

## GEOL - Geology

Courses numbered 100 to 299 = *lower-division*; 300 to 499 = *upper-division*; 500 to 799 = *undergraduate/graduate*.

### GEOL 102. Earth Science and the Environment (4).

*General education math and natural sciences course.* Studies the processes that shape the Earth's physical environment, the impact of human activities on modifying the environment, use and abuse of natural resources including soil, water and air, waste disposal, and natural environmental hazards. Lab required for 4 credit hour option. Four credit hour with lab option is recommended for students desiring general education credit for a natural sciences laboratory experience. Credit not allowed in both GEOL 102 and 111. *Course includes diversity content.*

### GEOL 111. General Geology (4). †

*General education math and natural sciences course.* Overview of the Earth, the concepts of its origin, composition, materials, structure, landforms and history, and natural processes operating to create the Earth's physical environment. May require field trips into the earth laboratory. Credit not allowed in both GEOL 102 and GEOL 111. This is a Kansas Systemwide Transfer Course. Corequisite(s): GEOL 111L.

### GEOL 150. Workshop (1-4).

An umbrella course created to explore a variety of subtopics differentiated by letter (e.g., 150A, 150B). Not all subtopics are offered each semester – see the course schedule for availability. Students enroll in the lettered courses with specific topics in the titles rather than in this root course.

### GEOL 150B. Introduction to Meteorology (0.5).

Covers basic concepts of meteorology, otherwise known as atmospheric science; in particular, the interrelationships and distributions of temperature, pressure, wind and moisture. The organization of weather systems and storms are presented, including a thorough description of severe storms. Students are given the capability to follow the progress of weather systems via sources of readily-available data on the internet, as they learn to read and understand weather maps, soundings, radar images and satellite photos. Exercises related to real example cases provide practice applying the basic concepts. Opportunities for students to share personal experiences with weather phenomena are also given.

### GEOL 150C. Introduction to Geology: Understanding Earth (0.5).

Geology is the study of the earth — its place in the universe, its formation, its history, and what makes it special. During this introductory course, students learn about the science of geology and how the work of geologists impacts everyday lives.

### GEOL 150D. Oceanography: Journey into the Abyss (0.5).

Although the majority of earth's surface is covered by seawater, most of us know very little about how it controls and affects the planet and human lives. Topics include how the oceans formed, what is at the bottom of the ocean, how and why ocean water moves, how the oceans affect human lives, current issues affecting oceans, and how land-locked Kansans play a role.

### GEOL 150E. Geology of Natural Disasters (0.5).

Earthquakes shake the ground beneath people's feet and crumble infrastructure. Volcanic eruptions spew lava and pyroclastics 50 to 60 times per year. Rock, soil and debris landslides occur in all 50 states and killed 43 people in a Washington community in 2014. Floods, hurricanes and tsunamis drown the land on all continents. In this course, students learn how no matter the place on the globe, people are at risk for experiencing a natural disaster. In fact, in the United States, 80% of the population lives in counties which have experienced at least one natural disaster since 2007. Learn the geology of these disasters, if their

occurrences can be predicted, and what disasters residents are at risk for in Kansas through readings, videos and group discussions.

### GEOL 150F. From Geysers to Glaciers: The Geology of Our National Parks (0.5).

National parks provide some of the most beautiful and spectacular scenery in the world and were established in 1872 with the creation of Yellowstone National Park. Like Yellowstone, many of the national parks were designated due to their inspiring geologic features and are locations of ancient and even ongoing dramatic geologic events. In this course, participants learn to recognize geologic features and interpret the story behind the scenery. Learn how Yellowstone, Hawaii Volcanoes, Grand Canyon, Death Valley, Hot Springs, Olympic, Zion and Glacier National Parks formed and what created their unique features.

### GEOL 150G. The Geology of Kansas State Parks (0.5).

The state parks of Kansas provide a variety of outdoor adventure options – hiking, camping, wildlife watching, bike riding, horseback riding, relaxing or simply escaping from the city – but they also tell the story of Kansas' rich and active geologic past. Since Precambrian time, geologic processes have been forming, flooding and reshaping the land that is now Kansas. Learn about parks in every region of the state, discovering high plains, springs, caves, canyons, mushroom-shaped rocks, marine fossils, sink holes, wetlands, and the geologic events that created them.

### GEOL 150J. Mass Extinctions: Are We in the Sixth? (0.5).

Mass extinction events occur when at least half of all species go extinct within a short period of geologic time. Over the past 542 million years, the fossil record indicates that this has happened five times, dramatically changing the diversity and course of life on Earth. Major environmental changes such as asteroid impacts, volcanism, climate change, changes in sea-level, anoxia and methane hydrate release have all been associated with mass extinctions. With humans now dominating the earth, climate change, the risk of catastrophic geologic events and rising sea levels, are we about to experience a sixth mass extinction? Explore the five past mass extinctions, analyze the geologic events that may have triggered them, and determine if we are entering into a sixth mass extinction event.

### GEOL 150M. When the Earth Shakes: Geology of Earthquakes (0.5).

Earthquakes have shaken and shaped our planet for millennia and are one of Earth's most unpredictable and destructive natural disasters. Earthquakes have toppled skyscrapers, disrupted transportation, caused fires, triggered landslides, started tsunamis and taken lives. To understand what earthquakes are and why they occur where they do, this course explores the grand unifying theory of geology – plate tectonics. It also covers how earthquakes are measured, how epicenters are determined, seismic waves, predictions, hazards, preparedness, and mitigation, while exploring noteworthy earthquakes from around the world and the mid-west. Recent Kansas earthquakes and the potential for more are also discussed.

### GEOL 150N. Finding Fossils: An Introduction to Paleontology and Earth's Geologic History (0.5).

Fossils play a major role in solving some of the mysteries of Earth's deep past. They shed light on tectonic activity, evolution, climate changes and large impact events. In this course, students take a walk through Earth's geologic history and meet some of her most interesting and unusual inhabitants, including: dinosaurs, trilobites, megalodons, archaeopteryxes, pterodactyls, plesiosaurs, microscopic fossils and many more. While learning about individual species, students pay close attention to their taxonomy and the geologic events that led to their extinction. Students also learn basic techniques of fossil identification,

learn where to find fossils, and explore the famous fossil discoveries of Kansas.

**GEOL 150O. Name That Rock!: An Introduction to Rocks, Minerals and Their Identification (0.5).**

Learning the basics of mineralogy and petrology can provide both beginners and hobbyists alike with a foundation on which to build rock and mineral identification skills. In this course, students study the formation processes of both minerals and rocks. Students look at the physical properties of minerals, learn to identify them, and explore some of their uses. Traveling through the rock cycle, the course stops at igneous rocks, sedimentary rocks and metamorphic rocks, to learn how plate tectonics and other processes affect them, their everyday and industrial uses, and classification systems. Along the way, students pick up identification techniques and look at several examples.

**GEOL 150P. Ring of Fire: The Geology of Volcanoes (0.5).**

Volcanoes have built our continents, released gases that helped form the oceans and atmosphere, heated and cooled the earth, sometimes to extremes, and contributed to mass extinction events throughout our geologic past. They have destroyed historic civilizations such as Santorini and Pompeii and continue to be a modern threat to human safety with 1 in 20 people living in the danger range of an active volcano. Yet without them, the earth would be uninhabitable. In this course, students learn how volcanoes form, the classification of volcanoes and their eruptions, the ways in which they affect the earth, how eruptions are monitored, what people can do to be prepared for an eruption, and what risk super volcanoes, such as Yellowstone, hold for the future. Along the way, students examine the geology and devastation of some of the world's most famous eruptions.

**GEOL 200. Introduction to Environment and Sustainability (3).**

*General education math and natural sciences course.* Explores a variety of environmental processes and contemporary environmental issues. The first eight weeks of the semester introduces the various aspects of environmental and sustainability issues and provides overviews of the science behind these issues, technology and policies developed to address them, the ethics that underlie how these issues are evaluated, and the impacts to human society. The second eight weeks of the semester are taught by WSU faculty and lecturers that specialize in aspects of environment and sustainability as it relates to the various tracks offered as part of the environment and sustainability certificate program. The second eight weeks of the class may involve field trips or other activities outside of normal class times. Course is required for all students enrolled in the certificate in environment and sustainability, but is open to all WSU students. *Course includes diversity content.*

**GEOL 235. Meteorology (3). ▸**

*General education math and natural sciences course.* Cross-listed as GEOG 235. Introductory study of the atmosphere and its properties and the various phenomena of weather. Includes a brief survey of important principles of physical, dynamic, synoptic and applied meteorology. Does not apply toward a major or minor in geology. Requires field trips at the option of the instructor. This is a Kansas Systemwide Transfer Course. Prerequisite(s): instructor's consent.

**GEOL 300. Energy, Resources and Environment (3).**

*General education math and natural sciences course.* Studies the dependence of human beings on the Earth's metallic, nonmetal, industrial mineral, energy, soil and water resources; the methods for their discovery and recovery; their uses, and the influence of economics, politics and social institutions in determining how exploitation affects the natural environment and our standard of living. *Course includes diversity content.* Prerequisite(s): any introductory course in biology, chemistry, geology or physics.

**GEOL 301. Dinosaurs: Fantastic Beasts and Lost Worlds (3).**

*General education math and natural sciences course.* Examines the origin, evolution, behavior and extinctions of dinosaurs and related creatures of the Mesozoic, as well as their relationships to the natural environment. Students examine the geologic record and the tools used by geologists and paleontologists to determine geologic ages, ancient environments, the evolutionary history and extinction of dinosaurs, and dinosaur behaviors. Mechanisms of global change ranging from plate tectonics, climate and asteroid impacts are discussed.

**GEOL 302. Earth and Space Sciences (3).**

*General education math and natural sciences course.* General survey of the physical environment, including elements of geology, geography, meteorology, climatology, oceanography and astronomy. May require field trips. Corequisite(s): GEOL 302L.

**GEOL 310. Oceanography (3).**

*General education math and natural sciences course.* Geologic origin of ocean basins and sea water; dynamics of waves, tides and currents; physical and chemical properties of sea water, diversity of life in the oceans, economic potential, law of the sea, and the effect of people on the marine environment.

**GEOL 312. Historical Geology (4).**

*General education math and natural sciences course.* Systematic review of earth history and its preservation in the rock record using field evidence for sequences of physical, biological and tectonic events in selected areas. Also includes the origin and evolution of life. Field trips required. Prerequisite(s): GEOL 102 or GEOL 111 or GEOL 302 or equivalent. Corequisite(s): GEOL 312L.

**GEOL 320. Mineralogy and Optical Mineralogy (4).**

Elementary crystallography. A study of the origin, composition and structure of the rock-forming minerals with laboratory emphasis on recognition of their typical forms, occurrences, associations and identification, and optical recognition via thin-section petrography. May require field trips. Prerequisite(s): GEOL 102 or GEOL 111; CHEM 103 or CHEM 211; MATH 112 or MATH 123. Corequisite(s): GEOL 320L.

**GEOL 324. Petrology and Petrography (3).**

The origin, distribution, occurrence, description and classifications of igneous, metamorphic and sedimentary rocks with laboratory emphasis on their hand-sample and optical (thin-section petrographic) recognition. Prerequisite(s): GEOL 320. Corequisite(s): GEOL 324L.

**GEOL 430. Field Studies in Geology (2-6).**

An umbrella course created to explore a variety of subtopics differentiated by letter (e.g., 430A, 430B). Not all subtopics are offered each semester – see the course schedule for availability. Students enroll in the lettered courses with specific topics in the titles rather than in this root course.

**GEOL 430C. Geology of National Parks (3).**

Examination of National Parks from a geologic perspective. The landscapes of U.S. national parks result from movements of large tectonic plates of Earth's outer shell. Mountains, volcanoes, shorelines and various types of rocks develop through interactions along plate boundaries, or where a plate moves over a hotspot. Course is intended for college and university students who have had no previous geology courses.

**GEOL 481. Cooperative Education (1-6).**

Provides practical field experience, under academic supervision, that complements and enhances the student's academic program. Prerequisite(s): departmental consent.

**GEOL 490. Environment and Sustainability Seminar (1).**

Focuses on the integration of the work each student has done in the environment and sustainability certificate program. Student discussion driven course in which students recap what they have learned during the certificate program and debate policies, practices and research needed to move towards a more environmentally sustainable society. As such, the capstone is not only about expanding knowledge, but also about communication, personal expression and advancing the conversation on environment and sustainability. Required for all students enrolled in the certificate in environment and sustainability. *Course includes diversity content.* Prerequisite(s): all required coursework for the certificate in environment and sustainability.

**GEOL 522. Sedimentology and Stratigraphy (4).**

Origin, classification, primary structures and physiochemical processes controlling deposition of sedimentary rocks. Surveys modern and ancient sedimentary depositional environments and petrographic study of sedimentary rocks in thin sections. Description, classification, methods of correlations and determination of relative ages of stratigraphic rock units; stratigraphic principles and practice, the nature of cyclic sedimentation and controls on deposition, and elements of sequence stratigraphy. May require field trips. This course has a lab component. Prerequisite(s): GEOL 102 (with lab) or GEOL 111.

**GEOL 530. Geology of Critical Minerals (3).**

Examines the geologic occurrence, exploration and uses of critical minerals and other geologic resources. The United States is reliant on certain critical minerals and resources that are vital to the nation's security and economic prosperity in its transition to a low-carbon, digitized economy. The list of critical and strategic minerals includes rare earth elements (REE), lithium, platinum group elements (PGM), antimony, rhenium, beryllium, tantalum, cobalt, chromium, tin, tantalum, tellurium, niobium, tungsten, gallium, yttrium, bauxite, nickel, zinc and germanium. These elements have applications in a range of developing markets such as consumer electronic devices, electric vehicles, wind turbines, solar panels, energy-efficient lighting and medical equipment. The current dependency of the United States on foreign sources for these resources creates a strategic vulnerability for both its economy and military. Supply disruptions of these key mineral resources can be due to adverse foreign relations, government actions, natural disasters and other events. Field trips may be required to examine deposits in Kansas and adjacent states. Prerequisite(s): any introductory course in biology, chemistry, geology or physics.

**GEOL 540. Field Map Methods (3).**

Field mapping methods with special reference to use of level, compass, barometer, alidade and airphotos. Field trips required. This course has a lab component. Prerequisite(s): GEOL 102 (with lab) or GEOL 111 or GEOL/GEOG 201.

**GEOL 544. Structural Geology (3).**

Stress-strain theory and mechanics of rock deformation, description and genesis of secondary structural features in crustal rocks resulting from diastrophism, elements of global tectonics, and laboratory solution of geologic problems in three dimensions and time. May require field trips and field problems. Prerequisite(s): MATH 112 or MATH 123; GEOL 312; and GEOL 324 or GEOL 522. Corequisite(s): GEOL 544L.

**GEOL 560. Geomorphology and Land Use (3).**

Cross-listed as GEOL 810AG. Identification of landforms and their genesis, processes producing landforms, the influence of geomorphology in aspects of natural hazards such as landslides, floods, earthquakes and volcanic activity; soil erosion, drainage basin modification, coastal and desert environments, mineral resource exploitation, and their effects on humans; importance of these

influences in environmental management and land-use planning.

Prerequisite(s): GEOL 111 or GEOL 102 or GEOL/GEOG 201.

**GEOL 564. Remote Sensing Interpretation (3).**

Introduces interpretation techniques for most types of images acquired by remotely positioned means. Physical principles that control various remote sensing processes using the electromagnetic spectra are applied to geology, land use planning, geography, resource evaluation and environmental problems. Derivative maps generated from a variety of images. May require field trips. This course has a lab component. Prerequisite(s): GEOL 102 or GEOL 111 or GEOL/GEOG 201.

**GEOL 570. Biogeology (3).**

*General education math and natural sciences course.* Systematic survey of major fossil biogeological materials, analysis of the origin and evolution of life, and paleoecological interpretation of ancient environments and climates. Includes handlens and binocular microscopic examination of major fossil biogeological materials. Includes application of analyzed fossil data to the solution of problems in biogeochronology, paleoecology, paleoclimatology and paleogeography. Cites examples from fields of invertebrate, vertebrate and micropaleontology, and palynology. May require museum and field trips. Prerequisite(s): GEOL 312. Corequisite(s): GEOL 570L.

**GEOL 574. Special Studies in Paleontology (3).**

*General education math and natural sciences course.* An umbrella course created to explore a variety of subtopics differentiated by letter (e.g., 574A, 574B). Not all subtopics are offered each semester – see the course schedule for availability. Students enroll in the lettered courses with specific topics in the titles rather than in this root course.

**GEOL 574C. Micropaleontology (3).**

*General education math and natural sciences course.* A systematic study in selected areas of micropaleontology. Gives appropriate laboratory instruction in the systematics, taxonomy and biogeological relationships within micropaleontology. May require field trips.

**GEOL 621. Geochemical Cycling (3).**

Capstone course. The geochemistry of earth materials and the important geochemical processes; cycles operating on and within the atmosphere, hydrosphere and lithosphere through time; anthropogenic effects on these cycles today. Prerequisite(s): GEOL 102 (with lab) or GEOL 111 and CHEM 211; or instructor's consent.

**GEOL 630. Field Studies in Geology (2-6).**

Off-campus, systematic field study in a selected area of geological significance. Course given upon demand, repeatable for credit when locality and/or content differ. Where appropriate, travel, lodging and board costs are charged. Prerequisite(s): instructor's consent.

**GEOL 640. Field Geology (6).**

Capstone course. Field investigation of sedimentary, igneous and metamorphic rock units and their structures. Includes the application of mapping methods in solving geologic problems. Held at an off-campus field camp for five weeks (including weekends). Preparation of geologic columns, sections, maps and an accompanying report are due on campus during the sixth week. Prerequisite(s): GEOL 324, 522, 540, 544.

**GEOL 650. Geohydrology (3).**

The hydrologic cycle, physical and chemical properties of water; fluid flow through permeable media, exploration for and evaluation of groundwater, water quality and pollution, and water law. Prerequisite(s): GEOL 522, MATH 242 and MATH 243; or instructor's consent. Corequisite(s): GEOL 650L.

**GEOL 657. Earth Science Instructional Methods (3).**

Practice in teaching an introductory course in the earth sciences. Developing and presenting the latest scientific laboratory techniques

and evaluating their effectiveness. May be taken more than once if content and objectives differ. Prerequisite(s): senior standing and department chairperson's permission.

**GEOL 678. Geologic Perspectives on Climatic Change (3).**

Capstone course. Modern climate and climactic changes and analysis of climactic deterioration; systematic study of geologic evidence of climate change through time. Emphasizes theoretical causes, feedback mechanisms and recognition of effects on climactic perturbations in the rock record. Prerequisite(s): GEOL 312, 522.

**GEOL 682. Petroleum Geology (3).**

The origin, migration and accumulation of oil and gas in the earth's crust; reservoir trap types in common hydrocarbon fields, origin and types of porosity systems, and distribution of world petroleum supplies. Introduces subsurface study techniques. May require field trips. Prerequisite(s): GEOL 522. Corequisite(s): GEOL 682L.

**GEOL 684. Methods of Subsurface Analysis (2).**

Methods of remotely logging and describing the geologic occurrence of subsurface strata; characterization of subsurface strata, including laboratory analysis of recovered subsurface samples; application to petroleum geology, mineral resource evaluation and environmental geology. This course has a lab component. Prerequisite(s): GEOL 312, GEOL 522; or instructor's consent.

**GEOL 690. Special Studies in Geology (1-3).**

An umbrella course created to explore a variety of subtopics differentiated by letter (e.g., 690A, 690B). Not all subtopics are offered each semester – see the course schedule for availability. Students enroll in the lettered courses with specific topics in the titles rather than in this root course. Prerequisite(s): instructor's consent.

**GEOL 690AC. Issues in Marine Environments (2).**

Oceans provide protein and livelihoods for millions of people, regulate the climate, and generate at least half of the oxygen humans and animals breathe. Sadly, many of the ocean systems are nearing tipping points that could threaten life on Earth, making much of the planet (including Kansas) inhospitable to humans. This course looks at the threats, challenges and opportunities that impact the oceans. What are the causes and more importantly, what can be done about it? While a previous oceanography or environmental class is recommended, it is not required.

**GEOL 690AJ. Computer Methods in Science (3).**

Cross-listed as EEPS 701. Surveys computer applications commonly used by scientists, emphasizing nonstatistical applications. Includes computer-assisted instruction, data management, presentation packages, internet resources, digital image analysis, graphics and spreadsheets, reference acquisition and management, desktop publishing, and specialized applications for modeling, simulations, mapping and time-series analysis. Lectures and demonstrations involve individual hands-on activities and student projects. This course has a lab component. Prerequisite(s): graduate standing or instructor's consent.

**GEOL 690AK. Soils (3).**

Geologic analysis of soil types, their formation, occurrence and mineralogy; soil management and conservation, environmental aspects of soil occurrence including stability studies, pollution and reclamation.

**GEOL 690AO. History of Geology (3).**

The course examines the historical development of Earth science from prehistoric to modern times. The course analyzes the various techniques of data collection and interpretation that were used throughout history.

**GEOL 690AP. Petroleum Engineering: An Introduction for Geoscientists (3).**

An introduction to the theory and application of petroleum engineering to oil and gas exploration and development. Oriented to students with a geology or geoscience background.

**GEOL 690AR. Environmental Politics (3).**

Cross-listed as POLS 305. Examines the politics of environmental protection and the management of natural resources at local, national and global levels. No prerequisites, but a background in introductory political, economic and environmental science courses is helpful.

**GEOL 690AS. Costa Rica Sustainability Travel Seminar (3).**

Provides an opportunity for students to experience a new country, its ecology, sustainability practices, culture, language and history. It is an interdisciplinary travel seminar that allows the student to travel abroad and learn experientially to gain credit for studies of ecology sustainability practices, culture, language, history, geography, geology and biodiversity. Prerequisite(s): instructor's consent.

**GEOL 690G. Applied Environmental Geology (3).**

Designed for students who plan on a career in environmental geology, a rapidly growing field which deals with the most pressing issues of today and the future. Qualified geoscientists may work with local, state and federal agencies; engineering services firms; environmental consulting firms; mining companies and waste management companies; and as environmental or sustainability officers with virtually any large enterprise. This course is based on refining skills in analytic assessment, synthesizing and manipulating data; and preparing, completing and presenting projects with an emphasis on oral and written communication. In addition to class projects, students interact with working professionals both as lecturers and with on-site visits. Students learn how to stand out with their resume and cover letter and learn what employers are looking for by talking with some of them. While previous environmental courses are strongly recommended, they are not a requirement.

**GEOL 690V. Geology of National Parks (3).**

Examination of national parks from a geologic perspective. The landscapes of U.S. national parks result from movements of large tectonic plates of Earth's outer shell. Mountains, volcanoes, shorelines and various types of rocks develop through interactions along plate boundaries, or where a plate moves over a hotspot. This course is intended for college and university students who have had no previous geology courses.

**GEOL 690Z. Applied GIS (3).**

Focuses on emerging supplementary and advanced geographic information system (GIS) skill sets. Students engage in an advanced level analysis of ESRI ArcGIS software. GIS spatial analyst, GIS spatial modeler, GIS visualization techniques, python scripting and ArcSDE are fully utilized. Individual projects are also required.

**GEOL 692. Spatial SQL and SDE (3).**

Spatial-SQL is a structural query language that allow students to effectively develop and manage spatial database. Course teaches principles of ESRI's spatial database engine (ArcSDE) which is designed to support multiple users to store and manage innumerable spatial data in a central location, and at the same time, enables others to develop (create, edit or modify and share) as well as manage the same data (concurrent multiuser geodatabase editing). Students learn how to develop geodatabase, manage the ArcSDE (enterprise geodatabase) service, script data loads with command-line ArcSDE tools, and install ArcSDE. Additionally, students are acquainted with the standard transact SQL script used frequently by Microsoft DBA's to manage large data.

**GEOL 693. Python for Geospatial Analysis (3).**

Students learn how to write Python scripting to perform geospatial analysis duties. Course deeply teaches how to use Python codes more efficiently to enhance, augment and even automate enormous amounts of GIS analytical tasks. The majority of this course is not spent learning to program in the Python language but on how to integrate different spatial libraries within Python code. Students learn how to do different GIS-related spatial analysis in Python programming language. Each lesson is a tutorial with specific topic(s) plus exercises where the aim is to learn how to solve both natural and social science problems while using Python tools.

**GEOL 698. Independent Study in Geology (1-3).**

Independent study on special problems in selected areas of geology: (a) general, (b) mineralogy, (c) petrology, (d) structural, (e) paleontology, (f) economic geology, (g) sedimentation, (i) stratigraphy, (j) geophysics, and (k) petroleum. Requires a written final report. Prerequisite(s): consent of sponsoring faculty.

**GEOL 720. Geochemistry (3).**

The chemistry of natural aqueous solutions and their interaction with minerals and rocks; thermodynamics and kinetics of reactions; emphasizes application to sedimentary environments and environmental problems. Requires some laboratory work. Prerequisite(s): GEOL 324 and CHEM 212 or instructor's consent.

**GEOL 724. Soils (3).**

Geologic analysis of soil types, their formation, occurrence and mineralogy; soil management and conservation, environmental aspects of soil occurrence including stability studies, pollution and reclamation.

**GEOL 726. Carbonate Sedimentology (3).**

The origin and genetic description of carbonate particles, sediments and rocks, mineralogy and textural classifications, depositional environments in carbonate rocks and analysis of modern and ancient depositional system. May require field trips. Prerequisite(s): GEOL 522 or equivalent. Corequisite(s): GEOL 726L.

**GEOL 740. Basin Analysis (3).**

A practical course in analysis of petroleum-bearing or other sedimentary basins; emphasizes detailed subsurface mapping to document depositional, tectonic and burial history of sedimentary basins; subsurface lithologic and geochemical sample analysis and evolution of sedimentary facies systems and hydrocarbons maturation history. Includes compilation of existing data to determine geologic evolution of basins. Prerequisite(s): GEOL 682, 684 or instructor's consent.

**GEOL 750G. History of Geology (3).**

The course examines the historical development of Earth science from prehistoric to modern times. The course analyzes the various techniques of data collection and interpretation that were used throughout history.

**GEOL 750O. Tectonics (1-3).**

Explores plate tectonics, the dynamic geo-process driving Earth's evolution and functioning, making Earth different from neighboring planets. It is a theory explaining the structure of the Earth's crust and many associated phenomena resulting from the interaction of rigid lithospheric plates that move slowly over the underlying mantle. Additionally, the course discusses geometry, determination and description of plate motions. Topics include how plates move, how their boundaries interact, how these have changed over time, and the resulting natural hazards are addressed with lectures and hands-on exercises. Prerequisite(s): GEOL 111 or instructor's consent.

**GEOL 751. Advanced Geohydrology (3).**

Integrations of practical and theoretical coverage of subsurface fluid flow as applied to shallow aquifers. Covers the mass transport

in both the saturated and vadose zones as well as the occurrence and movement of nonaqueous fluids. Covers groundwater quality, sources of groundwater contamination, retardation of contaminants, retardation and attenuation of dissolved solids, and the response of inorganic and organic substances to subsurface aqueous and framework chemistries. Computer simulation models used whenever practical along with detailed analysis of case histories, including those related to environmental geoscience. Prerequisite(s): GEOL 650, 681, MATH 344, or instructor's consent.

**GEOL 752. Climatic Evolution of Earth (3).**

Basics of climatology and paleoclimatology, and recognition of paleoclimatic indicators in the rock record. Climatic changes at different scales in Earth history and possible causes, and nature of climatic records. Roles of climate change on the evolution of Earth's biosphere, hydrosphere, atmosphere and lithosphere. Field trip(s) may be required. Prerequisite(s): GEOL 721, graduate standing, or instructor's consent.

**GEOL 760. Exploration Geophysics (3).**

Introduces the theory and application of geophysical techniques for hydrocarbon, mineral and groundwater prospecting. Includes use of seismic techniques, instrumentation for acquisition on land and sea, seismic processing, structural and stratigraphic modeling, 3-D seismic exploration, and seismic refraction techniques. Prerequisite(s): completion of geology undergraduate math and physics requirements; MATH 344 or 555; GEOL 324, 544, instructor's consent.

**GEOL 781. Advanced Numerical Geology (3).**

Involves practical implementation of algorithms and computer code. Includes the analysis of multivariate techniques and the development of the computer/algorithm skills needed to handle very large databases. Covers standard statistical approaches to data analysis, treatment of applied linear algebra and matrix theory; the application of linear and nonlinear discriminate analysis, various factor analytic techniques, hard and fuzzy clustering, linear and nonlinear unmixing analysis, and other forms of data modeling. Prerequisite(s): GEOL 681 or equivalent, competence in one or more high level computer languages, MATH 344 or 555, and instructor's consent.