

# EARTH AND ENVIRONMENTAL SCIENCES

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Earth and Environmental Sciences Department (<https://www.csuchico.edu/erth/>)  
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## 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 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 which 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

- Science Single Subject Matter Preparation Program (<https://catalog.csuchico.edu/colleges-departments/college-natural-sciences/earth-environmental-sciences/science-single-subject-matter-preparation-program/>)

## 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 \(https://catalog.csuchico.edu/academic-standards-policies/course-description-symbols-terms/\)](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.

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- ERTH 101 Our Changing Planet** 🌱 3 Units GE  
**Typically Offered:** Fall and spring  
 Earth materials, processes, and history, and their significance to humans in California and societies around the world. No college credit for students who have passed EARTH 102. 2 hours activity, 2 hours lecture. (004067)  
**General Education:** Laboratory Activity (B3); Physical Science (B1)  
**Grade Basis:** Graded  
**Repeatability:** You may take this course for a maximum of 3 units  
**Course Attributes:** Lower Division; Sustainable Course
- ERTH 102 Physical Geology** 🌱 3 Units GE  
**Prerequisite:** High school chemistry or physics is recommended; students with no previous science courses are advised to enroll in EARTH 101. No college credit for those who have passed EARTH 101.  
**Typically Offered:** Fall and spring  
 Physical and chemical processes in the earth, including origin and identification of rocks and minerals; earth's interior; movements and major features of the earth's crust; erosion and sedimentation; geological structures; topographic maps; mineral resources. 3 hours laboratory, 2 hours lecture. (004069)  
**General Education:** Laboratory Activity (B3); Physical Science (B1)  
**Grade Basis:** Graded  
**Repeatability:** You may take this course for a maximum of 3 units  
**Course Attributes:** Lower Division; Sustainable Course
- ERTH 104 Inquiry into the Science of Climate Change** 3 Units GE  
**Typically Offered:** Fall and spring  
 An experiential course that develops skills in critical thinking through inquiry into and analysis of arguments about climate change science (e.g. greenhouse effect, fossil fuels, evidence for human-caused global warming, predictions of our climate future, climate change solutions, etc.). 3 hours lecture. (021130)  
**General Education:** Critical Thinking (A3)  
**Grade Basis:** Graded  
**Repeatability:** You may take this course for a maximum of 3 units  
**Course Attributes:** Lower Division
- ERTH 110 Oceanography** 3 Units GE  
**Typically Offered:** Fall and spring  
 Introduction to the ocean environment with a special emphasis on exploring the interactions between the geological, physical, chemical and biological processes. Topics include how ocean basins developed and changed over geological time scales and how the properties of seawater are linked and provide the foundation for marine life, motion, and climate. 2 hours activity, 2 hours lecture. (021716)  
**General Education:** Laboratory Activity (B3); Physical Science (B1)  
**Grade Basis:** Graded  
**Repeatability:** You may take this course for a maximum of 3 units  
**Course Attributes:** Lower Division
- ERTH 130 Introduction to Environmental Science** 🌱 3 Units GE  
**Typically Offered:** Fall and spring  
 An introduction to human impact upon planet Earth. Scientific principles applied to air pollution, water pollution, and solid and radioactive waste problems. Population dynamics, world hunger, and environmental issue analysis are also covered. 2 hours activity, 2 hours lecture. (004131)  
**General Education:** Laboratory Activity (B3); Physical Science (B1)  
**Grade Basis:** Graded  
**Repeatability:** You may take this course for a maximum of 3 units  
**Course Attributes:** Lower Division; Sustainable Course
- ERTH 165 Principles of Environmental Science** 🌱 2 Units  
**Typically Offered:** Fall only  
 An introduction to environmental science as an integrative field of study and its parent disciplines. Field and laboratory techniques are introduced through examination of case studies. Students learn about the various professions engaged in environmental and resource management. 3 hours laboratory, 1 hour lecture. (020687)  
**Grade Basis:** Graded  
**Repeatability:** You may take this course for a maximum of 2 units  
**Course Attributes:** Lower Division; Sustainable Course
- ERTH 170 Atmospheric Science** 3 Units  
**Typically Offered:** Spring only  
 Composition and mean vertical structure of the atmosphere, energy and warming and cooling of the atmosphere and the surface, atmospheric water vapor, cloud types, static stability, the formation of clouds, precipitation, air pressure, and wind. 3 hours lecture. (004130)  
**Grade Basis:** Graded  
**Repeatability:** You may take this course for a maximum of 3 units  
**Course Attributes:** Lower Division
- ERTH 198 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. (004136)  
**Grade Basis:** Graded  
**Repeatability:** You may take this course more than once  
**Course Attributes:** Lower Division
- ERTH 199 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. (020352)  
**Grade Basis:** Credit/No Credit  
**Repeatability:** You may take this course for a maximum of 6 units  
**Course Attributes:** Lower Division
- ERTH 203 Principles of Historical Geology** 3 Units  
**Prerequisite:** EARTH 101 or EARTH 102.  
**Typically Offered:** Fall only odd years  
 Principles of historical geology as they relate to rock sequences and geologic maps. 3 hours laboratory, 2 hours lecture. (004070)  
**Grade Basis:** Graded  
**Repeatability:** You may take this course for a maximum of 3 units  
**Course Attributes:** Lower Division
- ERTH 265 Soils and Surficial Processes** 🌱 3 Units  
**Prerequisite:** CHEM 111 (may be taken concurrently); EARTH 101, EARTH 102, EARTH 165 or SCED 343 (may be taken concurrently).  
**Typically Offered:** Fall only  
 In-depth survey of the hydrologic cycle, and soil systems. Interactions between these systems are examined through case studies. 3 hours laboratory, 2 hours lecture. (020723)  
**Grade Basis:** Graded  
**Repeatability:** You may take this course for a maximum of 3 units  
**Course Attributes:** Lower Division; Sustainable Course

- 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:** EARTH 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:** EARTH 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:** EARTH 101 or EARTH 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:** EARTH 203 and EARTH 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:** EARTH 101 or EARTH 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; EARTH 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:** EARTH 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:** EARTH 102 or equivalent.  
**Typically Offered:** Fall and spring  
 Where do the 82 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:** EARTH 101 or EARTH 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:** EARTH 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 Inq/Quant Reason (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 Inq/Quant Reason (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

**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

- ERTH 382 Hydrologic Field Methods** **3 Units**  
**Prerequisite:** ERTH 380 (may be taken concurrently) or faculty permission.  
**Typically Offered:** Spring only  
 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. (020641)  
**Grade Basis:** Graded  
**Repeatability:** You may take this course for a maximum of 3 units  
**Course Attributes:** Upper Division
- ERTH 398 Special Topics** **1-4 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. (004092)  
**Grade Basis:** Graded  
**Repeatability:** You may take this course more than once  
**Course Attributes:** Upper Division
- ERTH 399 Special Problems** **1-3 Units**  
**Prerequisite:** Faculty permission.  
**Typically Offered:** Fall and spring  
 This course is an independent study of special problems. 3 hours supervision. (004154)  
**Grade Basis:** Credit/No Credit  
**Repeatability:** You may take this course for a maximum of 6 units  
**Course Attributes:** Upper Division
- ERTH 403 Igneous and Metamorphic Petrology** **4 Units**  
**Prerequisite:** ERTH 306 with grade of C- or higher.  
**Typically Offered:** Spring only  
 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. (004097)  
**Grade Basis:** Graded  
**Repeatability:** You may take this course for a maximum of 4 units  
**Course Attributes:** Upper Division
- ERTH 408 Structural Geology** **4 Units**  
**Prerequisite:** High school or college trigonometry; ERTH 203; ERTH 307 with grade of C- or higher.  
**Typically Offered:** Fall only  
 Behavior of geologic materials. Folds, faults, small-scale structures in sedimentary, igneous, and metamorphic rocks. Graphic methods. 4 hours activity, 2 hours lecture. (004082)  
**Grade Basis:** Graded  
**Repeatability:** You may take this course for a maximum of 4 units  
**Course Attributes:** Upper Division
- ERTH 410 Introduction to Watershed Hydrology** **3 Units**  
**Prerequisite:** ERTH 380 or prior hydrology course work and consent of instructor.  
**Typically Offered:** Spring only  
 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. (004161)  
**Grade Basis:** Graded  
**Repeatability:** You may take this course for a maximum of 3 units  
**Course Attributes:** Upper Division; Sustainable Course
- ERTH 415 Hydrogeology** **3 Units**  
**Prerequisite:** CHEM 111, ERTH 306, ERTH 380, MATH 120; PHYS 202A or PHYS 204A. Recommended: ERTH 307.  
**Typically Offered:** Spring only  
 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. (004102)  
**Grade Basis:** Graded  
**Repeatability:** You may take this course for a maximum of 3 units  
**Course Attributes:** Upper Division; Sustainable Course
- ERTH 420 Earth Systems Modeling** **3 Units**  
**Prerequisite:** BIOL 350W; CHEM 107 or CHEM 111; ERTH 102, ERTH 170, ERTH 265; PHYS 202A, PHYS 204A, or PHYS 341.  
**Typically Offered:** Spring only  
 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. (021924)  
**Grade Basis:** Graded  
**Repeatability:** You may take this course for a maximum of 3 units  
**Course Attributes:** Upper Division
- ERTH 425 Surficial Processes** **3 Units**  
**Prerequisite:** ERTH 101 or ERTH 102; MATH 120; PHYS 202A or PHYS 204A.  
**Typically Offered:** Fall only odd years  
 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. (004152)  
**Grade Basis:** Graded  
**Repeatability:** You may take this course for a maximum of 3 units  
**Course Attributes:** Upper Division; Sustainable Course

**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 known 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:** EARTH 101 or EARTH 102, EARTH 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:** EARTH 307, EARTH 403 (may be taken concurrently) both with a grade of C- or higher.

**Typically Offered:** Spring only even years

Study of the paleogeographic 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:** EARTH 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:** EARTH 370.

**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:** EARTH 360, EARTH 403, EARTH 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 identified, 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 the Geological and Environmental Sciences** **1 Unit**  
**Prerequisite:** Geological and Environmental Sciences (GEOS) majors only.  
**Typically Offered:** Fall and spring  
 The seminar series engages students in recent research and developments in the Geological 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 489T Internship in Geoscience Teaching** **3 Units**  
**Prerequisite:** EARTH 101 or EARTH 102, EARTH 203.  
**Typically Offered:** Fall and spring  
 This is a supervised internship in geoscience teaching which takes place in a local junior high or high school geoscience classroom, supervised by the classroom teacher and by a faculty member of the CSUC Department of Earth and Environmental Sciences. 9 hours supervision. (020620)  
**Grade Basis:** Credit/No Credit  
**Repeatability:** You may take this course for a maximum of 3 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 more than once  
**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  
**Repeatability:** You may take this course for a maximum of 3 units  
**Course Attributes:** Upper Division; Sustainable Course
- ERTH 537 Ecohydrology** **3 Units**  
**Prerequisite:** BIOL 350W, EARTH 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



<p><b>ERTH 565 Geochemistry</b> <span style="float: right;"><b>3 Units</b></span>  <b>Prerequisite:</b> CHEM 111, EARTH 102. Recommended: EARTH 306.  <b>Typically Offered:</b> Fall only even years  Investigation of the chemistry of minerals, rocks, and natural waters. Provides students with interests in geology, hydrology, environmental science, and other disciplines a background on the chemical compositions of rocks, minerals, and natural waters; chemical processes in the formation of rocks and waters; principles of reaction chemistry, thermodynamics, and kinetics applied to geochemical systems; and migration of chemical contaminants in the environment. 3 hours lecture. (004115)  <b>Grade Basis:</b> Graded  <b>Repeatability:</b> You may take this course for a maximum of 3 units  <b>Course Attributes:</b> Upper Division</p>	<p><b>ERTH 600 Graduate Seminar I</b> <span style="float: right;"><b>1 Unit</b></span>  <b>Typically Offered:</b> Fall only  This course is the first of a series of writing courses specifically for students in the M.S. Geosciences or Environmental Science programs. The goal of the course is to introduce students to the M.S. program, and aid them in putting together the preliminary literature review for their thesis research. This course introduces the principles of excellent academic writing for scientists while also utilizing peer support to improve communication. 1 hour seminar. (004177)  <b>Grade Basis:</b> Graduate Graded  <b>Repeatability:</b> You may take this course for a maximum of 1 unit  <b>Course Attributes:</b> Graduate Division</p>
<p><b>ERTH 572W Advanced Field Geology (W)</b> <span style="float: right;"><b>3 Units W, GW</b></span>  <b>Prerequisite:</b> GE Written Communication (A2) requirement; EARTH 403 with a grade of C- or higher.  <b>Corequisites:</b> EARTH 471 (winter field - grade of C- or higher).  <b>Typically Offered:</b> Spring only  Independent geologic mapping of a difficult area. Report required. Field work on weekends or during spring recess, totaling at least 10 days. 6 hours laboratory. (004107)  <b>Grade Basis:</b> Graded  <b>Repeatability:</b> You may take this course for a maximum of 3 units  <b>Course Attributes:</b> Upper Division; Writing Course; Graduation Writing Assessment</p>	<p><b>ERTH 601 Graduate Seminar II</b> <span style="float: right;"><b>1 Unit</b></span>  <b>Typically Offered:</b> Spring only  This course is the second of a series of writing courses specifically for students in the M.S. Geosciences or Environmental Science programs. The goal of the course is to support students through writing their research proposal. Emphasis placed on students completing an approved written thesis proposal, and giving a public oral presentation of their proposal by the end of the course. 1 hour seminar. (004178)  <b>Grade Basis:</b> Graduate Graded  <b>Repeatability:</b> You may take this course for a maximum of 1 unit  <b>Course Attributes:</b> Graduate Division</p>
<p><b>ERTH 580 Geological Evolution of North America</b> <span style="float: right;"><b>3 Units</b></span>  <b>Prerequisite:</b> EARTH 408, EARTH 455 (with grade of C- or higher for both).  <b>Typically Offered:</b> Spring only  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)  <b>Grade Basis:</b> Graded  <b>Repeatability:</b> You may take this course for a maximum of 3 units  <b>Course Attributes:</b> Upper Division</p>	<p><b>ERTH 602 Graduate Seminar III</b> <span style="float: right;"><b>1 Unit</b></span>  <b>Prerequisite:</b> EARTH 600, EARTH 601.  <b>Typically Offered:</b> Fall only  This course is the third of a series of writing courses specifically for students in the M.S. Geosciences or Environmental Science programs. The goal of the course is to build on the previous courses while focusing on the thesis or project itself. This course provides a forum for intensive analysis of the principles of excellent academic writing for scientists while also utilizing peer support to improve communication. 1 hour seminar. (022020)  <b>Grade Basis:</b> Graduate Graded  <b>Repeatability:</b> You may take this course for a maximum of 1 unit  <b>Course Attributes:</b> Graduate Division</p>
<p><b>ERTH 598 Special Topics</b> <span style="float: right;"><b>1-4 Units</b></span>  <b>Prerequisite:</b> Department permission.  <b>Typically Offered:</b> 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. (020063)  <b>Grade Basis:</b> Graded  <b>Repeatability:</b> You may take this course more than once  <b>Course Attributes:</b> Upper Division</p>	<p><b>ERTH 606 Teaching Assistant Preparation</b> <span style="float: right;"><b>2 Units</b></span>  <b>Prerequisite:</b> Graduate status.  <b>Typically Offered:</b> Fall only  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)  <b>Grade Basis:</b> Graduate Graded  <b>Repeatability:</b> You may take this course for a maximum of 2 units  <b>Course Attributes:</b> Graduate Division</p>
<p><b>ERTH 599 Special Problems</b> <span style="float: right;"><b>1-3 Units</b></span>  <b>Prerequisite:</b> Faculty permission.  <b>Typically Offered:</b> Fall and spring  This course is an independent study of special problems. You must register directly with a supervising faculty member. 3 hours supervision. (021283)  <b>Grade Basis:</b> Credit/No Credit  <b>Repeatability:</b> You may take this course for a maximum of 6 units  <b>Course Attributes:</b> Upper Division</p>	<p><b>ERTH 616 Natural Water Systems</b> <span style="float: right;"><b>3 Units</b></span>  <b>Prerequisite:</b> CHEM 111, EARTH 315. Recommended: CHEM 112.  <b>Typically Offered:</b> Fall only odd years  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. Students in this course interpret these processes in light of new ideas, problems, and materials. 3 hours lecture. (020287)  <b>Grade Basis:</b> Graduate Graded  <b>Repeatability:</b> You may take this course for a maximum of 3 units  <b>Course Attributes:</b> Graduate Division; Sustainable Course</p>

- 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 or field 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 516 or ERTH 565.  
**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:** Spring only even 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:** EARTH 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 CO<sub>2</sub> 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**ERTH 670 Environmental and Engineering Geology****3 Units**

**Prerequisite:** EARTH 102, EARTH 203, EARTH 306. For majors in related sciences and technical fields, EARTH 102 only.

**Typically Offered:** Fall only odd years

Practical application of techniques to solve geological engineering and environmental problems. Techniques of surface investigations and remote sensing; borehole and surface geophysics; soil descriptions and properties; landslide mapping, mechanics and remediation, subsurface investigation of rock masses; mapping of discontinuities, establishing rock quality, tunneling techniques. Seismic studies; surface and trench mapping of faults, seismic risk analysis. Ground water monitoring, site assessment, techniques of hazardous waste cleanup, state and federal regulations on hazardous waste, siting of landfills. Students in this course apply these theories to new ideas. 3 hours lecture. (004116)

**Grade Basis:** Graduate Graded**Repeatability:** You may take this course for a maximum of 3 units**Course Attributes:** Graduate Division; Sustainable Course**ERTH 697 Independent Study****1-4 Units****Typically Offered:** Fall and spring

This course is a graduate-level independent study. You must register directly with a supervising faculty member. 9 hours supervision. (004189)

**Grade Basis:** Graduate Graded**Repeatability:** You may take this course for a maximum of 40 units**Course Attributes:** Graduate Division**ERTH 699P Master's Project****1-6 Units****Prerequisite:** Instructor permission.**Typically Offered:** Fall and spring

This course is a master's project. You must register directly with a supervising faculty member. 9 hours supervision. (020469)

**Grade Basis:** Report in Progress: CR/NC**Repeatability:** You may take this course for a maximum of 6 units**Course Attributes:** Graduate Division**ERTH 699T Master's Thesis****1-6 Units****Typically Offered:** Fall and spring

This course is a master's thesis. You must register directly with a supervising faculty member. 3 hours supervision. (004194)

**Grade Basis:** Report in Progress: CR/NC**Repeatability:** You may take this course for a maximum of 6 units**Course Attributes:** Graduate Division

## Earth and Environmental Sciences Department

The Faculty

Emeritus Faculty