

# GEOLOGY (GEOL)

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**Any experimental courses offered by GEOL can be found at:**  
[registrar.iastate.edu/faculty-staff/courses/explisting/](http://registrar.iastate.edu/faculty-staff/courses/explisting/) (<http://www.registrar.iastate.edu/faculty-staff/courses/explisting/>)

**Courses primarily for undergraduates:**

## **GEOL 100: How the Earth Works**

(3-0) Cr. 3. F.S.SS.

How does the earth work, what is it made of, and how does it change through time? Plate tectonics, Earth materials, landforms, structures, climate, and natural resources. Emphasis on the observations and hypotheses used to interpret earth system processes. Students may also enroll in Geol 100L.

## **GEOL 100L: How the Earth Works: Laboratory**

(0-2) Cr. 1. F.S.

*Prereq: Credit or enrollment in GEOL 100*

Students will gain understanding of how Earth processes affect their lives and how they affect the Earth, and of the complex nature of the Earth and its processes. They will gain a deep knowledge of the methods used to understand the time scales and rates of Earth processes also through an applied research experience on groundwater and surface water.

## **GEOL 101: Environmental Geology: Earth in Crisis**

(Cross-listed with ENV S). (3-0) Cr. 3. F.S.SS.

An introduction to geologic processes and the consequences of human activity from local to global scales. Discussion of human population growth, resource depletion, pollution and waste disposal, global warming and ozone depletion, desertification, and geologic hazards such as earthquakes, landslides, flooding, and volcanism. Summer - online only.

## **GEOL 102: History of the Earth**

(3-0) Cr. 3. S.

*Prereq: GEOL 100 or GEOL 201*

The Earth's physical and biological evolution; concepts of global tectonics. Methods used to decipher earth history. Students majoring in geology must also enroll in Geol 102L.

## **GEOL 102L: History of the Earth: Laboratory**

(0-2) Cr. 1. S.

*Prereq: Credit or enrollment in GEOL 102*

Introduction to the use of sedimentary rocks and fossils in reconstructing the Earth's history.

## **GEOL 103: Age of Dinosaurs**

Cr. 1. F.

Introduction to the diversity of dinosaur species. Discussion of basic evolutionary theory and interpretation of fossil evidence. Overview of Mesozoic Earth history including paleogeographic and paleoclimate reconstructions. Course available via the World Wide Web.

## **GEOL 105: Gems and Gemstones**

(2-0) Cr. 1. F.

Offered in second half of the semester. Introduction to gems and gemstones, physical and optical properties of gems and gemstones, explanation of where gems come from and how they are found, how to distinguish between synthetic and naturally occurring gems, how the value of gems are determined, and the history of famous gems.

## **GEOL 106: Earth and Space Science for Elementary Education Majors**

(Cross-listed with ASTRO). (2-0) Cr. 2. F.S.

*Prereq: Major in elementary or early childhood education.*

Fundamental concepts of Earth and Space Science, including the solar system, weather and climate, water and soils, plate tectonics, and geologic hazards. Online course format.

## **GEOL 106L: Earth and Space Science for Elementary Education Majors: Laboratory**

(Cross-listed with ASTRO). (0-2) Cr. 1. F.S.

*Prereq: Restricted to elementary and early childhood education majors; to be taken concurrently with GEOL 106/ASTRO 106*

Inquiry-based lab exploring fundamental concepts of Earth and Space Science, including the solar system, weather and climate, water and soils, plate tectonics, and geologic hazards. Must be taken concurrently with GEOL/ASTRO 106.

## **GEOL 108: Introduction to Oceanography**

(Cross-listed with ENV S). (3-0) Cr. 3. F.

Introduction to study of the oceans. Ocean exploration. Waves and currents. Shape, structure, and origin of the ocean basins. Sedimentary record of oceanic life. Composition of seawater and its significance for life. Ocean circulation and its influence on climate. Life of the oceans, including coral reefs. Use and misuse of ocean resources. Anthropogenic impacts on the oceanic environment.

## **GEOL 111: Geological Disasters**

(Cross-listed with ENV S). (1-0) Cr. 1. F.S.SS.

Introduction to the catastrophic geologic processes that disrupt ecosystems and human activity. Includes a discussion on the role of plate tectonics, the hydrologic cycle, and humans as the driving forces behind selected case studies on volcanic eruptions, earthquakes, tsunamis, landslides, and floods. Summer and fall - online only.

**GEOL 112: Geoscience Orientation**

(Cross-listed with MTEOR). (1-0) Cr. 1. F.

Orientation course for students enrolled in the Earth, Wind and Fire Learning Community. Provides an introduction to Iowa State University and meteorology, geology, and Earth science programs for students enrolled in the department's learning community. Activities include academic and social activities, talks and presentations on academic success, resume writing, and study abroad, as well as research talks by faculty members.

**GEOL 113: Spring Geoscience Orientation for Earth, Wind and Fire Learning Community**

(Cross-listed with MTEOR). (1-0) Cr. 1. S.

Spring orientation course for students enrolled in the "Earth, Wind and Fire" Learning Community. Develop and apply quantitative, data-analysis, management, and communication skills on an authentic research project in a team to focus on professionalism and resilience. Introduction to interview strategies and the importance of creating a professional image on social media. Academic and social events, plus two field trips.

**GEOL 160: Water Resources of the World**

(Cross-listed with AGRON, ENV S, MTEOR). (3-0) Cr. 3. S.

Study of the occurrence, history, development, and management of world water resources. Basic hydrologic principles including climate, surface water, groundwater, and water quality. Historical and current perspectives on water policy, use, and the role of water in society and the environment. Meets International Perspectives Requirement.

**GEOL 201: Geology for Engineers and Environmental Scientists**

(2-2) Cr. 3. F.

Introduction to Earth materials and processes with emphasis on engineering and environmental applications.

**GEOL 290: Independent Study**

Cr. 1-3. Repeatable.

*Prereq: Permission of instructor*

Independent study for freshman and sophomore students.

**GEOL 298: Cooperative Education**

Cr. R. F.S.SS.

*Prereq: GEOL 100 or GEOL 201, GEOL 100L, GEOL 102, GEOL 102L, and permission of the department cooperative education coordinator; sophomore classification*

Required of all cooperative education students. Students must register for this course prior to commencing the work period.

**GEOL 302: Summer Field Studies**

Cr. 6. SS.

*Prereq: GEOL 102, GEOL 356, GEOL 368*

Geologic mapping, structural, stratigraphic, sedimentologic, metamorphic, geomorphic, and environmental analyses. Study areas in the Bighorn Basin and Wind River Range and excursions to Yellowstone and Grand Teton National Parks. A 6-week summer field course required of all geology majors.

**GEOL 315: Mineralogy and Earth Materials**

(3-0) Cr. 3. F.

*Prereq: GEOL 100 or GEOL 201, CHEM 177*

Introduction to mineral classification, elementary crystal chemistry, crystal growth and morphology, mineral stability, and mineral associations.

**GEOL 315L: Laboratory in Mineralogy and Earth Materials**

(0-3) Cr. 1. F.

*Prereq: GEOL 100 or GEOL 201*

Mineral identification methods, especially hand-specimen identification.

**GEOL 316: Optical Mineralogy**

(1-2) Cr. 1. F.

*Prereq: GEOL 100 or GEOL 201, CHEM 177, credit or enrollment in GEOL 315*

Laboratory problems in mineral-identification methods utilizing optical microscopic techniques.

**GEOL 324: Energy and the Environment**

(Cross-listed with ENSCI, ENV S, MTEOR). (3-0) Cr. 3. S.

*Prereq: CHEM 163 or CHEM 177, MATH 140*

Exploration of the origin of Earth's energy resources and the environmental and climatic impacts of energy acquisition and consumption. Renewable and non-renewable energy resources within an Earth-system context. Various environmentally-relevant topics such as water quality and availability, habitat destruction, greenhouse-gas emissions, and health and safety hazards to wildlife and human communities.

**GEOL 356: Structural Geology and Tectonics**

(3-3) Cr. 4. S.

*Prereq: GEOL 100 or GEOL 201; PHYS 111*

Principles of stress, strain, and rheology. Brittle and ductile behavior of rocks. Mechanics of formation, description, and classification of fractures, faults, folds, foliation, and lineation. From micro-structures to tectonic processes. Laboratory includes application of learned concepts to real-world scenarios, geometrical techniques to solve structural problems.

**GEOL 357: Geological Mapping and Field Methods**

Cr. 1. S.

*Prereq: GEOL 100 or GEOL 201; PHYS 111; credit or enrollment in GEOL 356*

Generation and interpretation of geological maps via a combination of laboratory and field exercises. Developing skills in 3D thinking, cross-section construction, stereonet analysis, field data collection, and communicating scientific results.

**GEOL 365: Igneous and Metamorphic Petrology**

(2-3) Cr. 3. S.

*Prereq: GEOL 315, GEOL 315L, GEOL 316*

Nature and origin of igneous and metamorphic rocks. Emphasis on important rock-forming environments and processes and their influence on rock characteristics. Laboratory includes thin section study of rock textures and mineralogy and the interpretation of these features.

**GEOL 368: Sedimentary Geology**

(3-3) Cr. 4. F.

*Prereq: GEOL 102*

Exploration of the interplay between weathering, sedimentation, sea-level change, tectonics, and life through time that creates sedimentary rocks and stratigraphic packages. Understanding of the historical development of sedimentary geology through the development of petrography, paleontology, deep earth sampling, geophysical technologies, and geochemistry. Field and laboratory problem sets illuminate lecture material.

**GEOL 398: Cooperative Education**

Cr. R. F.S.SS.

*Prereq: GEOL 100 or GEOL 201, GEOL 100L, GEOL 102, GEOL 102L, and permission of the department cooperative education coordinator; junior classification*

Required of all cooperative education students. Students must register for this course prior to commencing each work period.

**GEOL 402: Watershed Hydrology**

(Dual-listed with GEOL 502). (Cross-listed with ENSCI, MTEOR, NREM).

(2-3) Cr. 3. F.

*Prereq: Four courses in physical or biological sciences or engineering; junior standing*

Examination of watersheds as systems, emphasizing the surface components of the hydrologic cycle. Combines qualitative understanding of hydrological processes and uncertainty with quantitative representation. Laboratory emphasizes field investigation and measurement of watershed processes.

**GEOL 406: Geology Field Course**

Cr. 1-2. Repeatable, maximum of 2 times. F.S.

*Prereq: GEOL 100 or GEOL 201*

Weekly seminar introduces students to a selected geological region or theme that is visited on a required ten-day field excursion. Introduction to field-safety leadership.

**GEOL 409: Field Methods in Hydrogeology**

(Dual-listed with GEOL 509). (Cross-listed with ENSCI). (0-4) Cr. 3. Alt. SS., offered even-numbered years.

*Prereq: GEOL/ENSCI 402 or GEOL/ENSCI 411 or C E 473*

Introduction to field methods used in groundwater investigations. In-field implementation of pumping tests, slug tests, monitoring well installation and drilling techniques, geochemical and water quality sampling, seepage meters, minipiezometers, stream gaging, and electronic instrumentation for data collection. Field trips to investigate water resource, water quality, and remediation projects.

**GEOL 411: Hydrogeology**

(Dual-listed with GEOL 511). (Cross-listed with ENSCI). (3-2) Cr. 4. F.

*Prereq: Four courses in biological or physical sciences*

Physical principles of groundwater flow, nature and origin of aquifers and confining units, well hydraulics, groundwater modeling, and contaminant transport. Lab emphasizes applied field and laboratory methods for hydrogeological investigations.

**GEOL 412: Micropaleontology**

(Dual-listed with GEOL 512). (Cross-listed with ENSCI). Cr. 3. Alt. F., offered even-numbered years.

*Prereq: GEOL 102 and GEOL 102L*

Evolution, identification and utility of major microfossil groups from the Mesozoic to present. Focus on Cenozoic applications including biostratigraphy, paleoclimate, and paleothermometry using assemblages, stable isotopes, Mg/Ca, and molecular fossils. Laboratory includes processing and analysis of specific microfossils. Major groups covered include foraminifera, calcareous nannofossils, sponge spicules, diatoms, radiolarians, and silicoflagellates.

**GEOL 413: Applied and Environmental Geophysics**

(Dual-listed with GEOL 513). (Cross-listed with C E, ENSCI). (2-2) Cr. 3. Alt. S., offered odd-numbered years.

*Prereq: GEOL 100 or GEOL 201, algebra and trigonometry*

Seismic, gravity, magnetic, resistivity, electromagnetic, and ground-penetrating radar techniques for shallow subsurface investigations and imaging. Data interpretation methods. Lab emphasizes computer interpretation packages. Field work with seismic - and resistivity-imaging systems and radar.

**GEOL 414: Applied Groundwater Flow Modeling**

(Dual-listed with GEOL 514). (Cross-listed with ENSCI). (2-2) Cr. 3. Alt. S., offered even-numbered years.

*Prereq: GEOL 411 or C E 473; MATH 165 or MATH 181*

Introduction to the principles of modeling groundwater flow systems. Finite-difference and analytic-element methods, spreadsheet models, boundary conditions, calibration, sensitivity analysis, parameter estimation, particle tracking, and post-audit analysis. Application of MODFLOW to regional flow-system analysis. Computer laboratory emphasizes assigned problems that illustrate topics discussed in the course.

**GEOL 415: Paleoclimatology**

(Dual-listed with GEOL 515). (Cross-listed with ENSCI). (3-0) Cr. 3. Alt. S., offered odd-numbered years.

*Prereq: Four courses in biological or physical science*

Introduction to mechanisms that drive climate, including the interplay between oceanic and atmospheric circulation and fluctuation in Earth's orbital parameters. Examination and analysis of past climate records ranging from historical documentation to ecological and geochemical proxies (e.g. tree ring analysis; O and C isotopes of skeletal carbonates and soils). Dating methods used to constrain and correlate climatic periods; utility of computer models to reconstruct past climates and predict future climate change. Emphasis placed on paleoclimatology and paleoecology of the late Quaternary (last ~1 million years).

**GEOL 416: Hydrologic Modeling and Analysis**

(Dual-listed with GEOL 516). (Cross-listed with ENSCI, MTEOR). (2-3) Cr. 3. Alt. S., offered odd-numbered years.

*Prereq: Four courses in Earth science, meteorology, or engineering; junior standing*

Study of the basic principles of hydrologic modeling, including rainfall-runoff analysis, lumped and distributed modeling, conceptual and physical models, parameter estimation and sensitivity analysis, input and validation data, uncertainty analysis, and the use of models in surface water hydrology. A range of common models are applied to study hydrologic topics such as flood forecasting and land use change impacts. Previous experience with Matlab or other programming language is needed.

**GEOL 419: Aqueous and Environmental Geochemistry**

(Dual-listed with GEOL 519). (Cross-listed with ENSCI). (2-2) Cr. 3. S.

*Prereq: CHEM 178, CHEM 178L; junior classification*

Geochemistry of natural waters and water-rock interactions. Acid-base equilibria, carbonate chemistry and buffer systems, mineral dissolution and precipitation, sorption, ion exchange, and redox reactions. Introduction to thermodynamics and kinetics. Laboratory emphasizes chemical analysis of waters and computer modeling.

**GEOL 420: Mineral Resources**

(Dual-listed with GEOL 520). (2-3) Cr. 3. Alt. F., offered even-numbered years.

*Prereq: GEOL 365*

Geology and geochemistry of non-metallic and metallic ore deposits. Major processes that concentrate metals in the Earth. Geochemical conditions of ore formation using stable-isotope and fluid-inclusion studies. Laboratory emphasizes the study of metallic ores.

**GEOL 426: Stable Isotopes in the Environment**

(Dual-listed with GEOL 526). (Cross-listed with ENSCI). (3-0) Cr. 3. Alt. S., offered even-numbered years.

*Prereq: Four courses in biological or physical science*

Introduction to the theory, methods and applications of stable isotopes. Primary focus on the origin, natural abundance, and fractionation of carbon, hydrogen, oxygen, nitrogen isotopes. Applications of isotopic occurrence for elucidation of physical, chemical, biological, and environmental processes. Effects of plant physiology, photosynthesis, trophic structure, diffusion, evaporation, chemical precipitation, soil and atmospheric processes, and environmental factors on isotope abundance.

**GEOL 439: Seismic Methods in Geology, Engineering, and Petroleum Exploration**

(Dual-listed with GEOL 539). (Cross-listed with C E). (2-2) Cr. 3. Alt. S., offered even-numbered years.

*Prereq: GEOL 100 or GEOL 201, algebra and trigonometry*

Physics of elastic-wave propagation. Seismic surveys in environmental imaging, engineering, and petroleum exploration. Reflection and refraction techniques. Data collection, processing, and geological interpretation. Field work with state-of-the-art equipment.

**GEOL 444: Petroleum Geoscience and Engineering**

(Dual-listed with GEOL 544). (2-2) Cr. 3. Alt. S., offered even-numbered years.

The geoscience and engineering aspects of exploration, development, and production of hydrocarbon resources around the world, as well as the historical and legal frameworks through which the industry has developed. Broader discussions of safety, risk, uncertainty, cost, and integrity as relevant to the petroleum industry.

**GEOL 452: GIS for Geoscientists**

(Dual-listed with GEOL 552). (Cross-listed with AGRON, ENSCI). (2-2) Cr. 3. F.S.

*Prereq: GEOL 100, GEOL 201 or equivalent*

Introduction to geographic information systems (GIS) with particular emphasis on geoscientific data. Uses ESRI's ArcGIS Desktop Software and extension modules. Emphasizes typical GIS operations and analyses in the geosciences to prepare students for advanced GIS courses.

**GEOL 468: Applied Geostatistics for Geoscientists**

(Dual-listed with GEOL 568). (Cross-listed with ENSCI, MTEOR). Cr. 3. F.

*Prereq: GEOL 452, C R P 351, C R P 452, NREM 345, or NREM 446*

Introduction to geospatial data collection, analysis, interpretation, and presentation. Geospatial techniques including geographic information systems (GIS), remote sensing (RS), and global positioning systems (GPS). Study of applied geostatistical analysis (e.g., interpolation and spatial regression).

**GEOL 474: Glacial and Quaternary Geology**

(Dual-listed with GEOL 574). (2-2) Cr. 3. Alt. S., offered odd-numbered years.

*Prereq: GEOL 100 or GEOL 201 or equivalent experience*

The study of glaciers and glacial processes. Discussion of glaciology, glacial sediment transport, glacial landforms, and Quaternary history. Laboratory emphasizes topographic map interpretation and the Quaternary landscapes of Iowa.

**GEOL 479: Surficial Processes**

(Dual-listed with GEOL 579). (Cross-listed with ENSCI). (2-3) Cr. 3. F.

*Prereq: GEOL 100 and GEOL 100L; or GEOL 201; or equivalent experience.*

The study of physical processes that shape Earth's surface. Topics include weathering, sediment transport, and landform genesis with emphasis on fluvial, glacial, hillslope, eolian, and coastal processes. Applications to engineering and environmental problems. Laboratory includes topographic map interpretation and local field trips.

**GEOL 487: Microbial Ecology**

(Dual-listed with GEOL 587). (Cross-listed with BIOL, ENSCI, MICRO). (3-0) Cr. 3. F.

*Prereq: Six credits in biology and 6 credits in chemistry*

Introduction to major functional groups of autotrophic and heterotrophic microorganisms and their roles in natural and environmental systems. Consequences of microbial activity on water chemistry, weathering, and precipitation/dissolution reactions will be emphasized.

**GEOL 488: GIS for Geoscientists II**

(Dual-listed with GEOL 588). (Cross-listed with AGRON, ENSCI). (2-2) Cr. 3. Alt. S., offered odd-numbered years.

*Prereq: GIS course, such as GEOL 452, CRP 451, CRP 452, NREM 345, NREM 446, AE 408 or equivalent*

GIS course with focus on the spatial analysis and modeling of raster data and triangulated irregular network (TIN) data. Uses ArcGIS and various extensions, such as Spatial Analyst, 3D Analyst, and ArcScene. Includes practical exercises during lectures, lab exercises, homework assignments, and (for GEOL 588) a class project.

**GEOL 489: Survey of Remote Sensing Technologies**

(Dual-listed with GEOL 589). (Cross-listed with E E, MTEOR, NREM). (3-0)

Cr. 3. F.

*Prereq: Four courses in physical or biological sciences or engineering*

Electromagnetic-radiation principles, active and passive sensors, multispectral and hyperspectral sensors, imaging radar, SAR, thermal imaging, lidar. Examples of applications. Also offered online S.

**GEOL 489L: Satellite Remote Sensing Laboratory**

(Dual-listed with GEOL 589L). (Cross-listed with E E, MTEOR, NREM). (0-3)

Cr. 1. F.

*Prereq: Completion or concurrent enrollment in MTEOR/GEOL/NREM/EE 489/589*

Processing and analysis of satellite sensor data (optical and radar).

Provides practical applications in an environmental context.

**GEOL 490: Independent Study**

Cr. 1-3. Repeatable, maximum of 9 credits.

*Prereq: 6 credits in geology and permission of instructor*

Independent study for senior students. No more than 9 credits of Geol 490 may be counted toward graduation.

**GEOL 495: Undergraduate Seminar**

Cr. 1. F.S.

*Prereq: Junior or senior classification*

Weekly seminar on topics of current research interest. Requires written summaries of three presentations of choice.

**GEOL 498: Cooperative Education**

Cr. R. F.S.SS.

*Prereq: Geol 100 or GEOL 201, GEOL 100L, GEOL 102, GEOL 102L, and permission of the department cooperative education coordinator; senior classification*

Required of all cooperative education students. Students must register for this course prior to commencing each work period.

**Courses primarily for graduate students, open to qualified undergraduates:****GEOL 502: Watershed Hydrology**

(Dual-listed with GEOL 402). (Cross-listed with ENSCI, MTEOR, NREM).

(2-3) Cr. 3. F.

*Prereq: Four courses in physical or biological sciences or engineering; junior standing*

Examination of watersheds as systems, emphasizing the surface components of the hydrologic cycle. Combines qualitative understanding of hydrological processes and uncertainty with quantitative representation. Laboratory emphasizes field investigation and measurement of watershed processes.

**GEOL 506: Geology Field Course**

Cr. 1-2. Repeatable, maximum of 2 times. F.S.

*Prereq: Graduate classification*

Weekly seminar introduces students to a selected geological region or theme that is visited on a required ten-day field excursion. Graduate students are expected to assist in field teaching and safety leadership.

**GEOL 507: Midwestern Geology Field Trip**

Cr. 1. Repeatable, maximum of 4 times. F.

*Prereq: GEOL 365*

On-site inspection of various ore deposits, mining operations, and terrains dominated by igneous or metamorphic rocks. Offered on a satisfactory-fail basis only.

**GEOL 509: Field Methods in Hydrogeology**

(Dual-listed with GEOL 409). (Cross-listed with ENSCI). (0-4) Cr. 3. Alt. SS., offered even-numbered years.

*Prereq: GEOL/ENSCI 402 or GEOL/ENSCI 411 or C E 473*

Introduction to field methods used in groundwater investigations. In-field implementation of pumping tests, slug tests, monitoring well installation and drilling techniques, geochemical and water quality sampling, seepage meters, minipiezometers, stream gaging, and electronic instrumentation for data collection. Field trips to investigate water resource, water quality, and remediation projects.

**GEOL 511: Hydrogeology**

(Dual-listed with GEOL 411). (Cross-listed with ENSCI). (3-2) Cr. 4. F.

*Prereq: Four courses in biological or physical sciences*

Physical principles of groundwater flow, nature and origin of aquifers and confining units, well hydraulics, groundwater modeling, and contaminant transport. Lab emphasizes applied field and laboratory methods for hydrogeological investigations.

**GEOL 512: Micropaleontology**

(Dual-listed with GEOL 412). Cr. 3. Alt. F., offered even-numbered years.

*Prereq: GEOL 102 and GEOL 102L*

Evolution, identification and utility of major microfossil groups from the Mesozoic to present. Focus on Cenozoic applications including biostratigraphy, paleoclimate, and paleothermometry using assemblages, stable isotopes, Mg/Ca, and molecular fossils. Laboratory includes processing and analysis of specific microfossils. Major groups covered include foraminifera, calcareous nannofossils, sponge spicules, diatoms, radiolarians, and silicoflagellates.

**GEOL 513: Applied and Environmental Geophysics**

(Dual-listed with GEOL 413). (Cross-listed with C E, ENSCI). (2-2) Cr. 3. Alt. S., offered odd-numbered years.

*Prereq: GEOL 100 or GEOL 201, algebra and trigonometry*

Seismic, gravity, magnetic, resistivity, electromagnetic, and ground-penetrating radar techniques for shallow subsurface investigations and imaging. Data interpretation methods. Lab emphasizes computer interpretation packages. Field work with seismic - and resistivity-imaging systems and radar.

**GEOL 514: Applied Groundwater Flow Modeling**

(Dual-listed with GEOL 414). (Cross-listed with ENSCI). (2-2) Cr. 3. Alt. S., offered even-numbered years.

*Prereq: GEOL 411 or C E 473; MATH 165 or MATH 181*

Introduction to the principles of modeling groundwater flow systems. Finite-difference and analytic-element methods, spreadsheet models, boundary conditions, calibration, sensitivity analysis, parameter estimation, particle tracking, and post-audit analysis. Application of MODFLOW to regional flow-system analysis. Computer laboratory emphasizes assigned problems that illustrate topics discussed in the course.

**GEOL 515: Paleoclimatology**

(Dual-listed with GEOL 415). (Cross-listed with ENSCI). (3-0) Cr. 3. Alt. S., offered odd-numbered years.

*Prereq: Four courses in biological or physical science*

Introduction to mechanisms that drive climate, including the interplay between oceanic and atmospheric circulation and fluctuation in Earth's orbital parameters. Examination and analysis of past climate records ranging from historical documentation to ecological and geochemical proxies (e.g. tree ring analysis; O and C isotopes of skeletal carbonates and soils). Dating methods used to constrain and correlate climatic periods; utility of computer models to reconstruct past climates and predict future climate change. Emphasis placed on paleoclimatology and paleoecology of the late Quaternary (last ~ 1 million years).

**GEOL 516: Hydrologic Modeling and Analysis**

(Dual-listed with GEOL 416). (Cross-listed with ENSCI, MTEOR). (2-3) Cr. 3. Alt. S., offered odd-numbered years.

*Prereq: Four courses in earth science, meteorology, or engineering; junior standing*

Study of the basic principles of hydrologic modeling, including rainfall-runoff analysis, lumped and distributed modeling, conceptual and physical models, parameter estimation and sensitivity analysis, input and validation data, uncertainty analysis, and the use of models in surface water hydrology. A range of common models are applied to study hydrologic topics such as flood forecasting and land use change impacts. Previous experience with Matlab or other programming language is needed.

**GEOL 519: Aqueous and Environmental Geochemistry**

(Dual-listed with GEOL 419). (Cross-listed with ENSCI). (2-2) Cr. 3. S.

*Prereq: CHEM 178, CHEM 178L; junior classification*

Geochemistry of natural waters and water-rock interactions. Acid-base equilibria, carbonate chemistry and buffer systems, mineral dissolution and precipitation, sorption, ion exchange, and redox reactions. Introduction to thermodynamics and kinetics. Laboratory emphasizes chemical analysis of waters and computer modeling.

**GEOL 520: Mineral Resources**

(Dual-listed with GEOL 420). (2-3) Cr. 3. Alt. F., offered even-numbered years.

*Prereq: GEOL 365*

Geology and geochemistry of non-metallic and metallic ore deposits. Major processes that concentrate metals in the Earth. Geochemical conditions of ore formation using stable-isotope and fluid-inclusion studies. Laboratory emphasizes the study of metallic ores.

**GEOL 526: Stable Isotopes in the Environment**

(Dual-listed with GEOL 426). (Cross-listed with ENSCI). (3-0) Cr. 3. Alt. S., offered even-numbered years.

*Prereq: Four courses in biological or physical science*

Introduction to the theory, methods and applications of stable isotopes. Primary focus on the origin, natural abundance, and fractionation of carbon, hydrogen, oxygen, nitrogen isotopes. Applications of isotopic occurrence for elucidation of physical, chemical, biological, and environmental processes. Effects of plant physiology, photosynthesis, trophic structure, diffusion, evaporation, chemical precipitation, soil and atmospheric processes, and environmental factors on isotope abundance.

**GEOL 539: Seismic Methods in Geology, Engineering, and Petroleum Exploration**

(Dual-listed with GEOL 439). (Cross-listed with C E). (2-2) Cr. 3. Alt. S., offered even-numbered years.

*Prereq: GEOL 100 or GEOL 201, algebra and trigonometry*

Physics of elastic-wave propagation. Seismic surveys in environmental imaging, engineering, and petroleum exploration. Reflection and refraction techniques. Data collection, processing, and geological interpretation. Field work with state-of-the-art equipment.

**GEOL 544: Petroleum Geoscience and Engineering**

(Dual-listed with GEOL 444). (2-2) Cr. 3. Alt. S., offered even-numbered years.

The geoscience and engineering aspects of exploration, development, and production of hydrocarbon resources around the world, as well as the historical and legal frameworks through which the industry has developed. Broader discussions of safety, risk, uncertainty, cost, and integrity as relevant to the petroleum industry.

**GEOL 552: GIS for Geoscientists**

(Dual-listed with GEOL 452). (Cross-listed with AGRON, ENSCI). (2-2) Cr. 3. F.S.

*Prereq: GEOL 100, GEOL 201 or equivalent*

Introduction to geographic information systems (GIS) with particular emphasis on geoscientific data. Uses ESRI's ArcGIS Desktop Software and extension modules. Emphasizes typical GIS operations and analyses in the geosciences to prepare students for advanced GIS courses.

**GEOL 555: Environmental Soil Mineralogy**

(Cross-listed with AGRON). (3-0) Cr. 3. Alt. S., offered odd-numbered years.

*Prereq: AGRON 473, CHEM 178. Recommend: GEOL 311*

Structure and behavior of clay minerals, humic substances and biochar in soil environments, with emphasis on reactions and environmental implications.

**GEOL 558: Introduction to the 3D Visualization of Scientific Data**

(Cross-listed with COM S, HCI). (2-2) Cr. 3. Alt. F., offered even-numbered years.

*Prereq: Graduate-student standing in the mathematical or natural sciences or engineering; basic programming knowledge*

Introduction to visualizing scientific information with 3D computer graphics and their foundation in human perception. Overview of different visualization techniques and examples of 3D visualization projects from different disciplines (natural sciences, medicine, and engineering). Class project in interactive 3D visualization using the ParaView, Mayavi, VTK, VTK or a similar system.

**GEOL 568: Applied Geostatistics for Geoscientists**

(Dual-listed with GEOL 468). (Cross-listed with ENSCI, MTEOR). Cr. 3. F.

*Prereq: GEOL 452, C R P 351, C R P 452, NREM 345, or NREM 446*

Introduction to geospatial data collection, analysis, interpretation, and presentation. Geospatial techniques including geographic information systems (GIS), remote sensing (RS), and global positioning systems (GPS). Study of applied geostatistical analysis (e.g., interpolation and spatial regression).

**GEOL 574: Glacial and Quaternary Geology**

(Dual-listed with GEOL 474). (2-2) Cr. 3. Alt. S., offered odd-numbered years.

*Prereq: GEOL 100 or GEOL 201 or equivalent experience*

The study of glaciers and glacial processes. Discussion of glaciology, glacial sediment transport, glacial landforms, and Quaternary history. Laboratory emphasizes topographic map interpretation and the Quaternary landscapes of Iowa.

**GEOL 579: Surficial Processes**

(Dual-listed with GEOL 479). (Cross-listed with ENSCI). (2-3) Cr. 3. F.  
*Prereq: GEOL 100 and GEOL 100L; or GEOL 201; or equivalent experience.*  
 The study of physical processes that shape Earth's surface. Topics include weathering, sediment transport, and landform genesis with emphasis on fluvial, glacial, hillslope, eolian, and coastal processes. Applications to engineering and environmental problems. Laboratory includes topographic map interpretation and local field trips.

**GEOL 587: Microbial Ecology**

(Dual-listed with GEOL 487). (Cross-listed with EEOB, ENSCI, MICRO). (3-0) Cr. 3. F.  
*Prereq: Six credits in biology and 6 credits in chemistry*  
 Introduction to major functional groups of autotrophic and heterotrophic microorganisms and their roles in natural and environmental systems. Consequences of microbial activity on water chemistry, weathering, and precipitation/dissolution reactions will be emphasized.

**GEOL 588: GIS for Geoscientists II**

(Dual-listed with GEOL 488). (Cross-listed with AGRON, ENSCI). (2-2) Cr. 3. Alt. S., offered odd-numbered years.  
*Prereq: GIS course, such as GEOL 452, CRP 451, CRP 452, NREM 345, NREM 446, AE 408 or equivalent*  
 GIS course with focus on the spatial analysis and modeling of raster data and triangulated irregular network (TIN) data. Uses ArcGIS and various extensions, such as Spatial Analyst, 3D Analyst, and ArcScene. Includes practical exercises during lectures, lab exercises, homework assignments, and (for GEOL 588) a class project.

**GEOL 589: Survey of Remote Sensing Technologies**

(Dual-listed with GEOL 489). (Cross-listed with E E, MTEOR, NREM). (3-0) Cr. 3. F.  
*Prereq: Four courses in physical or biological sciences or engineering*  
 Electromagnetic-radiation principles, active and passive sensors, multispectral and hyperspectral sensors, imaging radar, SAR, thermal imaging, lidar. Examples of applications. Also offered online S.

**GEOL 589L: Satellite Remote Sensing Laboratory**

(Dual-listed with GEOL 489L). (Cross-listed with E E, MTEOR, NREM). (0-3) Cr. 1. F.  
*Prereq: Completion or concurrent enrollment in MTEOR/GEOL/NREM/EE 489/589*  
 Processing and analysis of satellite sensor data (optical and radar). Provides practical applications in an environmental context.

**GEOL 590: Special Topics**

Cr. 1-3. Repeatable.  
*Prereq: Permission of instructor*

**GEOL 590A: Special Topics: Surficial Processes**

Cr. 1-3. Repeatable.  
*Prereq: Permission of instructor*

**GEOL 590B: Special Topics: Stratigraphy**

Cr. 1-3. Repeatable.  
*Prereq: Permission of instructor*

**GEOL 590C: Special Topics: Sedimentation**

Cr. 1-3. Repeatable.  
*Prereq: Permission of instructor*

**GEOL 590D: Special Topics: Paleontology**

Cr. 1-3. Repeatable.  
*Prereq: Permission of instructor*

**GEOL 590E: Special Topics: Petrology**

Cr. 1-3. Repeatable.  
*Prereq: Permission of instructor*

**GEOL 590F: Special Topics: Structural Geology**

Cr. 1-3. Repeatable.  
*Prereq: Permission of instructor*

**GEOL 590G: Special Topics: Geochemistry**

Cr. 1-3. Repeatable.  
*Prereq: Permission of instructor*

**GEOL 590H: Special Topics: Hydrogeology**

Cr. 1-3. Repeatable.  
*Prereq: Permission of instructor*

**GEOL 590I: Special Topics: Earth Science**

Cr. 1-3. Repeatable.  
*Prereq: Permission of instructor*

**GEOL 590J: Special Topics: Mineral Resources**

Cr. 1-3. Repeatable.  
*Prereq: Permission of instructor*

**GEOL 590K: Special Topics: Geophysics**

Cr. 1-3. Repeatable.  
*Prereq: Permission of instructor*

**GEOL 590L: Special Topics: Mineralogy**

Cr. 1-3. Repeatable.  
*Prereq: Permission of instructor*

**GEOL 590M: Special Topics: Tectonics**

Cr. 1-3. Repeatable.  
*Prereq: Permission of instructor*

**GEOL 590N: Special Topics: Paleoecology and Paleoclimatology**

Cr. 1-3. Repeatable.

*Prereq: Permission of instructor***GEOL 590O: Special Topics: Isotope Geochemistry**

Cr. 1-3. Repeatable.

*Prereq: Permission of instructor***GEOL 590P: Special Topics: Computational Methods and GIS**

Cr. 1-3. Repeatable.

*Prereq: Permission of instructor***GEOL 590R: Special Topics: Surface Hydrology**

Cr. 1-3. Repeatable.

*Prereq: Permission of instructor***GEOL 590S: Special Topics: Oceanography**

Cr. 1-3. Repeatable.

*Prereq: Permission of instructor***GEOL 595: Graduate Seminar**

(Cross-listed with MTEOR). Cr. 1. Repeatable. F.S.

*Prereq: Senior or graduate classification*

Weekly seminar on topics of current research interest. All students seeking a graduate degree must enroll during each semester of residence. Students pursuing a non-thesis option for the M.S. in Earth Science must enroll for one semester. Offered on a satisfactory-fail basis only.

**GEOL 595A: Graduate Seminar: Presentation Required**

(Cross-listed with MTEOR). (1-0) Cr. 1. Repeatable. F.S.

*Prereq: Senior or graduate classification*

Weekly seminar on topics of current research interest. All students seeking a graduate degree must enroll during each semester of residence. Students pursuing a non-thesis option for the M.S. in Earth Science must enroll for one semester. Offered on a satisfactory-fail basis only.

**GEOL 595B: Graduate Seminar: Attendance Only**

(Cross-listed with MTEOR). Cr. R. Repeatable. F.S.

*Prereq: Senior or graduate classification*

Attendance only. Weekly seminar on topics of current research interest. All students seeking a graduate degree must enroll during each semester of residence. Students pursuing a non-thesis option for the M.S. in Earth Science must enroll for one semester. Offered on a satisfactory-fail basis only.

**GEOL 599: Creative Component**

Cr. arr. Repeatable.

**Courses for graduate students:****GEOL 610: Advanced Seminar**

Cr. 1-3. Repeatable. F.S.

*Prereq: Graduate standing and permission of instructor***GEOL 610A: Advanced Seminar: Earth Materials**

Cr. 1-3. Repeatable. F.S.

*Prereq: Graduate standing and permission of instructor***GEOL 610B: Advanced Seminar: Economic Geology**

Cr. 1-3. Repeatable. F.S.

*Prereq: Graduate standing and permission of instructor***GEOL 610C: Advanced Seminar: Environmental Geochemistry**

Cr. 1-3. Repeatable. F.S.

*Prereq: Graduate standing and permission of instructor***GEOL 610D: Advanced Seminar: Geophysics**

Cr. 1-3. Repeatable. F.S.

*Prereq: Graduate standing and permission of instructor***GEOL 610E: Advanced Seminar: Geotectonics**

Cr. 1-3. Repeatable. F.S.

*Prereq: Graduate standing and permission of instructor***GEOL 610F: Advanced Seminar: Hydrogeology**

Cr. 1-3. Repeatable. F.S.

*Prereq: Graduate standing and permission of instructor***GEOL 610G: Advanced Seminar: Surficial Processes**

Cr. 1-3. Repeatable. F.S.

*Prereq: Graduate standing and permission of instructor***GEOL 610H: Advanced Seminar: Sedimentation and Stratigraphy**

Cr. 1-3. Repeatable. F.S.

*Prereq: Graduate standing and permission of instructor***GEOL 610I: Advanced Seminar: Paleoecology and Paleoclimatology**

Cr. 1-3. Repeatable. F.S.

*Prereq: Graduate standing and permission of instructor***GEOL 610J: Advanced Seminar: Isotope Geochemistry**

Cr. 1-3. Repeatable. F.S.

*Prereq: Graduate standing and permission of instructor***GEOL 610K: Advanced Seminar: Computational Methods and GIS**

Cr. 1-3. Repeatable. F.S.

*Prereq: Graduate standing and permission of instructor***GEOL 699: Research**

Cr. arr. Repeatable.

**GEOL 699A: Research: Surficial Processes**

Cr. arr. Repeatable.

**GEOL 699B: Research: Stratigraphy**

Cr. arr. Repeatable.

**GEOL 699C: Research: Sedimentation**

Cr. arr. Repeatable.

**GEOL 699D: Research: Paleontology**

Cr. arr. Repeatable.

**GEOL 699E: Research: Petrology**

Cr. arr. Repeatable.

**GEOL 699F: Research: Structural Geology**

Cr. arr. Repeatable.

**GEOL 699G: Research: Geochemistry**

Cr. arr. Repeatable.

**GEOL 699H: Research: Hydrogeology**

Cr. arr. Repeatable.

**GEOL 699I: Research: Earth Science**

Cr. arr. Repeatable.

**GEOL 699J: Research: Mineral Resources**

Cr. arr. Repeatable.

**GEOL 699K: Research: Geophysics**

Cr. arr. Repeatable.

**GEOL 699L: Research: Mineralogy**

Cr. arr. Repeatable.

**GEOL 699M: Research: Tectonics**

Cr. arr. Repeatable.

**GEOL 699N: Research: Paleoecology and Paleoclimatology**

Cr. arr. Repeatable.

**GEOL 699O: Research: Isotope Geochemistry**

Cr. arr. Repeatable.

**GEOL 699P: Research: Computational Methods and GIS**

Cr. arr. Repeatable.

**GEOL 699R: Research: Surface Hydrology**

Cr. arr. Repeatable.

**GEOL 699S: Research: Geoscience Education**

Cr. arr. Repeatable.