHYS 411–413 | Mechanics, Electricity, and Magnetism | 12 |

1 Pass/no pass

2 May include one course numbered 304–310.

## Bachelor of Science: Paleontology Track

| Code | Title | Credits |
|---|---|---|
| GEOL 101<br>& GEOL 102<br>& GEOL 103 | Exploring Planet Earth<br>and Exploring Earth's Environment<br>and Exploring Earth History [1] | 12 |
| or GEOL 201<br>& GEOL 202<br>& GEOL 203 | Dynamic Planet Earth<br>and Earth's Surface and Environment<br>and History of Life | |
| GEOL 311 | Earth Materials | 5-10 |
| or GEOL 331<br>& GEOL 332 | Mineralogy<br>and Introduction to Petrology | |
| GEOL 315 | Earth Physics | 4 |
| or GEOL 316 | Introduction to Hydrogeology | |
| GEOL 318 | Introduction to Field Methods | 3 |
| GEOL 418 | Earth and Environmental Data Analysis | 4 |
| or MATH 253 | Calculus III | |
| or MATH 343 | Statistical Models and Methods | |
| or MATH 425 | Statistical Methods I | |
| BI 211 | General Biology I: Cells | 4 |
| BI 212 | General Biology II: Organisms | 4 |
| or BI 213 | General Biology III: Populations | |
| CH 221–222 | General Chemistry | 8 |
| or CH 224H<br>& CH 225H | Advanced General Chemistry I<br>and Advanced General Chemistry II | |
| MATH 246–247 | Calculus for the Biological Sciences I-II | 8 |
| or MATH 251–252 | Calculus I-II | |
| PHYS 201 | General Physics | 4 |
| or PHYS 251 | Foundations of Physics I | |
| **Additional Requirements** | | |
| GEOL 334 | Sedimentology and Stratigraphy | 4 |
| GEOL 350<br>& GEOL 351<br>& GEOL 352 | Structural Geology<br>and Structural Geology Problems<br>and Structural Geology Laboratory and Field | 5 |
| GEOL 406 | Field Studies: [Topic] | 12 |
| Select two of the following: | | 8 |
| GEOL 433 | Paleobotany | |
| GEOL 434 | Vertebrate Paleontology | |
| GEOL 435 | Paleopedology | |
| **Electives** | | |
| See Electives table for choices | | 16 |
| Total Credits | | 101-106 |

1 The 200-level sequence is recommended for majors; however, the 100-level sequence may be substituted if the courses are passed with grades of mid-B or better.

## Electives

| Code | Title | Credits |
|---|---|---|
| **Anthropology** | | |
| ANTH 361 | Human Evolution | 4 |
| ANTH 366 | Human Osteology Laboratory | 4 |
| ANTH 462 | Primate Evolution | 4 |

| | | |
|---|---|---|
| ANTH 466 | Primate Feeding and Nutrition | 4 |
| ANTH 467 | Paleoecology and Human Evolution | 4 |
| ANTH 468 | Evolutionary Theory | 4 |
| ANTH 471 | Zooarchaeology: [Topic] | 4 |
| ANTH 479 | Taphonomy: Bones, Bugs, and Burials | 4 |
| **Biology** | | |
| Courses numbered 306 or higher | | |
| **Chemistry** | | |
| CH 227–229 | General Chemistry Laboratory | 6 |
| or CH 237–239 | Advanced General Chemistry Laboratory | |
| CH 223 | General Chemistry III | 4 |
| CH 331,335–336 | Organic Chemistry I-III | 12 |
| CH 411–413 | Physical Chemistry | 12 |
| CH 431–433 | Inorganic Chemistry | 12 |
| CH 444 | Chemical Thermodynamics | 4 |
| CH 445 | Statistical Mechanics | 4 |
| **Computer and Information Science** | | |
| CIS 210–212 | Computer Science I-III | 12 |
| CIS 315 | Intermediate Algorithms | 4 |
| **Geography** | | |
| GEOG 321 | Climatology | 4 |
| GEOG 322 | Geomorphology | 4 |
| GEOG 323 | Biogeography | 4 |
| GEOG 360 | Watershed Science and Policy | 4 |
| GEOG 361 | Global Environmental Change | 4 |
| GEOG 421 | Advanced Climatology: [Topic] | 4 |
| GEOG 423 | Advanced Biogeography: [Topic] | 4 |
| GEOG 425 | Hydrology and Water Resources | 4 |
| GEOG 427 | Fluvial Geomorphology | 4 |
| GEOG 430 | Long-Term Environmental Change | 4 |
| GEOG 481–482 | GIScience I-II | 8 |
| GEOG 495 | Geographic Data Analysis | 4 |
| **Earth Sciences** | | |
| GEOL 315 | Earth Physics | 4 |
| GEOL 316 | Introduction to Hydrogeology | 4 |
| GEOL 353 | Geologic Hazards | 4 |
| GEOL 401 | Research: [Topic] | 1-21 |
| GEOL 403 | Thesis | 1-6 |
| GEOL 410 | Experimental Course: [Topic] | 5 |
| GEOL 407 | Seminar: [Topic] [1] | 3 |
| Courses higher than 410 [2] | | |
| **Mathematics** | | |
| MATH 256 | Introduction to Differential Equations | 4 |
| MATH 281–282 | Several-Variable Calculus I-II | 8 |
| MATH 341–342 | Elementary Linear Algebra | 8 |
| MATH 411–412 | Functions of a Complex Variable I-II | 8 |
| MATH 420 | Ordinary Differential Equations | 4 |
| MATH 425–426 | Statistical Methods I-II | 8 |
| **Physics** | | |
| PHYS 204–206 | Introductory Physics Laboratory | 6 |
| PHYS 202 | General Physics | 4 |
| PHYS 203 | General Physics | 4 |
| PHYS 204 | Introductory Physics Laboratory | 2 |
| PHYS 205 | Introductory Physics Laboratory | 2 |
| PHYS 206 | Introductory Physics Laboratory | 2 |
| PHYS 253 | Foundations of Physics I | 4 |
| PHYS 290 | Foundations of Physics Laboratory | 1 |
| PHYS 351–353 | Foundations of Physics II | 12 |
| PHYS 411–413 | Mechanics, Electricity, and Magnetism | 12 |

1 Pass/no pass

2 May include one course numbered 304–310.

## Honors in Earth Sciences

Application for graduation with honors in earth sciences must be made no later than spring term of the student's junior year. To be eligible for graduation with honors, a student must

- maintain a grade point average (GPA) of 3.50 or better in geological sciences courses or a 3.00 or better in all science courses
- submit and orally present an acceptable honors thesis written under the supervision of a department faculty member and evaluated by a committee consisting of three faculty members including the supervisor. The thesis should be presented no later than three weeks before final examinations during the term the student plans to graduate

Honors students may register for 3 credits of Research: [Topic] (GEOL 401) the term before they intend to graduate, and 3 credits of Thesis (GEOL 403) the term of graduation. These credits may be applied toward electives.

## Minor Requirements

| Code | Title | Credits |
|---|---|---|
| GEOL 101 | Exploring Planet Earth | 12 |
| & GEOL 102 | and Exploring Earth's Environment | |
| & GEOL 103 | and Exploring Earth History | |
| or GEOL 201 | Dynamic Planet Earth | |
| & GEOL 202 | and Earth's Surface and Environment | |
| & GEOL 203 | and History of Life | |
| Choose from the following courses: [1] | | 15 |
| GEOL 213 | Geology of National Parks | |
| GEOL 300-499-499 | | |
| Total Credits | | 27 |

1 15 credits of earth sciences courses (exclusive of independent study courses) must be earned with course numbers greater than GEOL 299 (GEOL 213 is acceptable, however). No more than 8 credits may be applied to the minor from the following list: Geology of National Parks (GEOL 213), The Fossil Record (GEOL 304), Dinosaurs (GEOL 305), Volcanoes and Earthquakes (GEOL 306), Oceanography (GEOL 307), Geology of Oregon and the Pacific Northwest (GEOL 308), Earth Resources and the Environment (GEOL 310).

Undergraduate minors must take all required courses for letter grades and complete them with grades of C– or better.

## Group Requirements

Fourteen earth sciences courses satisfy university science group requirements. See the Group Requirements section of this catalog under **Registration and Academic Policies.**

## Kindergarten through Secondary Teaching Careers

Students who complete a degree with a major in earth sciences are eligible to apply to the College of Education's fifth-year licensure program in middle-secondary teaching or the fifth-year licensure program in elementary teaching. More information is available in the College of Education (http://catalog.uoregon.edu/archive/2019-2020/education) section of this catalog.

## Four-Year Degree Plan

*The degree plan shown is only a sample of how students may complete their degrees in four years. There are alternative ways. Students should consult their advisor to determine the best path for them.*

- **Geology Track** (p. )
- **Geophysics Track** (p. )
- **Environmental Geoscience Track** (p. )
- **Paleontology Track** (p. )

## Bachelor of Science in Earth Sciences: Geology Track

| Course | Title | | Credits |
|---|---|---|---|
| **First Year** | | | |
| **Fall** | | | |
| GEOL 101 or GEOL 201 | Exploring Planet Earth or Dynamic Planet Earth | 200-level courses recommended for majors; 100-level requires a grade of mid-B or better | 4 |
| MATH 111 | College Algebra | | 4 |
| WR 121 | College Composition I | | 4 |
| CH 221 or CH 224H | General Chemistry I or Advanced General Chemistry I | | 4 |
| | Credits | | 16 |
| **Winter** | | | |
| GEOL 102 or GEOL 202 | Exploring Earth's Environment or Earth's Surface and Environment | 200-level courses recommen for majors; 100-level requires a grade of mid-B or better | 4 |
| MATH 112 | Elementary Functions | | 4 |
| CH 222 or CH 225H | General Chemistry II or Advanced General Chemistry II | | 4 |
| General-education, multicultural, or other group-satisfying course | | | 4 |
| | Credits | | 16 |
| **Spring** | | | |
| GEOL 103 or GEOL 203 | Exploring Earth History or History of Life | 200-level courses recommended for majors; 100-level requires a grade of mid-B or better | 4 |
| WR 122 or WR 123 | College Composition II or College Composition III | | 4 |
| MATH 246 or MATH 251 | Calculus for the Biological Sciences I or Calculus I | | 4 |
| General-education, multicultural, or other group-satisfying course | | | 4 |
| | Credits | | 16 |
| | Total Credits | | 48 |

| Course | Title | | Credits |
|---|---|---|---|
| **Second Year** | | | |
| **Fall** | | | |
| PHYS 201 or PHYS 251 | General Physics or Foundations of Physics I | | 4 |
| MATH 247 or MATH 252 | Calculus for the Biological Sciences II or Calculus II | | 4 |
| GEOL 331 | Mineralogy | Could substitute GEOL 311 (spring term) for GEOL 331 and 332 | 5 |
| General-education, multicultural, or other group-satisfying course | | | 4 |
| | Credits | | 17 |
| **Winter** | | | |
| PHYS 202 or PHYS 252 | General Physics or Foundations of Physics I | | 4 |
| GEOL 315 | Earth Physics | | 4 |

| | | | |
|---|---|---|---|
| GEOL 332 | Introduction to Petrology | Could substitute GEOL 311 (spring term) for GEOL 331 and 332 | 5 |
| General-education, multicultural, or other group-satisfying course | | | 4 |
| | Credits | | 17 |
| **Spring** | | | |
| PHYS 203<br>or PHYS 253<br>or CH 223<br>or CH 226H | General Physics<br>or Foundations of Physics I<br>or General Chemistry III<br>or Advanced General Chemistry III | | 4 |
| GEOL 318 | Introduction to Field Methods | | 3 |
| GEOL 316 | Introduction to Hydrogeology | | 4 |
| General-education, multicultural, or other group-satisfying course | | | 4 |
| | Credits | | 15 |
| | Total Credits | | 49 |

| Course | Title | | Credits Milestones |
|---|---|---|---|
| **Third Year** | | | |
| **Fall** | | | |
| GEOL 418<br>or MATH 253<br>or MATH 343<br>or MATH 425<br>or PHYS 481 | Earth and Environmental Data Analysis<br>or Calculus III<br>or Statistical Models and Methods<br>or Statistical Methods I<br>or Design of Experiments | GEOL 418 is preferred, to be taken any term in the third year | 4 |
| General-education, multicultural, or other group-satisfying courses | | | 8 |
| Geology elective | | | 4 |
| | Credits | | 16 |
| **Winter** | | | |
| General-education, multicultural, or other group-satisfying courses | | | 8 |
| Geology elective | | | 4 |
| | Credits | | 12 |
| **Spring** | | | |
| GEOL 334 | Sedimentology and Stratigraphy | | 4 |
| GEOL 350 | Structural Geology | | 3 |
| GEOL 351 | Structural Geology Problems | | 1 |
| GEOL 352 | Structural Geology Laboratory and Field | | 1 |
| General-education, multicultural, or other group-satisfying course | | | 4 |
| | Credits | | 13 |
| **Summer** | | | |
| GEOL 406 | Field Studies: [Topic] | Each section of these three courses is two weeks; could also be taken after the fourth year | 12 |
| | Credits | | 12 |
| | Total Credits | | 53 |

| Course | Title | | Credits Milestones |
|---|---|---|---|
| **Fourth Year** | | | |
| **Fall** | | | |
| General-education, multicultural, or other group-satisfying courses | | | 8 |
| Geology or other science elective | | | 4 |
| | Credits | | 12 |
| **Winter** | | | |
| General-education, multicultural, or other group-satisfying courses | | | 8 |
| Geology or other science elective | | | 4 |
| | Credits | | 12 |
| **Spring** | | | |
| General-education, multicultural, or other group-satisfying courses | | | 8 |
| Geology or other science elective | | | 4 |
| | Credits | | 12 |
| | Total Credits | | 36 |

## Bachelor of Science in Earth Sciences: Geophysics Track

| Course | Title | | Credits Milestones |
|---|---|---|---|
| **First Year** | | | |
| **Fall** | | | |
| GEOL 101<br>or GEOL 201 | Exploring Planet Earth<br>or Dynamic Planet Earth | 200-level courses recommended for majors; 100-level requires a grade of mid-B or better | 4 |
| MATH 111 | College Algebra | | 4 |
| WR 121 | College Composition I | | 4 |
| CH 221<br>or CH 224H | General Chemistry I<br>or Advanced General Chemistry I | | 4 |
| | Credits | | 16 |

| | | | |
|---|---|---|---|
| **Winter** | | | |
| GEOL 102<br>or<br>GEOL 202 | Exploring Earth's Environment<br>or Earth's Surface and Environment | 200-level courses recommen for majors; 100-level requires a grade of mid-B or better | 4 |
| MATH 112 | Elementary Functions | | 4 |
| CH 222<br>or<br>CH 225H | General Chemistry II<br>or Advanced General Chemistry II | | 4 |
| General-education, multicultural, or other group-satisfying course | | | 4 |
| | Credits | | 16 |
| **Spring** | | | |
| GEOL 103<br>or<br>GEOL 203 | Exploring Earth History<br>or History of Life | 200-level courses recommended for majors; 100-level requires a grade of mid-B or better | 4 |
| WR 122<br>or WR 123 | College Composition II<br>or College Composition III | | 4 |
| MATH 246<br>or<br>MATH 251 | Calculus for the Biological Sciences I<br>or Calculus I | | 4 |
| General-education, multicultural, or other group-satisfying course | | | 4 |
| | Credits | | 16 |
| | Total Credits | | 48 |

| Course | Title | Credits Milestones | |
|---|---|---|---|
| **Second Year** | | | |
| **Fall** | | | |
| PHYS 251 | Foundations of Physics I | Pre- or corequisite: MATH 251 | 4 |
| MATH 252 | Calculus II | | 4 |
| GEOL 318 | Introduction to Field Methods | | 3 |
| General-education, multicultural, or other group-satisfying course | | | 4 |
| | Credits | | 15 |
| **Winter** | | | |
| PHYS 252 | Foundations of Physics I | Pre- or corequisite MATH 252 | 4 |
| MATH 253 | Calculus III | | 4 |
| GEOL 315 | Earth Physics | | 4 |
| General-education, multicultural, or other group-satisfying course | | | 4 |
| | Credits | | 16 |
| **Spring** | | | |
| PHYS 253 | Foundations of Physics I | Pre- or corequisite: MATH 253 | 4 |
| GEOL 311 | Earth Materials | Could substitute GEOL 331 (fall term) and GEOL 332 (winter) for GEOL 311, for more in-depth exposure to same material | 5 |
| GEOL 316 | Introduction to Hydrogeology | | 4 |
| General-education, multicultural, or other group-satisfying course | | | 4 |
| | Credits | | 17 |
| | Total Credits | | 48 |

| Course | Title | Credits Milestones | |
|---|---|---|---|
| **Third Year** | | | |
| **Fall** | | | |
| MATH 256 | Introduction to Differential Equations | | 4 |
| PHYS 351 | Foundations of Physics II | Could substitute PHYS 411 | 4 |
| General-education, multicultural, or other group-satisfying course | | | 4 |
| | Credits | | 12 |
| **Winter** | | | |
| MATH 281 | Several-Variable Calculus I | | 4 |
| PHYS 352 | Foundations of Physics II | Could substitute PHYS 412 | 4 |
| GEOL 455 | Mechanical Earth | | 4 |
| | Credits | | 12 |
| **Spring** | | | |
| MATH 282 | Several-Variable Calculus II | | 4 |
| PHYS 353 | Foundations of Physics II | Could substitute PHYS 413 | 4 |

| | | | |
|---|---|---|---|
| Geology or other science elective | | GEOL 318 recommended | 4 |
| | Credits | | 12 |
| | Total Credits | | 36 |

| Course | Title | Credits | Milestones |
|---|---|---|---|
| **Fourth Year** | | | |
| **Fall** | | | |
| General-education, multicultural, or other group-satisfying courses | | | 4 |
| Geology or other science elective | | | 8 |
| | Credits | | 12 |
| **Winter** | | | |
| General-education, multicultural, or other group-satisfying courses | | | 8 |
| Geology or other science elective | | | 4 |
| | Credits | | 12 |
| **Spring** | | | |
| General-education, multicultural, or other group-satisfying courses | | | 8 |
| Geology or other science elective | | | 4 |
| | Credits | | 12 |
| | Total Credits | | 36 |

## Bachelor of Science in Earth Sciences: Environmental Geoscience Track

| Course | Title | Credits | Milestones |
|---|---|---|---|
| **First Year** | | | |
| **Fall** | | | |
| GEOL 101 or GEOL 201 | Exploring Planet Earth or Dynamic Planet Earth | 200-level courses recommended for majors; 100-level requires a grade of mid-B or better | 4 |
| MATH 111 | College Algebra | | 4 |
| WR 121 | College Composition I | | 4 |
| CH 221 or CH 224H | General Chemistry I or Advanced General Chemistry I | | 4 |
| | Credits | | 16 |
| **Winter** | | | |
| GEOL 102 or GEOL 202 | Exploring Earth's Environment or Earth's Surface and Environment | 200-level courses recommen for majors; 100-level requires a grade of mid-B or better | 4 |
| MATH 112 | Elementary Functions | | 4 |
| CH 222 or CH 225H | General Chemistry II or Advanced General Chemistry II | | 4 |
| General-education, multicultural, or other group-satisfying course | | | 4 |
| | Credits | | 16 |
| **Spring** | | | |
| GEOL 103 or GEOL 203 | Exploring Earth History or History of Life | 200-level courses recommended for majors; 100-level requires a grade of mid-B or better | 4 |
| WR 122 or WR 123 | College Composition II or College Composition III | | 4 |
| MATH 246 or MATH 251 | Calculus for the Biological Sciences I or Calculus I | | 4 |
| General-education, multicultural, or other group-satisfying course | | | 4 |
| | Credits | | 16 |
| | Total Credits | | 48 |

| Course | Title | Credits | Milestones |
|---|---|---|---|
| **Second Year** | | | |
| **Fall** | | | |
| PHYS 201 or PHYS 251 | General Physics or Foundations of Physics I | | 4 |
| MATH 247 or MATH 252 | Calculus for the Biological Sciences II or Calculus II | | 4 |
| GEOL 331 | Mineralogy | Could substitute GEOL 311 (spring term) for GEOL 331 and 332 | 5 |

| | | | |
|---|---|---|---|
| Geology elective | | | 4 |
| | Credits | | 17 |
| **Winter** | | | |
| PHYS 202<br>or BI 211 | General Physics<br>or General Biology I: Cells | Could replace with PHYS 252 | 4 |
| GEOL 315 | Earth Physics | | 4 |
| GEOL 332 | Introduction to Petrology | Could substitute GEOL 311 (spring term) for GEOL 331 and 332 | 5 |
| General-education, multicultural, or other group-satisfying course | | | 4 |
| | Credits | | 17 |
| **Spring** | | | |
| PHYS 203<br>or PHYS 253<br>or BI 212<br>or BI 213<br>or CH 223<br>or CH 226H | General Physics<br>or Foundations of Physics I<br>or General Biology II: Organisms<br>or General Biology III: Populations<br>or General Chemistry III<br>or Advanced General Chemistry III | | 4 |
| GEOL 311 | Earth Materials | Could substitute GEOL 331 (fall term) and GEOL 332 (winter) for GEOL 311 | 5 |
| GEOL 316 | Introduction to Hydrogeology | | 4 |
| General-education, multicultural, or other group-satisfying course | | | 4 |
| | Credits | | 17 |
| | Total Credits | | 51 |

| Course | Title | Credits | Milestones |
|---|---|---|---|
| **Third Year** | | | |
| **Fall** | | | |
| GEOL 310 | Earth Resources and the Environment | 4 | |
| GEOL 318 | Introduction to Field Methods | Option: Take GEOL 318 spring term and enroll in a geology elective instead | 3 |
| General-education, multicultural, or other group-satisfying courses | | | 8 |
| | Credits | | 15 |
| **Winter** | | | |
| GEOL 353 | Geologic Hazards | | 4 |
| GEOL 451 | Hydrogeology | | 4 |
| GEOL 418<br>or MATH 253<br>or MATH 343<br>or MATH 425<br>or PHYS 481 | Earth and Environmental Data Analysis<br>or Calculus III<br>or Statistical Models and Methods<br>or Statistical Methods I<br>or Design of Experiments | GEOL 418 preferred, taken in any term this year | 4 |
| General-education, multicultural, or other group-satisfying course | | | 4 |
| | Credits | | 16 |
| **Spring** | | | |
| GEOL 334 | Sedimentology and Stratigraphy | | 4 |
| GEOG 323 | Biogeography | | 4 |
| General-education, multicultural, or other group-satisfying course | | | 4 |
| Geology elective | | GEOL 318 recommended | 4 |
| | Credits | | 16 |
| | Total Credits | | 47 |

| Course | Title | Credits | Milestones |
|---|---|---|---|
| **Fourth Year** | | | |
| **Fall** | | | |
| General-education, multicultural, or other group-satisfying courses | | 8 | |
| Geology or other science elective | | 8 | |
| | Credits | 16 | |
| **Winter** | | | |
| General-education, multicultural, or other group-satisfying courses | | 8 | |
| Geology or other science elective | | 8 | |
| | Credits | 16 | |
| **Spring** | | | |
| General-education, multicultural, or other group-satisfying courses | | 12 | |

| | | |
|---|---|---|
| Geology or other science elective | | 4 |
| | Credits | 16 |
| | Total Credits | 48 |

## Bachelor of Science in Earth Sciences: Paleontology Track

| Course | Title | Credits | Milestones |
|---|---|---|---|
| **First Year** | | | |
| **Fall** | | | |
| GEOL 101 or GEOL 201 | Exploring Planet Earth or Dynamic Planet Earth | 4 | 200-level courses recommended for majors; 100-level requires a grade of mid-B or better |
| MATH 111 | College Algebra | 4 | |
| WR 121 | College Composition I | 4 | |
| CH 221 or CH 224H | General Chemistry I or Advanced General Chemistry I | 4 | |
| | Credits | 16 | |
| **Winter** | | | |
| GEOL 102 or GEOL 202 | Exploring Earth's Environment or Earth's Surface and Environment | 4 | 200-level courses recommen for majors; 100-level requires a grade of mid-B or better |
| MATH 112 | Elementary Functions | 4 | |
| CH 222 or CH 225H | General Chemistry II or Advanced General Chemistry II | 4 | |
| General-education, multicultural, or other group-satisfying course | | 4 | |
| | Credits | 16 | |
| **Spring** | | | |
| GEOL 103 or GEOL 203 | Exploring Earth History or History of Life | 4 | 200-level courses recommended for majors; 100-level requires a grade of mid-B or better |
| WR 122 or WR 123 | College Composition II or College Composition III | 4 | |
| CH 223 or CH 226H | General Chemistry III or Advanced General Chemistry III | 4 | |
| MATH 251 | Calculus I | 4 | Could substitute MATH 246 |
| | Credits | 16 | |
| | Total Credits | 48 | |

| Course | Title | Credits | Milestones |
|---|---|---|---|
| **Second Year** | | | |
| **Fall** | | | |
| PHYS 201 or PHYS 251 | General Physics or Foundations of Physics I | 4 | |
| BI 211 | General Biology I: Cells | 4 | |
| MATH 252 | Calculus II | 4 | Could substitute MATH 247 |
| GEOL 331 | Mineralogy | 5 | Could substitute GEOL 311 (spring term) for GEOL 331 and 332 |
| | Credits | 17 | |
| **Winter** | | | |
| PHYS 202 | General Physics | 4 | Could replace with PHYS 252 |
| GEOL 315 or GEOL 316 | Earth Physics or Introduction to Hydrogeology | 4 | |
| GEOL 332 | Introduction to Petrology | 5 | Could substitute GEOL 311 (spring term) for GEOL 331 and 332 |
| General-education, multicultural, or other group-satisfying course | | 4 | |
| | Credits | 17 | |
| **Spring** | | | |
| PHYS 203 | General Physics | 4 | Could replace with PHYS 253 |

| | | |
|---|---|---|
| GEOL 318 | Introduction to Field Methods | 3 |
| General-education, multicultural, or other group-satisfying course | | 8 |
| | Credits | 15 |
| | Total Credits | 49 |

| Course | Title | Credits | Milestones |
|---|---|---|---|
| **Third Year** | | | |
| **Fall** | | | |
| Choose one from the following: | | 4 | These courses are typically offered in alternate years, so enrollment is necessary in the third or fourth year according to availability. Contact advisor or department office for scheduling of these courses. |
| GEOL 431 | | | |
| GEOL 433 | Paleobotany | | |
| GEOL 434 | Vertebrate Paleontology | | |
| GEOL 435 | Paleopedology | | |
| General-education, multicultural, or other group-satisfying courses | | 4 | |
| Geology or other science elective | | 4 | |
| | Credits | 12 | |
| **Winter** | | | |
| Choose one from the following: | | 4 | These courses are typically offered in alternate years, so enrollment is necessary in the third or fourth year according to availability. Contact advisor or department office for scheduling of these courses. |
| GEOL 431 | | | |
| GEOL 433 | Paleobotany | | |
| GEOL 434 | Vertebrate Paleontology | | |
| GEOL 435 | Paleopedology | | |
| General-education, multicultural, or other group-satisfying courses | | 4 | |
| Geology or other science course | | 4 | |
| | Credits | 12 | |
| **Spring** | | | |
| GEOL 334 | Sedimentology and Stratigraphy | 4 | |
| GEOL 350 | Structural Geology | 3 | |
| GEOL 351 | Structural Geology Problems | 1 | |
| GEOL 352 | Structural Geology Laboratory and Field | 1 | |
| General-education, multicultural, or other group-satisfying course | | 4 | |
| | Credits | 13 | |
| **Summer** | | | |
| GEOL 406 | Field Studies: [Topic] | 12 | Each section of these three courses is two weeks; could also be taken after the fourth year |
| | Credits | 12 | |
| | Total Credits | 49 | |

| Course | Title | Credits | Milestones |
|---|---|---|---|
| **Fourth Year** | | | |
| **Fall** | | | |
| General-education, multicultural, or other group-satisfying courses | | 8 | |
| Geology or other science elective | | 8 | |
| | Credits | 16 | |
| **Winter** | | | |
| General-education, multicultural, or other group-satisfying courses | | 8 | |
| Geology or other science elective | | 8 | |
| | Credits | 16 | |
| **Spring** | | | |
| General-education, multicultural, or other group-satisfying courses | | 12 | |
| Geology or other science elective | | 4 | |
| | Credits | 16 | |
| | Total Credits | 48 | |

# Graduate Studies

The Department of Earth Sciences offers programs of graduate study leading to master of science (MS), master of arts (MA), and doctor of philosophy (PhD) degrees with opportunity for research in a wide variety of specialty fields. Course work is designed to meet individual needs, and students may pursue independent research in geobiology, geochemistry, geodesy, geomechanics, geomorphology, geophysics, mineralogy, petrology, volcanology, paleontology, stratigraphy, sedimentary petrology, structural geology, and ore deposit geology. The master's degree program requires two years or more for completion.

Admission to the graduate program is competitive and based on academic records, scores on the Graduate Record Examinations (GRE), and letters of recommendation. Nonnative speakers of English must also submit scores for the Test of English as a Foreign Language (TOEFL) and the Test of Spoken English (TSE). Applications are welcome from students who are interested in using their background in related fields, such as physics, chemistry, and biology, to solve geologic or geophysical problems.

Graduate students are advised by a guidance committee consisting of three faculty members. This committee meets with each student shortly after he or she arrives on campus and as often thereafter as necessary for planning purposes.

## Requirements

Basic university requirements for graduate degrees are described in the Graduate School (http://catalog.uoregon.edu/graduate) section of this catalog. The department sets additional examination, course work, seminar, and thesis requirements. Applicants should read the *Guide to Graduate Study* on the department website (http://earthsciences.uoregon.edu/graduate-program) or write to the Department of Earth Sciences for details.

## Programs

Graduate study in earth sciences is offered in five broad areas:

1. volcanology-petrology-geochemistry
2. stratigraphy–surface processes
3. paleontology-paleopedology-geobiology
4. structural geology–geophysics
5. economic geology (mineral deposits)

### Volcanology-Petrology-Geochemistry

The department has excellent analytical and other research facilities for studies in these subdisciplines, and the volcanic and metamorphic terrane of the Northwest offers unsurpassed opportunities for field studies. Active research programs are diverse and include studies of eruption dynamics, magma volatile inventories, and magma rheology; experimental studies of igneous phase equilibria and trace element partitioning; calculations of multicomponent equilibria in aqueous systems and volcanic gases; and studies of igneous protogenesis.

### Stratigraphy–Surface Processes

The stratigraphic record of tectonically active sedimentary basins indicates the dynamic interactions among basin subsidence, sediment input from eroding sources, evolution of depositional systems, and active faulting and folding that govern these processes. Research in this area combines field-based stratigraphic, sedimentologic, and geomorphic analysis with provenance studies and concepts derived from theoretical models to decipher the complex structural and climatic controls on the filling histories of active basins.

Surface processes regulate how tectonics and climate affect landscape evolution. Field observations, numerical simulations, topographic analyses, and experimental facilities are used to study sediment transport processes over a range of spatial and temporal scales. Projects incorporate links between active tectonics and structural geology, biology, geomechanics, and surface processes to address problems such as landsliding and hill-slope evolution, biological contributions to soil creep and landscape lowering, and the geomorphic implications of seismic-induced landsliding.

### Paleontology-Paleopedology-Geobiology

Studies of fossil soils, plants, and vertebrates aim to reconstruct life on land and its role in global change. Global changes of interest include Neogene paleoclimate and paleoenvironment of ape and human evolution in East Africa, environmental effects of terminal Cretaceous impact and dinosaur extinction in Montana, consequences of mass extinction and methane clathrate degassing at the Permian-Triassic boundary, and the effect of early land plants and forests on weathering and atmospheric composition during the early Paleozoic.

Geobiology focuses on the interaction of microorganisms with the geologic environment and the ways life forms affect geological processes, such as weathering and mineralization.

### Structural Geology–Geophysics

Graduate work in the structural geology–geophysics area involves the study of the earth's dynamic processes.

Seismic imaging techniques using regional arrays provide tools for understanding regional tectonics. Studies of upper-mantle and lithospheric structure beneath the Rocky Mountains and in the Pacific Northwest subduction zone are providing essential constraints, unavailable from surface geology, for detailed dynamical models of plate-lithospheric deformation.

Structural geology focuses on applying modern field and analytical techniques to solving problems in Cenozoic tectonics and active faulting. Detailed field mapping, trench logging, and geomorphic analysis are

combined with seismic array data, land- and space-based geodetic data, and theoretical modeling to address problems including Oregon's Basin and Range province and coastal deformation, active tectonics of the San Andreas Fault system, and seismic risk along the Pacific margin of the United States and southeast and central Asia.

Geophysical experiments conducted at sea investigate the nature of sea-floor spreading including the segregation, transport, and storage of melt; the rifting of oceanic lithosphere; and the spatial and temporal connectivity between magmatic, tectonic, and hydrothermal processes.

### Mineral Deposits

Current research on ore deposits includes studies of porphyry copper deposits, epithermal veins, and active geothermal systems. These projects combine field mapping, petrography, and chemical analyses with theoretical chemical modeling of processes of ore fluid generation, alteration, and mineralization.

### Related Research Activities

The Condon Collection of Fossils at the Museum of Natural and Cultural History maintains strong ties to the Department of Earth Sciences. Two geology professors are curators of the collection, and paleontology undergraduate and graduate students are often employed as assistants. The Condon Collection contains 60,000 specimens, including invertebrate and vertebrate fossils, paleobotanical remains, and an extensive collection of modern animals that are available to interested researchers for study.

## Research Facilities

Students may use a variety of analytical facilities and equipment including a three-component broadband (0.03–50Hz) seismic array, an electron microprobe, a scanning electron microscope with image analysis, x-ray diffraction, FTIR spectroscopy, stable isotope mass spectroscopy, and a geobiology laboratory.

An experimental petrology laboratory covers a range of crustal temperatures and pressures and includes equipment for doing experiments in controlled atmospheres. Two piston-cylinder apparatus with pressure-temperature capability to 35 kilobars and 1,500° C may be used to study crystalline, partially molten, and molten silicates under mantlelike conditions.

Computers are used for much of the research in the department including acquisition and processing of seismic and gravity data and numerical modeling of geophysical processes and geochemical reactions. A geochemistry laboratory is equipped with sophisticated computer programs for thermodynamic calculations of gas-liquid-solid equilibria and reaction processes important in metamorphic, volcanic gas, hydrothermal, and diagenetic systems. The Internet can be accessed through the UONet fiber-optic link. A student computer facility, equipped with PC and Macintosh computers and laser printers, is also connected to the networks.

The sedimentological and paleontological laboratories have, in addition to standard laboratory equipment, an electronic particle-size analyzer, an x-radiography unit, photomicroscopes, a Leitz Aristophot unit, a fully maintained catalog of foraminifera, an acid room, and a conodont-processing laboratory.

## Financial Aid for Graduate Students

Most of the department's graduate students are fully supported through teaching and research assistantships. More information about financial assistance and department policies for awarding and renewing teaching and research fellowships may be obtained by reading the *Guide to Graduate Study* on the department website (http://earthsciences.uoregon.edu/graduate-program) or by writing to the department.

## Courses

**GEOL 101. Exploring Planet Earth. 4 Credits.**
Plate tectonics, mantle flow, and magmatism. Volcanoes, earthquakes, mountain building, generation of Earth's crust; rocks and minerals; Earth's internal structure. Comparison with other planets. Laboratory, lecture.

**GEOL 102. Exploring Earth's Environment. 4 Credits.**
Landforms, surface processes, and interactions between humans and the environment. Weathering, erosion, sedimentation, ground water, streams, glaciers, deserts, oceans, and coastlines; geologic hazards. Laboratory, lecture. Roering.

**GEOL 103. Exploring Earth History. 4 Credits.**
History of the Earth. Geologic time, sedimentary environments; oceans, mountains, and climate through time; stratigraphic history of North America; evolution of plants and animals. Laboratory, lecture.

**GEOL 110. People, Rocks, and Fire. 4 Credits.**
Investigation of topics in geology, ecology, and anthropology relevant to contemporary global energy debates; current energy policy issues investigated through term projects.

**GEOL 137. Mountains and Glaciers. 4 Credits.**
Survey of the geological processes that both create and destroy mountain ranges around the world, and an introduction to geological science.

**GEOL 156M. Scientific Revolutions. 4 Credits.**
Surveys several major revolutions in our views of the natural and technological world, focusing on scientific concepts and methodological aspects. For nonscience majors. Multilisted with PHYS 156M.

**GEOL 198. Laboratory Projects: [Topic]. 1-5 Credits.**
Repeatable.

**GEOL 199. Special Studies: [Topic]. 1-6 Credits.**
Repeatable. Studies of geologic topics combine background lectures with guided field trips to areas of geologic interest.

**GEOL 201. Dynamic Planet Earth. 4 Credits.**
Processes that cause earthquakes, volcanism, mountain building, and plate tectonics. Includes Earth's origin and internal structure, rocks and minerals, gravity and magnetics. Weekly lectures, two-hour laboratory. Series with GEOL 202, GEOL 203.

**GEOL 202. Earth's Surface and Environment. 4 Credits.**
Earth materials, the rock record, human interactions with surface environment. Sedimentary rocks and environments, chemical and physical weathering, mineral and energy resources, hydrogeology, ground-water contamination, surface processes, human impacts. Weekly lectures, two-hour laboratory. Series with GEOL 201, GEOL 203.

**GEOL 203. History of Life. 4 Credits.**
Origin, history, and physical evolution of the Earth; geologic time scales, development of the global stratigraphic section. Weekly lectures, two-hour laboratory. Series with GEOL 201, GEOL 202.

**GEOL 213. Geology of National Parks. 4 Credits.**
Examines selected geologic features in United States national parks and the processes that form them. Focuses on parks in the western states.

**GEOL 304. The Fossil Record. 4 Credits.**
Origin of life in Precambrian; evolution of plants and invertebrate animals; evolution of early chordates, fish, amphibians, reptiles, dinosaurs, birds, and mammals; speciation and extinction. Intended for junior and senior nonmajors but also open to geological sciences majors.

**GEOL 305. Dinosaurs. 4 Credits.**
Overview of the past and present biodiversity of vertebrate animals, including ourselves, dinosaurs, and what ruled the ocean when dinosaurs roamed the land.

**GEOL 306. Volcanoes and Earthquakes. 4 Credits.**
Mechanisms that cause earthquakes and volcanoes, relation to plate tectonics, associated hazards, examples in Oregon and the western United States.

**GEOL 307. Oceanography. 4 Credits.**
Characteristics and physical, chemical, and biological processes of the world's oceans. Includes sections on origin of the oceans, plate tectonics, and human use and misuse of oceans.

**GEOL 308. Geology of Oregon and the Pacific Northwest. 4 Credits.**
The region's geologic and tectonic history and the plate tectonic processes responsible for its evolution.

**GEOL 310. Earth Resources and the Environment. 4 Credits.**
Geology of energy, mineral, and water resources and environmental issues related to their use. Topics include fossil fuels, metals, nuclear waste disposal, and water pollution.

**GEOL 311. Earth Materials. 5 Credits.**
Chemical and mineralogical composition of rocks, sediment, and soil. Properties of common minerals; origin of rocks; microscopic study of rock textures; environmental issues.
Prereq: GEOL 101, 102 or 201, 202; coreq CH 221 or 224.

**GEOL 315. Earth Physics. 4 Credits.**
Physics of basic Earth processes; application of physics to plate tectonics and lithospheric deformation. Topics include forces, deformation, gravity, and seismology. Taught once or more per academic year.
Prereq: MATH 252, PHYS 201.

**GEOL 316. Introduction to Hydrogeology. 4 Credits.**
Examines the role of water in geologic and environmental processes. Topics include the water cycle, groundwater flow, and contaminant transport.
Pre- or coreq: MATH 252, PHYS 201.

**GEOL 318. Introduction to Field Methods. 3 Credits.**
Introduction to geologic mapping and related field skills, rock descriptions, cross sections, and structures. Lectures, laboratories, mandatory field trips.
Prereq: GEOL 101–103 or GEOL 201–203.

**GEOL 331. Mineralogy. 5 Credits.**
Crystal chemistry, systematic study of rock-forming silicate, and selected other minerals, mineral optics, and x-ray diffraction. Lab work with hand samples and petrographic microscopes.
Prereq: GEOL 201, 202 or GEOL 101, 102; coreq: CH 221 or 224.

**GEOL 332. Introduction to Petrology. 5 Credits.**
Origin and classification of igneous, metamorphic, and sedimentary rocks. Microscopic study of rocks in thin section.
Prereq: GEOL 331.

**GEOL 334. Sedimentology and Stratigraphy. 4 Credits.**
Sedimentary processes; characteristic properties of sedimentary rocks and their use in interpreting depositional environments; principles of lithostratigraphy and sequence stratigraphy.
Prereq: GEOL 101–103 or GEOL 201–203; pre- or coreq: GEOL 311 or 332.

**GEOL 350. Structural Geology. 3 Credits.**
Description, analysis, and origin of geologic structures including faults, folds, and tectonites. Focus on kinematic and dynamic analysis of deformation of earth materials.
Prereq: GEOL 318; GEOL 311 or 332.

**GEOL 351. Structural Geology Problems. 1 Credit.**
Exercises in solving structural geology problems using orthographic and stereographic projection techniques. Problems emphasize calculating stress and strain from structural markers.
Coreq: GEOL 350.

**GEOL 352. Structural Geology Laboratory and Field. 1 Credit.**
Collection and interpretation of field and map data for structural analysis. Includes field trips, map and cross-section generation, and some computer-based exercises.
Coreq: GEOL 350.

**GEOL 353. Geologic Hazards. 4 Credits.**
Examines geologic hazards, including both the physical processes that cause them and society's attempt to mitigate them.
Prereq: GEOL 101 or 201.

**GEOL 363. Computational Tools for Earth Sciences. 4 Credits.**
Introduction to computational tools vital to the work of Earth scientists, including data management and analysis, algorithms, basic programming, computational environments, and visualization.
Prereq: MATH 251.

**GEOL 399. Special Studies: [Topic]. 1-5 Credits.**
Repeatable.

**GEOL 401. Research: [Topic]. 1-21 Credits.**
Repeatable.

**GEOL 403. Thesis. 1-6 Credits.**
Repeatable thrice for maximum of 6 credits.
Prereq: earth sciences honors or senior thesis students only.

**GEOL 405. Reading and Conference: [Topic]. 1-21 Credits.**
Repeatable.

**GEOL 406. Field Studies: [Topic]. 1-6 Credits.**
Repeatable.

**GEOL 407. Seminar: [Topic]. 1-5 Credits.**
Repeatable.

**GEOL 408. Laboratory Projects: [Topic]. 1-6 Credits.**
Repeatable.

**GEOL 409. Practicum: [Topic]. 1-6 Credits.**
Repeatable once.

**GEOL 410. Experimental Course: [Topic]. 1-5 Credits.**
Repeatable.

**GEOL 414. Igneous and Metamorphic Petrology. 4 Credits.**
Advanced principles of igneous and metamorphic petrogenesis. Gibbs phase rule, phase diagrams, mineral thermodynamics; magma geochemistry and rheology; metamorphic facies, geothermometry and geobarometry. Johnston.
Prereq: GEOL 332; CH 223 or 226H.

**GEOL 415. Field Geophysics. 4 Credits.**
Introduction to geophysical methods for subsurface investigation, useful for exploration, geotechnical engineering, and characterization of subsurface groundwater and environmental conditions.
Prereq: MATH 112 or PHYS 201.

**GEOL 418. Earth and Environmental Data Analysis. 4 Credits.**
Tools-based instruction in data analysis for earth and environmental scientists. Topics include descriptive statistics, visualization, uncertainty analysis, hypothesis testing, regression, time series, and directional data.
Prereq: MATH 246 or 251.

**GEOL 420. Geocommunication. 3 Credits.**
Scientific writing and presentations for the geological sciences. Focus on writing scientific papers and proposals, preparing oral and visual presentations.

**GEOL 425. Geology of Ore Deposits. 5 Credits.**
Porphyry copper-molybdenum, epithermal, massive sulfides in volcanic rocks, and base and precious metals in sedimentary rocks. Geologic setting, alteration and ore mineral assemblages, and geochemistry of ore formation.
Prereq: CH 223; GEOL 332.

**GEOL 433. Paleobotany. 4 Credits.**
Evolution and ecology of plants and microbes from the origin of life to global warming. Laboratory exercises and field trip to collect plant fossils.
Pre- or coreq: GEOL 103 or 203.

**GEOL 434. Vertebrate Paleontology. 4 Credits.**
Evolution of vertebrates, including ourselves, based on fossil evidence. Physical and other evolutionary constraints are addressed, and lab exercises provide practical experience.
Prereq: GEOL 103 or 203.

**GEOL 435. Paleopedology. 4 Credits.**
Soil formation; mapping and naming fossil soils; features of soils in hand specimens and petrographic thin sections; interpretations of ancient environments from features of fossil soils.
Prereq: GEOL 311 or 332.

**GEOL 438. Geobiology. 4 Credits.**
Studies how microorganisms interact with geological environments at scales from enzymes to global element cycles.

**GEOL 440. Sedimentary Basin Analysis. 4 Credits.**
Evolution of sedimentary basins, emphasizing tectonic controls on basin formation and filling. Interpretation of subsidence mechanisms and sedimentary processes through analysis of the stratigraphic record.
Prereq: GEOL 334, GEOL 350.

**GEOL 441. Hillslope Geomorphology. 4 Credits.**
Hillslope processes and landforms; includes hillslope hydrology, overland flow erosion, weathering and soil formation, soil creep, landslides and related hazards, glacial and periglacial processes, effects of land-use practices and fire, and landscape evolution.

**GEOL 451. Hydrogeology. 4 Credits.**
Study of the origin, motion, and physical and chemical properties of ground water. Emphasizes quantitative analysis of flow and interaction with geologic materials.
Prereq: CH 222 or CH 225H; GEOL 316.

**GEOL 452. Neotectonics and Quaternary Geology. 4 Credits.**
Interpretation of active structures from deformed quaternary sediments and surfaces using case histories. Field project uses air photos and field techniques. Repeatable once for maximum of 8 credits.
Prereq: GEOL 334, GEOL 350.

**GEOL 453. Tectonics. 3 Credits.**
Tectonic processes and examples. Global kinematics of plates and the forces that drive them. Continental deformation in compressional, shear, and extensional settings.
Prereq: GEOL 350 and calculus.

**GEOL 454. Fluid Dynamics. 4 Credits.**
Introduction to the continuum theory of fluid dynamics, focusing on the Navier-Stokes equations of motion including common simplified limits and extensions. Applications are drawn from Earth and Planetary Science, Biology, and Physics.
Prereq: PHYS 252, MATH 252.

**GEOL 455. Mechanical Earth. 4 Credits.**
Introduction to continuum mechanics. Includes stress and strain, friction, elasticity, viscous fluids, constitutive laws, equations of motion, and deformation of the Earth.
Prereq: GEOL 315, PHYS 202, or equivalent; MATH 256.

**GEOL 462. Environmental Geomechanics. 4 Credits.**
Application of fluid and solid mechanics to understanding processes in the earth and environmental sciences. Offered alternate years.
Prereq: GEOL 455.

**GEOL 463. Computational Earth Science. 4 Credits.**
Practical techniques for scientific computing. Topics include root finding, curve fitting, interpolation, integration and differentiation, optimization, differential equations.
Prereq: MATH 253; GEOL 363 or equivalent.

**GEOL 466. Geodynamics. 4 Credits.**
Introduction to the process of the earth's physical workings. Includes rheology, bending of lithosphere, viscous flow, and heat transport.
Prereq: MATH 256 or equivalent; GEOL 455.

**GEOL 467. Fault Mechanics. 4 Credits.**
The physics of faulting throughout the earthquake cycle. Topics include fault friction, seismic rupture, earthquake triggering, and other fault zone processes. Offered alternate years.
Prereq: GEOL 315, MATH 253.

**GEOL 468. Introduction to Seismology. 4 Credits.**
Introduction to observational, theoretical, and computational seismology. Includes review of earth structure, source representation, ray theory, and seismic wave phenomena.
Prereq: MATH 256, GEOL 455.

**GEOL 471. Thermodynamic Geochemistry. 4 Credits.**
Introduction to geologic application of classical chemical thermodynamics. Gibbs free energy and its temperature, pressure, and composition derivatives; fugacity, activity, and chemical potential. Solutions, ideal and nonideal.
Prereq: GEOL 311 or 332, CH 223, MATH 253.

**GEOL 472. Aqueous-Mineral-Gas Equilibria. 4 Credits.**
Aqueous chemistry applied to natural waters (geothermal, diagenetic, continental brines). Equilibrium calculations applied to aqueous-mineral-gas systems.
Prereq: CH 223; MATH 252.

**GEOL 473. Isotope Geochemistry. 4 Credits.**
Introduction to nuclear physics and isotope systematics; techniques of isotope analysis; applications of stable and radioactive isotopes in geochronology and as tracers of geological processes.

**GEOL 503. Thesis. 1-16 Credits.**
Repeatable.

**GEOL 507. Seminar: [Topic]. 1-5 Credits.**
Repeatable.

**GEOL 508. Laboratory Projects: [Topic]. 1-6 Credits.**
Repeatable.

**GEOL 510. Experimental Course: [Topic]. 1-5 Credits.**
Repeatable.

**GEOL 514. Igneous and Metamorphic Petrology. 4 Credits.**
Advanced principles of igneous and metamorphic petrogenesis. Gibbs phase rule, phase diagrams, mineral thermodynamics; magma geochemistry and rheology; metamorphic facies, geothermometry and geobarometry. Johnston.

**GEOL 515. Field Geophysics. 4 Credits.**
Introduction to geophysical methods for subsurface investigation, useful for exploration, geotechnical engineering, and characterization of subsurface groundwater and environmental conditions.

**GEOL 518. Earth and Environmental Data Analysis. 4 Credits.**
Tools-based instruction in data analysis for earth and environmental scientists. Topics include descriptive statistics, visualization, uncertainty analysis, hypothesis testing, regression, time series, and directional data. Prereq: MATH 246 or 251.

**GEOL 520. Geocommunication. 3 Credits.**
Scientific writing and presentations for the geological sciences. Focus on writing scientific papers and proposals, preparing oral and visual presentations.

**GEOL 525. Geology of Ore Deposits. 5 Credits.**
Porphyry copper-molybdenum, epithermal, massive sulfides in volcanic rocks, and base and precious metals in sedimentary rocks. Geologic setting, alteration and ore mineral assemblages, and geochemistry of ore formation.

**GEOL 533. Paleobotany. 4 Credits.**
Evolution and ecology of plants and microbes from the origin of life to global warming. Laboratory exercises and field trip to collect plant fossils.

**GEOL 534. Vertebrate Paleontology. 4 Credits.**
Evolution of vertebrates, including ourselves, based on fossil evidence. Physical and other evolutionary constraints are addressed, and lab exercises provide practical experience.

**GEOL 535. Paleopedology. 4 Credits.**
Soil formation; mapping and naming fossil soils; features of soils in hand specimens and petrographic thin sections; interpretations of ancient environments from features of fossil soils.

**GEOL 538. Geobiology. 4 Credits.**
Studies how microorganisms interact with geological environments at scales from enzymes to global element cycles.

**GEOL 540. Sedimentary Basin Analysis. 4 Credits.**
Evolution of sedimentary basins, emphasizing tectonic controls on basin formation and filling. Interpretation of subsidence mechanisms and sedimentary processes through analysis of the stratigraphic record.

**GEOL 541. Hillslope Geomorphology. 4 Credits.**
Hillslope processes and landforms; includes hillslope hydrology, overland flow erosion, weathering and soil formation, soil creep, landslides and related hazards, glacial and periglacial processes, effects of land-use practices and fire, and landscape evolution.

**GEOL 551. Hydrogeology. 4 Credits.**
Study of the origin, motion, and physical and chemical properties of ground water. Emphasizes quantitative analysis of flow and interaction with geologic materials.

**GEOL 552. Neotectonics and Quaternary Geology. 4 Credits.**
Interpretation of active structures from deformed quaternary sediments and surfaces using case histories. Field project uses air photos and field techniques. Repeatable once for maximum of 8 credits.

**GEOL 553. Tectonics. 3 Credits.**
Tectonic processes and examples. Global kinematics of plates and the forces that drive them. Continental deformation in compressional, shear, and extensional settings.

**GEOL 554. Fluid Dynamics. 4 Credits.**
Introduction to the continuum theory of fluid dynamics, focusing on the Navier-Stokes equations of motion including common simplified limits and extensions. Applications are drawn from Earth and Planetary Science, Biology, and Physics.

**GEOL 555. Mechanical Earth. 4 Credits.**
Introduction to continuum mechanics. Includes stress and strain, friction, elasticity, viscous fluids, constitutive laws, equations of motion, and deformation of the earth.

**GEOL 562. Environmental Geomechanics. 4 Credits.**
Application of fluid and solid mechanics to understanding processes in the earth and environmental sciences. Offered alternate years.

**GEOL 563. Computational Earth Science. 4 Credits.**
Practical techniques for scientific computing. Topics include root finding, curve fitting, interpolation, integration and differentiation, optimization, differential equations.

**GEOL 566. Geodynamics. 4 Credits.**
Introduction to the process of the earth's physical workings. Includes rheology, bending of lithosphere, viscous flow, and heat transport.

**GEOL 567. Fault Mechanics. 4 Credits.**
The physics of faulting throughout the earthquake cycle. Topics include fault friction, seismic rupture, earthquake triggering, and other fault zone processes. Offered alternate years.

**GEOL 568. Introduction to Seismology. 4 Credits.**
Introduction to observational, theoretical, and computational seismology. Includes review of earth structure, source representation, ray theory, and seismic wave phenomena.

**GEOL 571. Thermodynamic Geochemistry. 4 Credits.**
Introduction to geologic application of classical chemical thermodynamics. Gibbs free energy and its temperature, pressure, and composition derivatives; fugacity, activity, and chemical potential. Solutions, ideal and nonideal.

**GEOL 572. Aqueous-Mineral-Gas Equilibria. 4 Credits.**
Aqueous chemistry applied to natural waters (geothermal, diagenetic, continental brines). Equilibrium calculations applied to aqueous-mineral-gas systems.
Prereq: CH 223; MATH 252.

**GEOL 573. Isotope Geochemistry. 4 Credits.**
Introduction to nuclear physics and isotope systematics; techniques of isotope analysis; applications of stable and radioactive isotopes in geochronology and as tracers of geological processes.

**GEOL 601. Research: [Topic]. 1-16 Credits.**
Repeatable.

**GEOL 602. Supervised College Teaching. 1-16 Credits.**
Repeatable.

**GEOL 603. Dissertation. 1-16 Credits.**
Repeatable.

**GEOL 605. Reading and Conference: [Topic]. 1-16 Credits.**
Repeatable.

**GEOL 606. Field Studies: [Topic]. 1-6 Credits.**
Repeatable. Geologic fieldwork principally in connection with graduate thesis or dissertation. Emphasis on individual problems.

**GEOL 607. Seminar: [Topic]. 1-5 Credits.**
Repeatable.

**GEOL 608. Laboratory Projects: [Topic]. 1-3 Credits.**
Repeatable.

**GEOL 609. Practicum: [Topic]. 1-3 Credits.**
Repeatable.

**GEOL 610. Experimental Course: [Topic]. 1-5 Credits.**
Repeatable.

**GEOL 620. Advanced Igneous Petrology. 3 Credits.**
Ingeous rocks of the ocean basins, continental margins, and stable continental interior including basalts, calcalkaline series, and granites. Content varies according to research interests.
Prereq: GEOL 414/514, 471/571 or equivalent.

**GEOL 692. Volcanology. 3 Credits.**
Products and processes of volcanism, origin of magmas, eruptive mechanisms, and relation of volcanism to orogeny and tectonic processes.