Earth and Environmental Sciences Department (https://www.csuchico.edu/erth/)
Science Building 258A
530-898-5262
Email: erth@csuchico.edu
Chair: Todd J. Greene

Insight
Earth and Environmental Sciences encompasses an interdisciplinary suite of studies, all engaged to better understand the Earth and the environmental problems facing us. By integrating principles of physics, chemistry, biology, and mathematics, as well as quantitative and critical thinking skills, our graduates address geological and environmental issues related to the solid earth, the biosphere, hydrosphere, and the atmosphere. We are a department focused on providing students with opportunities to conduct applied and basic research in an effort to understand physical processes on and within the Earth and human influences that affect the environment.

The department offers three undergraduate degrees and two graduate degrees at the master’s level. The BS in environmental science prepares students for careers in areas such as pollution remediation, resource conservation, or environmental management, as well as providing a firm foundation for graduate studies. Graduates with the BS in geology have gone on to careers in soil and water resources, mining, environmental protection, and as park naturalists. The geosciences BS prepares students for careers in K-12 education. Graduate students use their advanced degrees to further their careers in the geological and environmental sciences, working for both public and private agencies. In keeping with the interdisciplinary nature of the department, the faculty represent diverse academic areas, complemented by industrial experience. All have a strong commitment to excellence in teaching and engage in professional development.

Experience
Our department offers many opportunities for students outside the classroom. Our student group, the Association of Geological and Environmental Students (AGES), is open to everyone. AGES hosts several off-campus field trips each semester. Many majors are also members of national organizations such as the American Geophysical Union, Groundwater Resources of America, American Meteorological Society, and the Geological Society of America. Lecture courses are accompanied by laboratories, discussions, and field trips. Internships and work experience are also available.

Students have many opportunities to engage in research with faculty. We are very proud of the excellent research facilities we have developed over the years with support from national funding sources such as the National Science Foundation, National Oceanic and Atmospheric Administration, and NASA. Department equipment and facilities are extensive and include equipment for field and laboratory work in environmental science, geology, and hydrology/hydrogeology including cutting edge geochemical analysis, field environmental sensors, and tools for studying wind and atmospheric turbulence. In recent years, our undergraduate students have been involved in a number of research studies from the effects of local wildfires to modeling volcanic eruptions and international projects in Europe, South America, and Africa.

Outlook
Employment opportunities are excellent and growing as society accepts the challenges we face with climate change and loss of water resources. Our graduates work for agencies such as the California Department of Water Resources, the United States Geological Survey, and the Environmental Protection Agency. Graduates are also employed by private companies specializing in mineral and petroleum exploration, engineering or environmental consulting, and pollution remediation. Graduates with a bachelor’s degree find entry-level positions that involve gathering and interpreting scientific data, while management and field-oriented research positions generally require a master’s degree.

Programs
Undergraduate
Bachelor’s
- Environmental Science BS (https://catalog.csuchico.edu/colleges-departments/college-natural-sciences/earth-environmental-sciences/environmental-science-bs/)
- Geology BS (https://catalog.csuchico.edu/colleges-departments/college-natural-sciences/earth-environmental-sciences/geology-bs/)
- Geosciences BS (https://catalog.csuchico.edu/colleges-departments/college-natural-sciences/earth-environmental-sciences/geosciences-bs/)

Minors
- Geology Minor (https://catalog.csuchico.edu/colleges-departments/college-natural-sciences/earth-environmental-sciences/geology-minor/)

Credentials

Graduate
Master’s
- Environmental Science MS (https://catalog.csuchico.edu/colleges-departments/college-natural-sciences/earth-environmental-sciences/environmental-science-ms/)
- Geosciences MS (https://catalog.csuchico.edu/colleges-departments/college-natural-sciences/earth-environmental-sciences/geosciences-ms/)

See Course Description Symbols and Terms (https://catalog.csuchico.edu/academic-standards-policies/course-description-symbols-terms/) for an explanation of course description terminology and symbols, the course numbering system, and course credit units.
Course Attributes: 

Repeatability: 

Grade Basis: 

General Education: 

- Course Attributes: 
  - Repeatability: You may take this course for a maximum of 3 units 
  - Grade Basis: Graded 
  - General Education: Laboratory Activity (B3); Physical Science (B1) 
  - Typically Offered: Fall only odd years 
  - Prerequisite: GE Physical Sciences (B1) requirement. 
  - This course is an independent study of special problems. 9 hours supervision. 
  - Course Attributes: Lower Division 

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  - Repeatability: You may take this course for a maximum of 6 units 
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  - Typically Offered: Fall only odd years 
  - Prerequisite: GE Physical Sciences (B1) requirement. 
  - This course is an independent study of special problems. 9 hours supervision. 
  - Course Attributes: Lower Division
**ERTH 289 Geoscience Internship**  
1-3 Units  
Typically Offered: Fall and spring  
This course is an internship. You must register directly with a supervising faculty member. 9 hours supervision. (021015)  
Grade Basis: Graded  
Repeatability: You may take this course for a maximum of 15 units  
Course Attributes: Lower Division  

**ERTH 299 Special Problems**  
1-3 Units  
Prerequisite: Faculty permission.  
Typically Offered: Fall and spring  
This course is an independent study of special problems. 9 hours supervision. (020353)  
Grade Basis: Credit/No Credit  
Repeatability: You may take this course for a maximum of 6 units  
Course Attributes: Lower Division  

**ERTH 300W Earth System Science (W)**  
3 Units W, GW  
Prerequisite: GE Written Communication (A2) requirement; CHEM 107 or CHEM 111; PHYS 202A or PHYS 204A or PHYS 341.  
Typically Offered: Fall only  
An intermediate treatment of astronomy, meteorology, and oceanography, with emphasis on climate change and its impacts. 3 hours discussion. (004137)  
Grade Basis: Graded  
Repeatability: You may take this course for a maximum of 3 units  
Course Attributes: Upper Division; Sustainable Course; Writing Course; Graduation Writing Assessment  

**ERTH 303 Invertebrate Paleontology**  
3 Units  
Prerequisite: ERTH 102 or course in Biology.  
Typically Offered: Spring only  
Study of main groups of invertebrate fossils and their uses in biostratigraphy, paleobiogeography, and paleoecology. 3 hours laboratory, 2 hours lecture. (004138)  
Grade Basis: Graded  
Repeatability: You may take this course for a maximum of 3 units  
Course Attributes: Upper Division  

**ERTH 304 Atmospheric Science II**  
3 Units  
Prerequisite: ERTH 170.  
Typically Offered: Fall only even years  
Air masses and fronts, midlatitudes cyclones, weather and climate prediction, severe weather including thunderstorms, tornadoes, and hurricanes, climate and global climate change, and air pollution. 3 hours lecture. (022010)  
Grade Basis: Graded  
Repeatability: You may take this course for a maximum of 3 units  
Course Attributes: Upper Division  

**ERTH 306 Mineralogy and Lithology**  
4 Units  
Prerequisite: ERTH 101 or ERTH 102; CHEM 107 or CHEM 111 or equivalent; or faculty permission.  
Typically Offered: Fall only  
Identification and origins of the more common minerals and rocks. 4 hours activity, 2 hours lecture. (004080)  
Grade Basis: Graded  
Repeatability: You may take this course for a maximum of 4 units  
Course Attributes: Upper Division  

**ERTH 307 Stratigraphy**  
3 Units  
Prerequisite: ERTH 203 and ERTH 306 (both may be taken concurrently), or faculty permission.  
Typically Offered: Fall only  
Basic concepts of stratigraphy. Methods of strata description, correlation, mapping, and interpretation. Sedimentary tectonics and lithic associations. Graphic representation of data. 2 hours discussion, 3 hours laboratory. (004081)  
Grade Basis: Graded  
Repeatability: You may take this course for a maximum of 3 units  
Course Attributes: Upper Division  

**ERTH 310 Geological Field Reconnaissance**  
2 Units  
Prerequisite: ERTH 101 or ERTH 102.  
Typically Offered: Spring only  
Faculty permission required to take the course a second time for credit. Generalized field study of geologically noteworthy areas. (Minimum of eight consecutive days in the field during January intersession or spring vacation; and additional work or classroom meetings.) 6 hours supervision. (004083)  
Grade Basis: Credit/No Credit  
Repeatability: You may take this course for a maximum of 4 units  
Course Attributes: Upper Division  

**ERTH 315 Pollution Science**  
3 Units  
Prerequisite: CHEM 107 or CHEM 111; ERTH 265.  
Typically Offered: Spring only  
Principles and applications of major natural and anthropogenic pollution processes which include origins, transport, and sinks of contaminants in the environment. Topics include acid rain, mine waste and drainage, and agricultural pesticides. Environmental impacts, remediation and control of pollution are discussed. 3 hours laboratory, 2 hours lecture. (020373)  
Grade Basis: Graded  
Repeatability: You may take this course for a maximum of 3 units  
Course Attributes: Upper Division  

**ERTH 320 Water Equity and Power**  
3 Units GE  
Prerequisite: GE Oral Communication (A1); GE Written Communication (A2); GE Critical Thinking (A3); GE Mathematics/Quantitative Reasoning (B4) requirements, or consent of the instructor.  
Typically Offered: Fall and spring  
California law mandates that every human has the right to safe, clean, affordable, and accessible water; yet inequities in water policy, resource allocation (quantities of water available), and water quality are prevalent throughout the state as well as globally. This course explores how water resource management (distribution and use of surface water and groundwater) is impacted by water law and policy, which in turn have critical equity issues associated with water supply and quality. Students examine the competing needs of industrial, agricultural, and residential water users in the context of economic impacts and pressures on the environment. The implications of water rights and key water policies are considered when evaluating how water is used. 3 hours lecture. (022290)  
General Education: Upper-Division Scientific Inq/Quant Reason (UDB); Equity, Ethics, and Policy Pathway; Race, Ethnicity, and Sovereignty Pathway  
Grade Basis: Graded  
Repeatability: You may take this course for a maximum of 3 units  
Course Attributes: Upper Division; Sustainable Course
ERTH 321 Introduction to Meteorology  3 Units
Prerequisite: ERTH 170.
 Typically Offered: Fall only
Survey of physical and dynamic meteorology. Topics covered include thermodynamics, radiation, clouds and precipitation formation, tropical and extratropical weather systems, forecasting, and climate change. 3 hours lecture. (004140)
 Grade Basis: Graded
 Repeatability: You may take this course for a maximum of 3 units
 Course Attributes: Upper Division

ERTH 322 Mineral Resources  3 Units
Prerequisite: ERTH 102 or equivalent.
 Typically Offered: Fall and spring
Where do the B2 elements in our cell phones come from? Why do we see the scars of historical mining across the landscape of northern California? What is acid mine drainage and how can we prevent or treat it? These questions and more are addressed in this course, which explores the mineral resources available on Earth, and the environmental impacts associated with their extraction and use. There are positive and negative aspects to the extraction and use of each resource, and we strive to consider the economic, societal, and political aspects of these topics in addition to the environmental aspects in order to gain a more rounded perspective. 3 hours laboratory, 2 hours lecture. (022042)
 Grade Basis: Graded
 Repeatability: You may take this course for a maximum of 3 units
 Course Attributes: Upper Division

ERTH 325 Geology of California  3 Units
Prerequisite: ERTH 101 or ERTH 102.
 Typically Offered: Spring only even years
Geologic setting of California and historical development of its geologic provinces. The impact of earthquakes, volcanic activity, coastal erosion, and earth resources on California. Field trip required. 3 hours discussion. (004085)
 Grade Basis: Graded
 Repeatability: You may take this course for a maximum of 3 units
 Course Attributes: Upper Division

ERTH 330 Environmental Science  3 Units GE
Prerequisite: GE Oral Communication (A1); GE Written Communication (A2); GE Critical Thinking (A3); GE Physical Sciences (B1); GE Life Sciences (B2); GE Mathematics/Quantitative Reasoning (B4) requirements, or consent of the instructor.
 Typically Offered: Spring, summer, fall
Human impact on life-support systems; use of physical and ecological principles in environmental management and protection; discussion of land use and its environmental impact; and an evaluation of human influence on natural cycles. 3 hours lecture. (004141)
 General Education: Upper-Division Scientific Inq/Quant Reason (UDB); Sustainability and Climate Change Pathway
 Grade Basis: Graded
 Repeatability: You may take this course for a maximum of 3 units
 Course Attributes: Upper Division; Sustainable Course

ERTH 330W Environmental Science (W)  3 Units GE, W
Prerequisite: GE Oral Communication (A1); GE Written Communication (A2); GE Critical Thinking (A3); GE Physical Sciences (B1); GE Life Sciences (B2); GE Mathematics/Quantitative Reasoning (B4) requirements, or consent of the instructor.
 Typically Offered: Fall and spring
Human impact on life-support systems; use of physical and ecological principles in environmental management and protection; discussion of land use and its environmental impact; and an evaluation of human influence on natural cycles. 3 hours lecture. (021331)
 General Education: Upper-Division Scientific Inq/Quant Reason (UDB); Sustainability and Climate Change Pathway
 Grade Basis: Graded
 Repeatability: You may take this course for a maximum of 3 units
 Course Attributes: Upper Division; Sustainable Course; Writing Course

ERTH 340 Sustainability of Marine Environments: The Fate between People and the Sea  3 Units GE
Prerequisite: GE Oral Communication (A1); GE Written Communication (A2); GE Critical Thinking (A3); GE Mathematics/Quantitative Reasoning (B4) requirements, or consent of the instructor.
 Typically Offered: Fall and spring
In this course, students learn what is necessary to become good stewards of the ocean ecosystem. Discussions of stewardship focus on the importance of sustainable ocean management and explore how competing interests among countries impact international plans to use and manage ocean resources. In addition to this top-down approach of ocean management, this course also examines the role of individual responsibility for preservation of the ocean environment, as well as justice issues for marginalized communities who rely on the ocean. During these discussions, students also learn how the physio-chemical properties of seawater (i.e., temperature, density, salinity, sounds, light) are linked and provide the foundation for marine life, motion (i.e., currents, tides, waves, transportation), energy, and climate. 3 hours lecture. (022295)
 General Education: Upper-Division Scientific Inq/Quant Reason (UDB); Sustainability and Climate Change Pathway
 Grade Basis: Graded
 Repeatability: You may take this course for a maximum of 3 units
 Course Attributes: Upper Division; Sustainable Course

ERTH 341 Teaching Practicum in Geological and Environmental Sciences  3 Units
Prerequisite: ERTH 102 or SCED 342.
 Typically Offered: Inquire at department
This course provides students with classroom experience that utilizes a variety of interactive, engaging teaching styles that develop and reinforce skills and concepts through open-ended activities such as direct instruction, discourse, demonstrations, individual and cooperative learning explorations, peer instruction, and student-centered discussion. 9 hours supervision. (020329)
 Grade Basis: Graded
 Repeatability: You may take this course for a maximum of 3 units
 Course Attributes: Upper Division
ERTH 342 Concepts in Earth and Space Science 3 Units
Prerequisite: SCED 141, SCED 142, GE Physical Sciences (B1), or GE Life Sciences (B2). Open to Liberal Studies online students only.
Typically Offered: Fall and spring
This course is for future elementary/middle school teachers and designed to meet the Elementary Subject Matter Standards required by the California Commission on Teacher Credentialing. The overall goal is to provide a learning environment that fosters content knowledge and interest in teaching earth and space science and appreciation for the role that science plays in our everyday lives. 3 hours lecture. (022004)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Upper Division

ERTH 352 Recovery of Altered Ecosystems 3 Units
Prerequisite: BIOL 350W (may be taken concurrently), ERTH 265 and ERTH 315 (may be taken concurrently).
Typically Offered: Spring only
This course provides students with an understanding of the role of stresses and disturbances in aquatic and terrestrial ecosystems and natural processes of recovery. Students are introduced to the practices used to modify, restore, and remediate ecosystems altered by human activities and develop a restoration program for a nearby, altered ecosystem that contains both land and water components. In addition, we discuss policy and regulations as they relate to specific projects. 3 hours laboratory, 2 hours lecture. (021925)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Upper Division

ERTH 353 Environmental Fluid Mechanics 3 Units
Prerequisite: MATH 109 or MATH 120; PHYS 202A or PHYS 204A.
Typically Offered: Fall only odd years
Fluids (gases and liquids) are ubiquitous and play central roles in shaping the environment and transporting heat, momentum, pollutants, and constituents that support life and control climate. This course provides students with an introduction to fundamental concepts in fluid mechanics and an illumination of the vital and fascinating, and often non-intuitive, world of fluid phenomena. 3 hours lecture. (022002)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Upper Division

ERTH 355 Natural Disasters 3 Units GE
Prerequisite: GE Oral Communication (A1); GE Written Communication (A2); GE Critical Thinking (A3); GE Physical Sciences (B1); GE Life Sciences (B2); GE Mathematics/Quantitative Reasoning (B4) requirements, or consent of the instructor.
Typically Offered: Fall and spring
The purpose of this course is to provide students with the material and opportunity to learn the science behind geological and natural disasters and gain an appreciation of how these events shape both our lives and the development of societies with specific reference to California. The course focuses on, but not be limited to, a discussion of how much of a disaster is a natural phenomenon and how much a tragedy is imposed by the designs of populations. Along the way, we develop the methodology of science and build writing and quantitative skills. 3 hours lecture. (004148)
General Education: Upper-Division Scientific Inquiry/Quantitative Reasoning (UDB); California Studies Pathway; Sustainability and Climate Change Pathway
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Upper Division; Sustainable Course

ERTH 360 Field Methods 2 Units
Prerequisite: ERTH 306, ERTH 307 with a grade of C- or higher.
Typically Offered: Spring only
Elementary geologic field methods, descriptive geometry, photogeology, and geologic mapping. Ten days in the field during January intersession. 6 hours laboratory. (004074)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 2 units
Course Attributes: Upper Division

ERTH 361W Preparation of the Geological Report (W) 1 Unit W, GW
Prerequisite: GE Written Communication (A2) requirement.
Corequisites: ERTH 360.
Typically Offered: Spring only
This course is a continuation of the writing experience that is initiated in ERTH 360. It deconstructs scientific writing through a re-writing of the ERTH 360 field report and analysis of other examples of geologic articles. 1 hour lecture. (004075)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 1 unit
Course Attributes: Upper Division; Writing Course; Graduation Writing Assessment

ERTH 370W Energy in the Human Environment (W) 3 Units W, GW
Prerequisite: GE Written Communication (A2) requirement; ERTH 170 (may be taken concurrently) or ERTH 306; and PHYS 202A or PHYS 204A (may be taken concurrently).
Typically Offered: Fall only
Analysis of present and long-term global energy crises; coverage of scientific concepts needed to understand energy and its environmental interactions; in-depth examination of alternative energy sources and their environmental impact. 3 hours lecture. (004149)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Upper Division; Sustainable Course; Writing Course; Graduation Writing Assessment

ERTH 375 Geology of Food and Health 3 Units GE
Prerequisite: GE Oral Communication (A1); GE Written Communication (A2); GE Critical Thinking (A3); GE Mathematics/Quantitative Reasoning (B4) requirements, or consent of the instructor.
Typically Offered: Fall and spring
Focuses on the relation between natural geological factors, food production, and health problems in humans and animals on a global scale, and explores the impacts of diverse proposed solutions on population health and public policy. 3 hours lecture. (021128)
General Education: Upper-Division Scientific Inquiry/Quantitative Reasoning (UDB); Agriculture, Food, and Environment Pathway
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Upper Division; Sustainable Course

ERTH 380 Hydrology 3 Units
Prerequisite: PHYS 202A or PHYS 204A (may be taken concurrently).
Typically Offered: Fall only
A survey of the mass transfer processes and storage elements within the hydrologic cycle: precipitation, interception, surface runoff, infiltration, evapo-transpiration, soil water and groundwater. Quantitative methods for estimating flow and storage, use of probability concepts to predict extreme hydrologic events in a time series. 3 hours laboratory, 2 hours lecture. (004150)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Upper Division; Sustainable Course
<table>
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<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
<th>Prerequisite</th>
<th>Typically Offered</th>
<th>Grade Basis</th>
<th>Repeatability</th>
<th>Course Attributes</th>
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</thead>
<tbody>
<tr>
<td>ERTH 380</td>
<td>Hydrologic Field Methods</td>
<td>3</td>
<td>ERTH 380 (may be taken concurrently) or faculty permission.</td>
<td>Spring only</td>
<td>Graded</td>
<td>You may take this course for a maximum of 3 units</td>
<td>Upper Division</td>
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<td>Provides analysis of groundwater flow, including fluid physics, aquifer properties, soil water, groundwater recharge, hydrogeologic environments, aquifer mechanics, and water quality degradation. 3 hours lecture.</td>
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<td>ERTH 398</td>
<td>Special Topics</td>
<td>1-4</td>
<td>High school or college trigonometry; ERTH 306 with grade of C- or higher.</td>
<td>Fall and spring</td>
<td>Graded</td>
<td>You may take this course more than once</td>
<td>Upper Division</td>
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<td>Develops field and related laboratory skills in performing common measurements in surface water and soil water components of the hydrologic cycle. Students learn to critically evaluate the theoretical basis for field methods and hydrologic characterization approaches. 3 hours lecture.</td>
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<td>ERTH 399</td>
<td>Special Problems</td>
<td>1-3</td>
<td>Department permission.</td>
<td>Fall and spring</td>
<td>Credit/No Credit</td>
<td>You may take this course for a maximum of 6 units</td>
<td>Upper Division</td>
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<td>Provides a survey of the processes governing uplift and denudation of landscapes, including isostasy, chemical and physical weathering, mass movements, surface water erosion, formation of channels, and flow and sediment transport. 3 hours laboratory, 2 hours lecture.</td>
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<td>ERTH 403</td>
<td>Igneous and Metamorphic Petrology</td>
<td>4</td>
<td>ERTH 306 with grade of C- or higher.</td>
<td>Spring only</td>
<td>Graded</td>
<td>You may take this course for a maximum of 4 units</td>
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<td>Physical-chemical development and geotectonic settings of igneous and metamorphic rocks. Analysis of rock thin sections. Field trip required. 4 hours activity, 2 hours lecture.</td>
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<td>ERTH 408</td>
<td>Structural Geology</td>
<td>4</td>
<td>High school or college trigonometry; ERTH 203; ERTH 307 with grade of C- or higher.</td>
<td>Fall only</td>
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<td>Behavior of geologic materials. Folds, faults, small-scale structures in sedimentary, igneous, and metamorphic rocks. Graphic methods. 4 hours activity, 2 hours lecture.</td>
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<tr>
<td>ERTH 410</td>
<td>Introduction to Watershed Hydrology</td>
<td>3</td>
<td>ERTH 380 or prior hydrology course work and consent of instructor.</td>
<td>Spring only</td>
<td>Graded</td>
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<td>Upper Division; Sustainable Course</td>
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<td>A survey of the hydrologic processes governing the movement and storage of water at the watershed scale. Emphasis is on computer-based methods for characterizing the physical framework and quantifying the resultant hydrology in terms of its temporal and spatial variability. 3 hours laboratory, 2 hours lecture.</td>
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<td>ERTH 415</td>
<td>Hydrogeology</td>
<td>3</td>
<td>CHEM 111, ERTH 306, MATH 120; PHYS 202A or PHYS 204A. Recommended: ERTH 307.</td>
<td>Spring only</td>
<td>Graded</td>
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<td>Upper Division; Sustainable Course</td>
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<td>Theory and analysis of groundwater flow, including fluid physics, aquifer properties, soil water, groundwater recharge, hydrogeologic environments, aquifer mechanics, and water quality degradation. 3 hours laboratory, 2 hours lecture.</td>
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<td>ERTH 420</td>
<td>Earth Systems Modeling</td>
<td>3</td>
<td>BIOL 350W; CHEM 107 or CHEM 111; ERTH 102, ERTH 170, ERTH 265; PHYS 202A, PHYS 204A, or PHYS 341.</td>
<td>Spring only</td>
<td>Graded</td>
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<td>Upper Division; Sustainable Course</td>
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<td>This course will seek to understand fundamental earth system processes and interactions on a global scale. Particular emphasis is placed on climate change and its impacts. 3 hours lecture.</td>
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<tr>
<td>ERTH 425</td>
<td>Surficial Processes</td>
<td>3</td>
<td>ERTH 101 or ERTH 102; MATH 120; PHYS 202A or PHYS 204A.</td>
<td>Fall only odd years</td>
<td>Graded</td>
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<td>Upper Division; Sustainable Course</td>
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<td>A survey of the processes governing uplift and denudation of landscapes, including isostasy, chemical and physical weathering, mass movements, surface water erosion, formation of channels, and flow and sediment transport. 3 hours laboratory, 2 hours lecture.</td>
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</tbody>
</table>
ERTH 430  Wetland Ecology and Management  3 Units
Prerequisite: Upper division standing in BS Environmental Science, BA Biological Sciences, BS Biological Sciences, BS Microbiology, BA Geography, or BS Agriculture. Highly recommended: BIOL 161 and/or BIOL 350W.
Typically Offered: Fall only even years
This course examines the ecology, management, and restoration of wetland ecosystems, including biotic and abiotic processes, functions, wildlife and policy discussions. We place emphasis on biological, physical, chemical, and ecological aspects of major wetland ecosystems found in North America. We also discuss ecosystem services, wetland classification/delineation, legal protection of wetlands, and the relationship between wetlands and climate change. 3 hours laboratory, 2 hours lecture. (022003)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Upper Division

ERTH 435  Boundary Layer Meteorology  3 Units
Prerequisite: MATH 109 or MATH 120; PHYS 202A or PHYS 204A.
Typically Offered: Spring only
The atmospheric boundary layer (ABL) is the lowest part of the Earth’s atmosphere that is in constant contact with the surface of the Earth and responds quickly to the thermal and mechanical forcings. The ABL has a very strong role in the vertical fluxes of heat, momentum, and trace gases. Turbulence is the main physical process by which those fluxes occur and hence statistical descriptions are the norm. Therefore, this course focuses on small scale meteorology (also know as micrometeorology), turbulence, and the behavior of the atmosphere near the surface. 3 hours lecture. (022043)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Upper Division

ERTH 436  Volcanology  3 Units
Prerequisite: ERTH 101 or ERTH 102, ERTH 306, or faculty permission.
Typically Offered: Spring only odd years
An introduction to physical processes associated with terrestrial and extraterrestrial volcanoes and their products. Specific topics include volcano monitoring, rheologic properties of magma and volcanic flows, experimental volcanology, theoretical and analog flow modeling, as well as in-depth examination of local volcanoes and various eruptions (past, present, and future). This course includes an extended (4-5 days) field trip, required for all students. Students participate in the field by collecting data for future course projects, presenting prepared information at various field trip stops, or both. Students also complete research projects throughout the semester. 3 hours lecture. (020293)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Upper Division

ERTH 440  Environmental Sensing  3 Units
Prerequisite: PHYS 202B, PHYS 204B, or PHYS 204C (may be taken concurrently).
Typically Offered: Fall only
Instruments are critical to making quantitative observations, and observations are critical to the scientific method. The subject of environmental instrumentation is vast and constantly changing as new technologies emerge. Through a combination of lectures and hands-on projects, students are (1) introduced to the process of assembling and characterizing an electronic instrument of their own, (2) forming a hypothesis and testing it by collecting data, and (3) writing reports and giving presentations on their results. 3 hours laboratory, 2 hours lecture. (020639)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Upper Division

ERTH 455  Sedimentary Basin Analysis  3 Units
Prerequisite: ERTH 307, ERTH 403 (may be taken concurrently) both with a grade of C- or higher.
Typically Offered: Spring only even years
Study of the paleographic evolution of sedimentary basins. Includes stratigraphic and paleontologic correlation, facies analysis, sedimentary petrology, depositional systems, and the tectonic framework of sedimentary basins. 3 hours laboratory, 2 hours lecture. (004114)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Upper Division

ERTH 460  Water Resources Management  3 Units
Prerequisite: ERTH 380 (may be taken concurrently).
Typically Offered: Spring only even years
Water-resources, management plans of world; emphasis on California and Israeli plans. Water plans in primitive, agrarian, and industrial societies. Data gathering and interpretation, regulation of water resources, and control of water pollution. 3 hours lecture. (004168)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Upper Division; Sustainable Course

ERTH 470  Renewable Energy  3 Units
Prerequisite: ERTH 370W.
Typically Offered: Fall only odd years
Teach students about the wide range of renewable energy technologies that are available, how they harvest energy from the environment, how they impact the environment, and their varying degrees of competitiveness with fossil fuels. Major forms of renewable energy covered include solar thermal, solar photovoltaics, bioenergy, hydroelectricity, tidal power, wind energy, wave energy, and geothermal energy. Students also gain experience reading, researching, and presenting findings. 3 hours lecture. (021766)
Grade Basis: Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Upper Division
**ERTH 471 Field Geology**  
2 Units  
Prerequisite: ERTH 360, ERTH 403, ERTH 408 all with grade of C- or higher.  
Typically Offered: Spring only  
Mapping, recording, and interpreting data in the field; use of Brunton compass and topographic maps emphasized. Reports required. Field work during January Intersession totaling at least 10 days. 6 hours laboratory. (004105)  
Grade Basis: Graded  
Repeatability: You may take this course for a maximum of 2 units  
Course Attributes: Upper Division

**ERTH 475 Senior Seminar**  
3 Units  
Prerequisite: Senior standing in Environmental Science.  
Typically Offered: Spring only  
This seminar provides a culminating experience for students to draw on their accumulated content knowledge and skills to address one or more environmental problems. Select problems addressed by students working in interdisciplinary teams. Project plans and timelines described in individually-prepared proposals. Relevant policies and regulations indentified, and this guidance informs student projects. Existing comparative data employed and analyzed to develop project plans and reports. Computer skills employed, possibly including spreadsheets, statistical software, and GIS. 3 hours discussion. (004169)  
Grade Basis: Graded  
Repeatability: You may take this course for a maximum of 3 units  
Course Attributes: Upper Division

**ERTH 480 Seminar in Earth and Environmental Sciences**  
1 Unit  
Prerequisite: Earth and Environmental Sciences (ERTH) majors only.  
Typically Offered: Fall and spring  
The seminar series engages students in recent research and developments in the Earth and Environmental Sciences, and develops skills in scientific literature retrieval. 1 hour seminar. (021562)  
Grade Basis: Credit/No Credit  
Repeatability: You may take this course for a maximum of 8 units  
Course Attributes: Upper Division; Sustainable Course

**ERTH 489 Geoscience Internship**  
1-3 Units  
Typically Offered: Fall and spring  
This course is an internship. You must register directly with a supervising faculty member. 9 hours supervision. (021016)  
Grade Basis: Graded  
Repeatability: You may take this course for a maximum of 15 units  
Course Attributes: Upper Division

**ERTH 498 Special Topics**  
1-3 Units  
Prerequisite: Department permission.  
Typically Offered: Fall and spring  
This course is for special topics. Typically the topic is offered on a one-time-only basis and may vary from term to term and be different for different sections. See the Class Schedule for the specific topic being offered. 3 hours discussion. (004172)  
Grade Basis: Graded  
Repeatability: You may take this course for a maximum of 8 units  
Course Attributes: Upper Division

**ERTH 499 Special Problems**  
1-3 Units  
Prerequisite: Faculty permission.  
Typically Offered: Fall and spring  
This course is an independent study of special problems. You must register directly with a supervising faculty member. 3 hours supervision. (004175)  
Grade Basis: Credit/No Credit  
Repeatability: You may take this course for a maximum of 6 units  
Course Attributes: Upper Division

**ERTH 499H Honors Research in the Geosciences**  
3 Units  
Prerequisite: First semester: 9 upper-division units in major, B average, faculty permission. Second semester: B or higher in first semester, faculty permission.  
Typically Offered: Fall and spring  
An intensive two-semester course in research within a subdiscipline of the physical sciences. Students enroll for 3 units each semester. Open only to students with at least a 3.0 GPA in the major. The course consists of a research project done under the supervision of a faculty member, a formal written paper, and a public presentation. This course may be used to fulfill a maximum of 3 units of the upper-division requirement for the major. 9 hours supervision. (004176)  
Grade Basis: Graded  
Repeatability: You may take this course for a maximum of 6 units  
Course Attributes: Upper Division

**ERTH 536 Applied Ecology**  
3 Units  
Prerequisite: BIOL 350W, MATH 315.  
Typically Offered: Spring only  
Examination of the mechanisms, directions, and magnitude of an organism’s or ecosystem’s response to human perturbation. 3 hours discussion. (004166)  
Grade Basis: Graded  
Course Attributes: Upper Division; Sustainable Course

**ERTH 537 Ecohydrology**  
3 Units  
Prerequisite: BIOL 350W, ERTH 380, or instructor consent.  
Typically Offered: Spring only odd years  
The study of linkages between hydrologic processes and ecosystem functions; field methods for data gathering; hydrologic transport of nutrients and pollutants through ecosystems; case studies of problems in ecohydrology. 3 hours lecture. (020330)  
Grade Basis: Graded  
Repeatability: You may take this course for a maximum of 3 units  
Course Attributes: Upper Division; Sustainable Course
<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Units</th>
<th>Prerequisite(s)</th>
<th>Typically Offered</th>
<th>Corequisites</th>
</tr>
</thead>
<tbody>
<tr>
<td>ERTH 565</td>
<td>Geochemistry</td>
<td>3</td>
<td>CHEM 111, ERTH 102. Recommended: ERTH 306</td>
<td>Fall only even years</td>
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<tr>
<td>ERTH 572W</td>
<td>Advanced Field Geology (W)</td>
<td>3, W, GW</td>
<td>GE Written Communication (A2) requirement; ERTH 403 with a grade of C- or higher.</td>
<td>Spring only</td>
<td>Group study of topics related to the geological evolution of North America. Student presentations and group discussion will focus on common themes or geologic regions. 3 hours lecture.  (004170)</td>
</tr>
<tr>
<td>ERTH 580</td>
<td>Geological Evolution of North America</td>
<td>3</td>
<td>ERTH 408, ERTH 455 (with grade of C- or higher for both).</td>
<td>Spring only</td>
<td>Group study of topics related to the geological evolution of North America.  3 hours lecture.  (004170)</td>
</tr>
<tr>
<td>ERTH 598</td>
<td>Special Topics</td>
<td>1-4</td>
<td>Department permission.</td>
<td>Fall and spring</td>
<td>Group study of topics related to the geological evolution of North America.  3 hours lecture.  (020063)</td>
</tr>
<tr>
<td>ERTH 599</td>
<td>Special Problems</td>
<td>1-3</td>
<td>Faculty permission.</td>
<td>Fall and spring</td>
<td>This course is an independent study of special problems. You must register directly with a supervising faculty member.  3 hours supervision.  (021283)</td>
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<tr>
<td>ERTH 600</td>
<td>Graduate Seminar I</td>
<td>1</td>
<td>ERTH 600, ERTH 601.</td>
<td>Fall only</td>
<td>This course is the first of a series of writing courses specifically for students in the M.S. Geosciences or Environmental Science programs.</td>
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<tr>
<td>ERTH 601</td>
<td>Graduate Seminar II</td>
<td>1</td>
<td>ERTH 600, ERTH 601.</td>
<td>Spring only</td>
<td>This course is the second of a series of writing courses specifically for students in the M.S. Geosciences or Environmental Science programs.</td>
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<tr>
<td>ERTH 602</td>
<td>Graduate Seminar III</td>
<td>1</td>
<td>ERTH 600, ERTH 601.</td>
<td>Fall only</td>
<td>This course is the third of a series of writing courses specifically for students in the M.S. Geosciences or Environmental Science programs.</td>
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<tr>
<td>ERTH 606</td>
<td>Teaching Assistant Preparation</td>
<td>2</td>
<td>Graduate status.</td>
<td>Fall only</td>
<td>This is a seminar course for teaching assistants focusing on the theory and practice of active learning in science laboratory settings. The overall goals of the course; 1) To increase participants understanding of strategies to engage students in active learning, 2) to provide opportunities for modeling best practices in science teaching and 3) confidence in his/her ability as effective science lab instructors.  2 hours seminar.  (021000)</td>
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<tr>
<td>ERTH 616</td>
<td>Natural Water Systems</td>
<td>3</td>
<td>CHEM 111, ERTH 315. Recommended: CHEM 112.</td>
<td>Fall only odd years</td>
<td>Fundamentals of processes in environmental aquatic systems emphasizing acid-base and pE-pH relationships, solubility of carbon species in natural waters, and interactions at the solid-liquid interface.  3 hours lecture.  (020287)</td>
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**Course Attributes:**

- **Grade Basis:** Graded
- **Repeatability:** You may take this course for a maximum of 3 units
- **Course Attributes:** Upper Division; Writing Course; Graduation Writing Assessment

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**Course Attributes:**

- **Grade Basis:** Graded
- **Repeatability:** You may take this course for a maximum of 3 units
- **Course Attributes:** Upper Division

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**Course Attributes:**

- **Grade Basis:** Graded
- **Repeatability:** You may take this course for a maximum of 3 units
- **Course Attributes:** Upper Division

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**Course Attributes:**

- **Grade Basis:** Graded
- **Repeatability:** You may take this course for a maximum of 3 units
- **Course Attributes:** Upper Division
ERTH 617 Advanced Topics in Geology 3 Units
Typically Offered: Fall and spring
You must register directly with a supervising faculty member.
Discussions and library research into selected topics; may include some lab work. Different topics presented each semester. May be repeated for credit, with permission of instructor. 9 hours supervision. (004180)
Grade Basis: Graduate Graded
Repeatability: You may take this course for a maximum of 9 units
Course Attributes: Graduate Division

ERTH 619 Advanced Topics in Atmospheric Science 3 Units
Typically Offered: Fall and spring
You must register directly with a supervising faculty member.
Discussions and library research into selected topics; may include some lab work. Different topics presented each semester. May be repeated for credit, with permission of instructor. 9 hours supervision. (004181)
Grade Basis: Graduate Graded
Repeatability: You may take this course for a maximum of 9 units
Course Attributes: Graduate Division

ERTH 621 Advanced Topics in Hydrology 3 Units
Typically Offered: Fall and spring
You must register directly with a supervising faculty member.
Discussions and library research into selected topics; may include some lab work. Different topics presented each semester. May be repeated for credit, with permission of instructor. 9 hours supervision. (004182)
Grade Basis: Graduate Graded
Repeatability: You may take this course for a maximum of 9 units
Course Attributes: Graduate Division

ERTH 625 Advanced Topics in Environmental Science 3 Units
Typically Offered: Fall and spring
You must register directly with a supervising faculty member.
Discussions and library research into selected topics; may include some lab work. Different topics presented each semester. May be repeated for credit, with permission of instructor. 9 hours supervision. (004184)
Grade Basis: Graduate Graded
Repeatability: You may take this course for a maximum of 9 units
Course Attributes: Graduate Division

ERTH 630 Geotectonic Development of California 3 Units
Prerequisite: Graduate standing or consent of instructor.
Typically Offered: Spring only
Geological and geophysical characteristics of the geomorphic provinces of California. Formation of surficial features, such as mountain ranges, drainage networks, and valleys as a response to active tectonic processes. Detailed geologic and physiographic framework of Northern California as a setting for field-based studies in the geosciences. 3 hours lecture. (004185)
Grade Basis: Graduate Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Graduate Division

ERTH 640 Hydrogeochemistry 3 Units
Prerequisite: CHEM 111, CHEM 112. Recommended: ERTH 565 or ERTH 616.
Typically Offered: Spring only
Origins and sources of chemical constituents of natural waters, including water-rock interactions, equilibrium aqueous speciation, reaction-path modeling, oxidation-reduction reactions, mineral solubility relations, geochemical transport, reaction kinetics, and aqueous isotopic systems. 3 hours seminar. (004186)
Grade Basis: Graduate Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Graduate Division

ERTH 645 Applied Geophysics 3 Units
Prerequisite: One year of physics, ERTH 102, or faculty permission.
Typically Offered: Fall only odd years
Introduction to solid-earth geophysical exploration techniques and data analysis. Includes electrical, electromagnetic, gravimetric, and seismic surveying, and wireline well logging. Concentration on problems in environmental science, hydrology, mineral prospecting, and oil exploration. Students apply these techniques to solve real-world problems. 3 hours discussion. (004112)
Grade Basis: Graduate Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Graduate Division

ERTH 649 Economic Geology 3 Units
Prerequisite: ERTH 306, ERTH 307, or faculty permission.
Typically Offered: Fall only odd years
The integrative course dealing with origins and occurrences of metallic and non-metallic mineral deposits, including factors in their use. 3 hours discussion. (004111)
Grade Basis: Graduate Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Graduate Division

ERTH 650 Environmental Monitoring 2 Units
Typically Offered: Fall only
Survey of environmental monitoring for air quality, water quality, pollution, waste disposal, environmental resources, etc., including field and laboratory observations and exercises. An individual term project in environmental monitoring is required and may involve collection of field data, interpretation of field data, development of analytical capabilities, or other subjects pertinent to the student's research interests. 1 hour discussion, 3 hours laboratory. (004187)
Grade Basis: Graduate Graded
Repeatability: You may take this course for a maximum of 2 units
Course Attributes: Graduate Division; Sustainable Course

ERTH 652 Science and Environmental Regulations 3 Units
Prerequisite: CHEM 270 or CHEM 320, MATH 120, PHYS 202B. Recommended: BIOL 350W or BIOL 360.
Typically Offered: Fall only
Examination of the scientific basis of environmental regulations, case studies. 3 hours lecture. (020466)
Grade Basis: Graduate Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Graduate Division
ERTH 654 Environmental Risk Assessment 3 Units
Prerequisite: CHEM 270 or CHEM 320, MATH 120, PHYS 202B. Recommended: BIOL 350W or BIOL 360.
Typically Offered: Spring only
The scientific basis of risk assessment in various sectors of human activity, with particular emphasis on business, industrial, governmental agency, and planning concerns. 3 hours lecture. (020467)
Grade Basis: Graduate Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Graduate Division

ERTH 655 Fossil Fuels 3 Units
Prerequisite: ERTH 307 or faculty permission.
Typically Offered: Fall only even years
Geological principles and environmental impacts of exploring for and exploiting resources of petroleum, natural gas, oil shales, oil sands, coal, and coalbed-methane. Applications using geological data, potential sites for CO2 sequestration and environmental impact assessments are emphasized. This course involves the application of theory to new ideas, problems, and materials. 3 hours lecture. (020574)
Grade Basis: Graduate Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Graduate Division

ERTH 656 Environmental Sciences Capstone 3 Units
Prerequisite: Completion of three semesters of coursework in either the Environmental Sciences MS program or the proposed PSM option of the Environmental Sciences MS program.
Typically Offered: Spring only
Overview of environmental science issues, including biological, chemical, and engineering examples. Particular focus is on future issues and approaches. Social and ethical issues are also examined. 9 hours supervision. (020465)
Grade Basis: Graduate Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Graduate Division

ERTH 660 Numerical Analysis 3 Units
Prerequisite: MATH 120.
Typically Offered: Fall only
Survey and implementation of common numerical techniques in use in geoscientific data analysis, including multivariate data analysis, geostatistics, finite difference and finite element analyses, time-series analysis, and fractal geometry. 3 hours lecture. (004188)
Grade Basis: Graduate Graded
Repeatability: You may take this course for a maximum of 3 units
Course Attributes: Graduate Division

Earth and Environmental Sciences Department
The Faculty Emeritus Faculty