Geology and Geophysics

Bachelor of Science
Master of Science
Doctor of Philosophy

Emphasis areas at the Bachelor of Science level in geochemistry, geology, geophysics, groundwater and environmental geochemistry, and petroleum geology.

The Geology and Geophysics program is offered under the Department of Geological Sciences and Engineering.

Geology, geochemistry and geophysics study the history, composition, and structure of Earth and other planetary bodies. The expertise and activities in the Geology and Geophysics program make the Missouri University of Science and Technology one of the leading U.S. research universities. Faculty and students are investigating areas such as the study of nuclear waste disposal, ground water pollution, paleostratigraphy (micro fossils), geophysical characterization of geological hazards (e.g., earthquakes, collapsed caverns) reflection and theoretical seismology, computational geophysics, 3D seismic applications to petroleum exploration, evolution of petroleum reservoirs, genesis of ore deposits, the role of magmatism and tectonics, and industrial processing of minerals. We provide the only program in Missouri in geophysics and geochemistry with an emphasis upon exploration and environmental applications.

Students are drawn to geology and geophysics by a desire to explore a topic that is for many a personal passion. As a student in the Geology and Geophysics program, you may become involved in a wide range of studies. We have students investigating their world and beyond in areas as diverse as planetary geology, fossils and evolution, volcanology, structure and dynamics of Earth’s deep interior, development of cave systems, exploration for oil and gas, adsorption of pollutants by soils, ore mineralization, creation of mountain systems, the beauty of minerals, to name but a few. Many courses involve work outdoors within the state of Missouri as well as in national parks such as the Grand Canyon. You may even find yourself snorkeling over a coral reef in the Caribbean Sea, working in the rifted valleys in Africa or examining geologic evolution of the Egyptian Nile.

In the first two years of study, students develop a strong foundation in geology through the core curriculum. This foundation is strengthened by course work in chemistry, physics, mathematics and computer science, and the humanities and social sciences. Students begin to take more specialized courses pertaining to their particular area of interest in their junior and senior years. The numerous elective courses offered by the Geology and Geophysics program, as well as courses outside the department, provide our majors with the flexibility to custom design an emphasis area of their choice, focusing in on aspects of Earth Science that are of most interest to them. In this way, our majors develop a broad understanding of the fundamentals of our diverse discipline while preserving this important opportunity to develop their own passion within geology and geophysics.

The Earth Sciences have been an integral part of Missouri S&T since its founding in 1870. Our student organizations in geology and geophysics are among the oldest in the nation and include the Dake Society, American Association of Petroleum Geologists, Society of Exploration Geophysicists, and the Sigma Gamma Epsilon (Eta Chapter) honor society. These organizations provide numerous opportunities for social and scientific interaction among students, professionals, and faculty.

The Geology and Geophysics program is located in McNutt Hall and it is especially well endowed with modern, state-of-the-art equipment for teaching and research in most areas of the Earth Sciences. The availability of such equipment provides our students with an excellent laboratory and field educational experience. In addition, cooperative studies with the Missouri Geological Survey and the U.S. Geological Survey provide students with opportunities for part time employment and on-the-job experience while they pursue their degree.

Geological Scientists enjoy their work. As a professional geologist or geophysicist you may explore for oil, gas, and coal to provide for our nation's energy needs. You may search for minerals critical to industry. You may become involved in minimizing environmental hazards. In all cases, you will have the opportunity to work outdoors, in the lab, and with cutting edge technology.

Mission Statement

1) Provide the highest quality education to students leading to the B.S., M.S., and Ph.D. degrees in geology and geophysics. Prepare students for professional careers in five emphasis areas: geology, geochemistry, geophysics, groundwater and environmental geochemistry, and petroleum geology. Provide service courses for students in related programs (including geological engineering, mining engineering, petroleum engineering, metallurgical engineering, ceramic engineering, civil engineering, physics, biology and chemistry) as well as many of the programs in the humanities and liberal arts.

2) The program has both the opportunity and the mission to engage in basic and applied research that contributes to the solution of problems related to mankind and the environment. To meet this goal, the program collaborates on projects that transcend the traditional boundaries between scientific and engineering disciplines. Faculty and students commonly conduct research with geologists in the Rolla offices of the United States Geological Survey and the Missouri Geological Survey, with scientists and engineers from various disciplines at Missouri S&T and other campuses of
the University of Missouri system, as well as with other Earth Scientists in universities within the United States and abroad (e.g. Ireland, Republic of South Africa).

3) Provide graduates to the mining, petroleum, groundwater, and environmental industries; to the Missouri Geological Survey, the U.S. Geological Survey and other educational research institutions.

4) Provide professional service in the fields of geology, geophysics, geochemistry, groundwater and environmental geology. Such service includes the identification of minerals, rocks, and fossils that are sent to the department, the assessment of geologic hazards, contributing to the development and operation of professional organizations, and when called upon, assisting local and state agencies with the evaluation of geological problems.

5) Provide a strong foundation in fundamental principles of geology and geophysics for undergraduate students who desire to pursue opportunities for advanced research in the top graduate schools across the United States. Our graduates have continued their education in prestigious programs, including Arizona State, California-Berkeley, Colorado, Colorado School of Mines, Delaware, MIT, Michigan, Michigan State, Oklahoma, Stanford, Texas, Virginia Tech, Washington, University of Missouri-Columbia and the Missouri University of Science and Technology.

Faculty

Professors:
Mohamed Abdelsalam, Ph.D., University of Texas at Dallas
Stephen Gao, Ph.D., University of California, Los Angeles
Kelly Liu, Ph.D., University of California, Los Angeles
Francisca Oboh-Ikuenobe (Program Head)1, Ph.D., Cambridge

Associate Professors:
John P. Hogan, Ph.D., Virginia Poly Tech.
David J. Wronkiewicz, Ph.D., New Mexico Institute of Mining and Technology
Wan Yang, Ph.D., University of Texas at Austin

Lecturers:
Cheryl Seeger, Lecturer, Ph.D., University of Missouri-Rolla
James E. Vandike, M.S., South Dakota School of Mines

Emeritus Professors:
Richard Hagni1,2 (Curators’ Professor Emeritus), Ph.D., University of Missouri-Columbia
Robert Laudon1,2 (Emeritus), Ph.D., University of Texas at Austin
Gerald Rupert (Emeritus), Ph.D., University of Missouri-Rolla
Alfred Spreng1,2 (Emeritus), Ph.D., Wisconsin

1 Certified Professional Geologist
2 Registered Geologist

Bachelor of Science
Geology and Geophysics

A minimum of 129 credit hours is required for a Bachelor of Science degree in Geology and Geophysics and an average of at least two grade points per credit hour must be obtained.

The Geology and Geophysics curriculum requires nine semester hours in humanities, exclusive of a foreign language, and must include English 60. A minimum of six semester hours is required in social sciences and must include either Economics 121 or 122 and either History 112, 175, 176 or Political Science 90. Six semester hours of course work are available to the student to choose course work that best fits their individual needs for completion of the degree. Specific requirements for the bachelor degree program are outlined in the sample program below

FRESHMAN YEAR
First Semester
Credit
Math 4-College Algebra or Sci & Eng Elective . . . . . .3
Math 6-Trig (or 2 hours free electives) . . . . . . . . . . .2
English 20-Exposition and Argumentation . . . . . . . .3
Chem 4-Intro to Lab Safety . . . . . . . . . . . . . . . . . . .1
Geo 51-Physical Geology . . . . . . . . . . . . . . . . . . . . .3
Geo 53-Physical Geology Lab . . . . . . . . . . . . . . . . .1
Free elective1 . . . . . . . . . . . . . . . . . . . . . . . . . . . . 1
14
Second Semester
Math 8-Calculus w/Analytic Geometry I . . . . . . . . . . .5
Chem 1-General Chemistry . . . . . . . . . . . . . . . . . . .4
Chem 2-General Chemistry Lab . . . . . . . . . . . . . . . . .1
Geo 52-Evolution of the Earth(5) . . . . . . . . . . . . . . . . .3
Geo 54-Evolution of the Earth Lab . . . . . . . . . . . . . . .1
14

SOPHOMORE YEAR
First Semester
Credit
Math 21-Calculus w/Analytic Geometry II . . . . . . . . . . .5
Geop 270-Intro to Geophysics . . . . . . . . . . . . . . . . .3
Geo 113-Mineralogy & Crystallography . . . . . . . . . . .4
Geo 338 or Cmp Sc 53, (71 or 73) & 77 . . . . . . . . . . .3
Elective (Geo & Geop)(4) . . . . . . . . . . . . . . . . . . . . .3
17
Second Semester
English 60 (writing course) . . . . . . . . . . . . . . . . . . .3
Econ 121-Prin of Micro or 122-Prin of Macro . . . . . . . .3
Geo 130-Igneous and Metamorphic Petrology(5) . . . . . . .4
Geo 275-Intro to Geochemistry . . . . . . . . . . . . . . . . .3
Hum/Soc Sci Elective . . . . . . . . . . . . . . . . . . . . . . .3
16

SUMMER OF SOPHOMORE YEAR
Credit
Geo 373-Field Geology . . . . . . . . . . . . . . . . . . . . . .3

JUNIOR YEAR
First Semester
Credit
Physics 23-Engineering Physics I(2) . . . . . . . . . . . . . .4
Stat 213,215,217 or Ge Eng 315-Stat . . . . . . . . . . . . .3
Geo 220-Structural Geology(5) . . . . . . . . . . . . . . . . . .4
History (112,175 or 176) or Pol Sc 90 . . . . . . . . . . . . .3
Elective (Geo & Geop)(4) . . . . . . . . . . . . . . . . . . . . .3
17
Second Semester
Physics 24-Engineering Physics II .... 4
Geo 223/224-Stratigraphy & Sedimentation Lab .... 4
Elective (Geo & Geop) .... 3
Hum/Soc Sci Elective .... 3
Free Elective .... 3
SUMMER OF JUNIOR YEAR
Geo 374-Advanced Field Geology .... 3

SENIOR YEAR
First Semester
Elective (Science & Eng) .... 6
Geo 344-Remote Sensing Technology .... 3
Elective (Geo & Geop) .... 3
Hum/Soc Sci Elective .... 3
Total 15
Second Semester
Electives (Science & Eng) .... 6
Electives (Geo & Geop) .... 5
Geo 310-Seminar .... 1
Geo 381-Global Tectonics .... 3
Total 15

1) Free elective hours may be taken in any combination of credit hours (1,2,3 etc.) and can include any course offerings at the University.
2) Students may substitute Physics 21 and 22 for Physics 23; Physics 25 and 26 for Physics 24.
3) All Geology/Geophysics students must complete at least 15 hours of course work in science (which may include additional Geology/Geophysics courses), mathematics, and/or engineering in addition to Geology/Geophysics, mathematics, and science courses required for the basic program. 12 hours of this course work must be numbered 100 or above.
4) All Geology/Geophysics students including those taking emphasis areas, must complete at least 14 hours of course work numbered 200 or above in the Geology and Geophysics program, in addition to the required core curriculum. Of these 18 hours, at least one course should be selected from each of three (out of five) emphasis area groups listed in the program.
5) Communications emphasized (CE) courses

Core Curriculum
Taken by all students in Geology & Geophysics.
Geo 51-Physical Geology .... 3
Geo 53-Physical Geology Lab .... 1
Geo 52-Evolution of the Earth .... 3
Geo 54-Evolution of the Earth Lab .... 1
Geo 113-Mineralogy & Crystallography .... 4
Geo 130-Igneous & Metamorphic Petrology .... 4
Geo 220-Structural Geology .... 4
Geo 223-Stratigraphy & Sedimentation .... 3
Geo 224-Stratigraphy Lab .... 1
Geo 270-Intro to Geophysics .... 3
Geo 275-Intro to Geochemistry .... 3
Geo 310-Seminar .... 1
Geo 344-Remote Sensing Technology .... 3
Geo 373-Field Geology .... 3
Geo 374-Advanced Field Geology .... 3
Geo 381-Global Tectonics .... 3
Total 43

Geochemistry Emphasis Area
The following courses are required:
Geo 234-Petrology & Petrography .... 3
Geo 275-Intro to Geochemistry .... 3
Geo 294-Metallic & Industrial Mineral Deposits .... 3
Geo 376-Aqueous Geochemistry .... 3
Total 12
In addition, to complete degree requirements with an emphasis area in Groundwater and Environmental Geology students must complete 4 courses (12 hours minimum) to be selected from an approval list and with guidance from student’s advisor.

General Geology Emphasis Area
The following courses are required:
Geo 227-Systematic Paleontology .... 3
Geo 275-Introduction to Geochemistry .... 3
Geo 234-Petrology and Petrography .... 3
Geo 294-Metallic and Industrial Mineral Deposits .... 3
Geo 340-Petroleum Geology .... 3
Total 15
In addition to complete degree requirements with an emphasis area in General Geology students must complete 4 courses (12 hrs. minimum) to be selected from an approved list and with guidance from student’s advisor.

Geophysics Emphasis Area
The following courses are required:
Math/Stat 22-Calculus III .... 3
Geo 286-Intro to Geophysical Data Analysis .... 3
Geo 320-Computational Geophysics .... 3
Geo 377-Seismic Interpretation .... 3
Total 12
12 hours from the following:
Math 204-Elementary Differential Equations .... 3
Math 208-Linear Algebra I .... 3
Math 325-Partial Differential Equations .... 3
Geo 336-Geophysical Field Methods .... 3
Geo 340-Petroleum Geology .... 3
Geo 382-Environmental and Eng Geophysics .... 3
Geo 385-Exploration and Development Seismology .... 3

Groundwater and Environmental Geochemistry Emphasis Area
The following courses are required:
Geo 275-Intro to Geochemistry .... 3
Geo 375-Applied Geochemistry .... 3
Geo 376-Aqueous Geochemistry .... 3
Ge Eng 335-Environmental Geological Eng or
Ge Eng 331-Subsurface Hydrology .... 3
Ge Eng 337-Geol Aspects of Haz Waste Mgt .... 3
Total 15
In addition, to complete degree requirements with an emphasis area in Groundwater and Environmental Geology students must complete 4 courses (12 hrs. minimum) to be selected from an approval list and with guidance from student's advisor.

**Petroleum Geology Emphasis Area**

The following courses are required:

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<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit</th>
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<tbody>
<tr>
<td>Geo 227</td>
<td>Systematic Paleontology</td>
<td>3</td>
</tr>
<tr>
<td>Geo 275</td>
<td>Intro to Geochemistry</td>
<td>3</td>
</tr>
<tr>
<td>Geo 324</td>
<td>Adv Stratigraphy &amp; Basin Evolution</td>
<td>3</td>
</tr>
<tr>
<td>Geo 338</td>
<td>Computer Mapping</td>
<td>2</td>
</tr>
<tr>
<td>Geo 340</td>
<td>Petroleum Geology</td>
<td>3</td>
</tr>
<tr>
<td>Geo 385</td>
<td>Exploration &amp; Dev Seismology</td>
<td>3</td>
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<tr>
<td>Pe Eng 232</td>
<td>Well Logging I</td>
<td>3</td>
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<td><strong>Total</strong></td>
<td><strong>20</strong></td>
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</table>

In addition, to complete degree requirements with an emphasis area in Petroleum Geology students must complete two courses (6 hours minimum) to be selected from an approval list and with guidance from student’s advisor.

**Minor Curriculum in Geology**

The minor will consist of 18 hours of Geology related course work and must include Geo 125 and one of Geo 51 or GE 50 or Geo 52. Six additional hours of course work must come from any combination of 100, 200, 300 geology courses. The remaining 6 hours of course work can be from any combination of geology related courses approved by the Geology and Geophysics program.

Approved Geology related course work:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit</th>
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<tbody>
<tr>
<td>Bio 110</td>
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<td>Geo Eng 315</td>
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<tr>
<td>Bio 111</td>
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<td>Mi Eng 221</td>
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<tr>
<td>Bio 235</td>
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<td>Mi Eng 232</td>
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<tr>
<td>Bio 251</td>
<td></td>
<td>Mi Eng 312</td>
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<tr>
<td>Env Eng 263</td>
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<td>Mi Eng 331</td>
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<tr>
<td>Eng Eng 361</td>
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<td>Pe Eng 232</td>
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<tr>
<td>Env Eng 364</td>
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<td>Pe Eng 333</td>
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<tr>
<td>Geo Eng 275</td>
<td></td>
<td>Pe Eng 366</td>
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<td><strong>Total</strong></td>
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</table>

**Geology Courses**

50 **Introduction to Physical Geology** (LEC 2.0 and LAB 1.0) A study of Earth materials, surface features, internal structures and processes. Particular attention is paid to Earth resources, geological hazards, engineering and environmental problems. Prerequisite: Entrance requirements. (Co-listed with Geo Eng 50)

51 **Physical And Environmental Geology** (LEC 3.0) Materials, structure, and surface features of the Earth and planets are studied in the context of the processes that continuously transform the Earth and affect management of Earth resources, hazards, and environmental challenges. A one day field trip is required. Prerequisite: Entrance requirements.

52 **Evolution Of The Earth** (LEC 3.0) A survey of the Earth history from the coalescence of the solar system to the present and the events that have profoundly transformed the planet in the context of the dynamic feedback between physical and biological systems. A one day field trip is required. Prerequisites: Recommend Geo Eng 50 or Geology 51 or Bio Sci 110 but not required.

53 **Physical and Environmental Geology Laboratory** (LAB 1.0) Geology 53 is designed to accompany Geology 51 and consists of laboratory explorations of the study of common rocks and minerals, air photographs, maps, and case studies of geological problems related to management of Earth resources, hazards, and environmental challenges. Prerequisite: Preceded or accompanied by Geology 51.

54 **Evolution of the Earth Laboratory** (LAB 1.0) Geology 54 is designed to accompany Geology 52 and consists of laboratory explorations of fundamental concepts in geology and the diversity of the fossil record. Prerequisite: Preceded or accompanied by Geology 52.

101 **Special Topics** (Variable 0.0-6.0) This course is designed to give the department an opportunity to test a new course. Variable title.

113 **Mineralogy And Crystallography** (LEC 3.0 and LAB 1.0) An introduction to the study of minerals, including their systematic classification, crystallography, morphology, chemistry, societal use, geologic occurrence, environmental application and impact, and identification by means of their physical and chemical properties. Prerequisites: Chem 1 and Chem 2.

125 **Physical Mineralogy And Petrology** (LEC 2.0 and LAB 1.0) An introduction to the study of physical mineralogy and petrology, overviewing systematic determination of minerals and rocks by means of their physical properties. Includes the recognition of crystal forms and field relationships of rocks. Course designed for non-geology majors, credit will not count towards a geology-geophysics degree. Prerequisites: Chem 1 and Chem 2 or Chem 5; Ge Eng 50 or Geo 51.

130 **Igneous And Metamorphic Petrology** (LEC 3.0 and LAB 1.0) A comprehensive study of megascopic and microscopic characteristics of igneous and metamorphic rocks. Fundamental theories for their origin are presented. The class includes a trip to examine these rock types in the field. Prerequisite: Geology 113.

200 **Special Problems** (IND 0.0-6.0) Problems or readings on specific subjects or projects in the department. Consent of instructor required.

201 **Special Topics** (Variable 0.0-6.0) This course is designed to give the department an opportunity to test a new course. Variable title.

220 **Structural Geology** (LEC 3.0 and LAB 1.0) A study of the architecture of the earth. Geologic structures, criteria for recognition, solution of structural problems, and properties and behavior of rocks under different geologic conditions are emphasized. Field trip fee required. Prerequisite: Geo 51 or Ge Eng 50.

223 **Stratigraphy And Sedimentation** (LEC 3.0) Principles of physical stratigraphy, bio-
stratigraphy and introductory sedimentation. Introduction to depositional systems, facies, unconformities, stratigraphic nomenclature and correlation. One field trip at student expense is required. Prerequisite: Geo 130 or Geo 125.

224 Stratigraphy Lab (LAB 1.0) This course re-enforces the principles of stratigraphy and sedimentation through the use of "hands-on" laboratory procedures such as seive and pipette analyses, correlation problems, fence diagrams and stratigraphic maps. One field trip at student expense is required. Prerequisite: Concurrent with Geo 223.

227 Systematic Paleontology (LEC 2.0 and LAB 1.0) Introduction to the study of fossil invertebrates. Emphasis of the course is on fossil morphology, classification, and environmental relationships. Prerequisite: Geo 52.

248 Fundamentals Of Geographic Information Systems (LEC 2.0 and LAB 1.0) Introduction to the fundamental concepts and components of Geographic Information Systems. Techniques for acquiring, manipulating and analyzing digital terrain data for geological and geotechnical applications. (Co-listed with Geo Eng 248)

260 Methods Of Karst Hydrogeology (LEC 3.0) This course is designed to familiarize geologists and geological engineers with karst hydrogeology. It will include the formation of karst, aquatic geochemistry in karst areas, identifying karst features and understanding their hydrologic significance. The techniques for investigating groundwater in karst areas will be emphasized, and will include groundwater tracing using fluorescent dyes. Several field trips at student expense will be required. Prerequisites: Geo 51 or Ge Eng 50 and Geo 223.

275 Introduction To Geochemistry (LEC 3.0) Application of basic chemical principals towards investigations of element distributions in geologic systems. Emphasis on origin of elements in our Solar System, element distribution during planetary formation, phase equilibria, rock-water interactions, thermodynamic principles, environmental and isotope geochemistry. Prerequisite: Chem 1.

294 Metallic And Industrial Mineral Deposits (LEC 3.0) Basic processes involved in the formation of metallic and industrial mineral deposits illustrated by typical examples of deposits from throughout the world. Exploration and economic factors in mineral exploration and development are reviewed. Two all day field trips at student expense required. Prerequisites: Geo 51 and 113.

300 Special Problems (IND 0.0-6.0) Problems or readings on specific subjects or projects in the department. Consent of instructor required.

301 Special Topics (Variable 0.0-6.0) This course is designed to give the department an opportunity to test a new course. Variable title.

305 Hydrogeology (LEC 3.0) This course discusses geologic aspects of major surface and subsurface hydrologic systems of North America. Chemical and physical relationships between groundwater and fractures, faults, karst, subsurface pressures, mineral deposits plus both contaminant and hydrocarbon migration are discussed. Prerequisites: Ge Eng 50 or Geo 51, Geo 223 recommended.

307 Physical Oceanography (LEC 3.0) An introduction to the study of the physical and geological processes in the world’s oceans including the importance of the oceans to the environment and to life on Earth. Prerequisite: Geology 325 or equivalent.

308 Astronomy and Planetary Science (LEC 3.0) Basic principles of astronomy, the origin and evolution of the universe, stellar evolution, and the origin, composition, and processes operating on the planetary bodies in the solar system (besides the Earth). Prerequisite: Entrance requirements for the MST program in Earth Science.

309 Meteorology and Climatology (LEC 3.0) An introduction to the atmospheric and climatic systems of the Earth including weather, paleoclimatology, and global climate change. Prerequisite: Geology 325 or equivalent.

310 Seminar (RSD 0.0-6.0) Discussion of current topics. Required for two semesters during senior year. (Course cannot be used for graduate credit). Prerequisite: Senior standing. (Co-listed with Geo Eng 310, Pet Eng 310)

312 Ore Microscopy (LEC 1.0 and LAB 2.0) A study of polished sections of minerals and ores under reflected light. Includes the preparation of polished sections, the identification of ore minerals, and the study of the textures, associations, and alterations of ore minerals. Prerequisite: Geo 113.

320 Advanced Structural Geology (LEC 2.0 and LAB 1.0) The course provides theoretical background, analytical techniques, and hands-on experience for analyzing geologic structures at a variety of scales hand sample to global. Prerequisites: Geology 220, Geophysics 381.

324 Advanced Stratigraphy And Basin Evolution (LEC 3.0) Advanced topics in sedimentary geology including: tectonic controls on sedimentary basin development, global sequence stratigraphy, regional facies and diagenetic patterns, basin hydrogeology, thermal evolution of basins and distribution of economic resources. Prerequisites: Geo 223, 220, preceded or accompanied by Geo 275 recommended.

326 Advanced Historical Geology (LEC 2.0 and LAB 1.0) Study of the physical and biological history of the Earth beginning with the origin of the solar system up to the present. Emphasis will be placed on processes that shaped the Earth and its ecosystems. Prerequisite: Entrance requirements for the MST program in Earth Science.
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<tr>
<th>Course Number</th>
<th>Course Title</th>
<th>Description</th>
<th>Prerequisites</th>
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<tbody>
<tr>
<td>329</td>
<td>Micropaleontology</td>
<td>Introduction to the preparation and study of microscopic fossils. Prerequisite: Geo 227.</td>
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<td>330</td>
<td>Granites And Rhyolites</td>
<td>Processes governing the generation and crystallization of felsic magma will be covered,</td>
<td>Ge Eng 248. (Co-listed with Geo Eng 344)</td>
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<td>with specific reference to: 1) crust vs mantle sources, 2) melt migration and emplacement, 3) magma</td>
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<td>chamber dynamics, 4) the volcanic-plutonic connection, and 5) the relationship to tectonic setting.</td>
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<td>A field trip at the student’s expense is required.</td>
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<tr>
<td>332</td>
<td>Depositional Systems</td>
<td>Development of three dimensional depositional models using Walther’s Law, Walther’s Warning and</td>
<td>Geo 130.</td>
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<td>seismic stratigraphy. Emphasis on overall geometries and internal porosity and permeability</td>
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<td>characteristics of aquifers and hydrocarbon reservoirs. Includes 3-D models for clastic, carbonate</td>
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<td>and evaporate sequences. Prerequisite: Geology 51 or Geo Eng 50.</td>
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<tr>
<td>334</td>
<td>Advanced Igneous and Metamorphic Petrology</td>
<td>Processes governing the formation of igneous and metamorphic rocks as constrained by geochemical,</td>
<td>Geo 51 or Geo Eng 50.</td>
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<td>isotopic, and thermodynamic data, with particular reference to the relationship between rock suites</td>
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<td>and tectonic setting. The laboratory will emphasize the description of rock suites in hand sample</td>
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<td>and thin section. A field trip at the student’s expense is required.</td>
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<td>338</td>
<td>Computer Mapping In Geology</td>
<td>This course introduces the basics of both surface and subsurface geologic mapping. It introduces</td>
<td>Geography 130.</td>
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<td>procedures and problems associated with digitizing, gridding, contouring, volumetrics and</td>
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<td>generation of three dimensional diagrams on the PC. Integration of field gathered data with USGS</td>
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<td>and GSI databases for the purpose of making surface geologic maps is also included.</td>
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<tr>
<td>340</td>
<td>Petroleum Geology</td>
<td>Principles of origin, migration, and accumulation of oil and gas. The laboratory introduces the</td>
<td>Two Geology courses.</td>
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<td>procedures used for exploration, and development of hydrocarbon resources. Prerequisite: Geology</td>
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<td>51 or Geo Eng 50 (Introductory Geology course)</td>
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<td>341</td>
<td>Applied Petroleum Geology</td>
<td>The principles of petroleum geology are applied in solving hydrocarbon exploration and</td>
<td>Geo 340.</td>
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<td>developmental problems. Geological and economical techniques for evaluating hydrocarbonbearing</td>
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<td>reservoirs are presented, with methods for decision making under conditions of extreme uncertainty.</td>
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<td>classification. Emphasis upon design and implementation of remote sensing systems and analysis of</td>
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<td>remotely sensed data for geotechnical and environmental investigations. Prerequisite: Ge Eng</td>
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<td>248. (Co-listed with Geo Eng 344)</td>
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<td>345</td>
<td>Radioactive Waste Management And Remediation</td>
<td>Sources and classes of radioactive waste, long-term decay, spent fuel storage, transport, disposal</td>
<td>Geography 52.</td>
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<td>options, regulatory control, materials issues, site selection and geologic characterization,</td>
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<td>containment, design and monitoring requirements, domestic and foreign waste disposal programs,</td>
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<td>economic and environmental issues; history of disposal actions, and conduct of remedial actions and</td>
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<td>cleanup. Prerequisite: Math 204. (Co-listed with Nu Eng 345)</td>
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<td>346</td>
<td>Applications Of Geographic Information Systems</td>
<td>Applications of Geographical Information Systems and remote sensing to environmental monitoring,</td>
<td>Two Geology courses.</td>
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<td>mineral resource exploration, and geotechnical site evaluation. Prerequisite: Geo Eng 275 or</td>
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<td>consent of instructor. (Co-listed with Geo Eng 346)</td>
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<td>350</td>
<td>Paleoclimatology and Paleoecology</td>
<td>This course will introduce students to the elements of climate, evidence of climate changes, proxy</td>
<td>Geography 52.</td>
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<td>measurements and paleoclimate models. There is a review of Holocene climates and Archean to</td>
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<td>Pleistocene paleoclimates. Prerequisite: Geography 52.</td>
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<td>372</td>
<td>Geological Field Studies</td>
<td>Intensive review of the scientific literature corresponding to a selected geographical region of</td>
<td>Geography 51 or Geo Eng 50.</td>
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<td>geologic interest; followed by a 7 to 10 day long field trip to be held over spring break or after</td>
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<td>the end of the semester. Students will be expected to bear a portion of the field trip expenses.</td>
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<td>373</td>
<td>Field Geology</td>
<td>Field practice in geologic mapping and interpretation in the Western United States using topographic</td>
<td>Geography 51 or Geo Eng 50.</td>
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<td>base maps and aerial photos. Emphasizes the description and interpretation of stratigraphic</td>
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<td>sections, sedimentary and tectonic structures. Prerequisite: Two Geology courses.</td>
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<td>374</td>
<td>Advanced Field Geology</td>
<td>Detailed field work in areas related to the projects of Geology 373. Courses to be taken the same</td>
<td>Geo 373.</td>
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<td>summer. A written report on the full summer’s projects is required. Prerequisite: Geo 373.</td>
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<td>375</td>
<td>Applied Geochemistry</td>
<td>Application of the principles of geochemistry and techniques of geochemical analysis in a student</td>
<td>Geo 113 and Geo 275.</td>
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<td>research project investigating geochemical processes (mineral deposits, environmental geochemistry,</td>
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<td>trace element migration, or water-rock interaction). Field trip fee required. Prerequisites: Geo 113</td>
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<td>376</td>
<td>Aqueous Geochemistry</td>
<td>Studies of the interaction of water with minerals and organic materials at low temperatures;</td>
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<td>including processes affecting the migration of elements</td>
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(alteration, precipitation, and adsorption), the influence of geochemical processes on water composition, weathering, soil formation, and pollution. Field trip fee required. Prerequisite: Geo 275.

378 Isotope Geochemistry (LEC 2.0 and LAB 1.0) Introduction to the fundamentals of radiogenic and stable isotopes as used to understand geologic processes. The use of selected isotopic systems in petrology, ore petrogenesis, paleontology, and the global climate systems will be discussed. Prerequisites: Geology 130, 223, 275.

383 Electrical Methods In Geophysics (LEC 3.0) The theory and instrumentation for measurements of the electrical properties of the earth. Includes passive and active techniques, the advantages and disadvantages of the various techniques, and geologic interpretations of electrical soundings. Several weekends are spent making a variety of electrical surveys of local features. Prerequisites: Math 325 and Geop 321.

390 Undergraduate Research (IND 0.0-6.0) Designed for the undergraduate student who wishes to engage in research. Not for graduate credit. Not more than six (6) credit hours allowed for graduation credit. Subject and credit to be arranged with the instructor.

394 Coal Petrology (LEC 3.0) Formation, composition, and properties of coals. Discussion of the geology of selected coal deposits, the analysis of coal, and the optical identification of coal minerals. Prerequisite: Permission of instructor.

Geophysics Courses

201 Special Topics (Variable 0.0-6.0) This course is designed to give the department an opportunity to test a new course.

270 Introduction to Geophysics (LEC 3.0) An introduction to a broad area of solid earth geophysics and exploration geophysics. Topics include plate tectonics, earthquake study, structure and dynamics of the Earth’s deep interior, gravity, magnetism, heat flow, and geophysical exploration for natural resources. Prerequisites: Math 8 and Geology 51.

285 Geophysical Imaging (LEC 2.0 and LAB 1.0) A study of the major geophysical methods applicable to shallow engineering and environmental geoscience. Topics include the background theory and practical application of gravity, magnetics, radiometrics, resistivity, induced polarization, spontaneous potential, reflection and refraction seismics, ground penetrating radar, electromagnetics, and borehole logging methods. Prerequisites: Physics 24; Ge Eng 50 or Geo 51.

286 Introduction To Geophysical Data Analysis (LEC 3.0) The application of time series and spatial series analysis techniques to geophysical data. Topics covered include digitization and aliasing of geophysical signals, frequency and wave number spectra, digital filtering and linear systems theory. Prerequisites: Math 22 and Cmp Sc 53, 73 & 77, or 74 & 78.

300 Special Problems (IND 0.0-6.0) Problems or readings on specific subjects or projects in the department. Consent of instructor required.

301 Special Topics (Variable 0.0-6.0) This course is designed to give the department an opportunity to test a new course. Variable title.

320 Computational Geophysics (LEC 1.0 and LAB 2.0) Scientific programming in a UNIX/Linux environment, with emphasis on solving geophysical problems such as linear and nonlinear inversion, spectral analysis, seismicity, seismic wave attenuation, shear-wave splitting, and seismic tomography. Prerequisite: Geophys 270.

321 Potential Field Theory (LEC 3.0) The mathematics and physics of gravitational, magnetic, and electrical fields of the earth as derived from potential functions, with applications to practical problems. The theorems of Laplace, Poisson, Gauss, and Green and their applications to geophysics are presented. Prerequisite: Accompanied or preceded by Math 325.

336 Geophysical Field Methods (LEC 2.0 and LAB 1.0) Imaging of selected subsurface features and engineering structures using various geophysical tools. Special emphasis is placed on ground penetrating radar and surface wave techniques. One field trip at student expense required. Prerequisite: Junior level standing or higher. (Co-listed with Geo Eng 336)

361 Transportation Applications of Geophysics (LEC 2.0 and LAB 1.0) Overview of geophysical and non-destructive test methods that are commonly used to investigate transportation structures and their foundations. Emphasis is placed on bridge system substructure, bridge system superstructure, pavement, roadway subsidence, subsurface characterization and vibration measurements. Prerequisite: Junior level standing or higher. (Co-listed with Geo Eng 361 and Civ Eng 351)

377 Seismic Interpretation (LEC 1.0 and LAB 2.0) An introduction to 2-D/3-D seismic structural interpretation, stratigraphic interpretation, reservoir identification and evaluation, and horizon and formation attributes. The students are expected to master interactive 2-D/3-D seismic interpretation software packages that are routinely used in the petroleum industry. Prerequisite: Geophys 270 or 385.

380 Seismic Stratigraphy (LEC 2.0 and LAB 1.0) A study of the seismic expression of depositional models. Reflection patterns and reflection amplitudes are interpreted to determine bed thicknesses, fluid content, depositional environment, and lithology. Special data acquisition and processing techniques are
examined. Prerequisites: Geop 385, Geo 220, 223.

381 Global Tectonics (LEC 3.0) An integrated view of the Earth's structure and dynamics with an emphasis on information gained through geophysical methods. Topics include seismology, heat flow, gravity, rheological and compositional structure, plate motions and intermotions, and mantle driving mechanisms for plate tectonics. Prerequisite: Geo 220.

382 Environmental And Engineering Geophysics (LEC 2.0 and LAB 1.0) An introduction to the theory and application of the gravity, magnetic, resistivity, self-potential, induced polarization and electromagnetic methods as applied to the solution of engineering and environmental problems. Prerequisite: Math 22. (Co-listed with Geo Eng 382)

383 Electrical Methods In Geophysics (LEC 2.0 and LAB 1.0) The theory and instrumentation for measurements of the electrical properties of the earth. Includes passive and active techniques, the advantages and disadvantages of the various techniques, and geologic interpretations of electrical soundings. Several weekends are spent making a variety of electrical surveys of local features. Prerequisites: Math 325 and Geop 285 or Geop 382.

385 Exploration And Development Seismology (LEC 2.0 and LAB 1.0) Principles of reflection seismology as applied to the delineation of geologic structures and the determination of stratigraphy and lithology. Emphasis on both the capabilities and limitations of the seismic method. The laboratory utilizes both modeled and actual seismic data. Prerequisite: Math 22.

386 Wave Propagation (LEC 3.0) A study of Hamilton's principle and energy theorems, fundamentals of plane wave theory, waves in stratified fluids, elastic waves in solids, electromagnetic and hydromagnetic radiation, and Allen's functions and point sources. Prerequisites: Geop 281, 321.

388 Geophysical Instrumentation (LAB 1.0) Field and laboratory practice in the use of geophysical instruments. Techniques of geophysical data reduction and interpretation are also covered. May be taken more than once for credit with Geop 383 and Geop 384. Prerequisite: Concurrent registration in Geop 382, 283 or 384.

389 Seismic Data Processing (LEC 2.0 and LAB 1.0) Introduction to seismic data processing. Topics to be covered include statics corrections, filtering, velocity analysis, deconvolution, stacking and migration. Prerequisites: Math 22, and Geop 285 or Geop 385.

390 Undergraduate Research (IND 0.0-6.0) Designed for the undergraduate student who wishes to engage in research. Not for graduate credit. Not more than six credit hours allowed for graduation credit. Subject and credit to be arranged with the instructor.

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German Courses

1. Elementary German I (LEC 4.0) Introduction to grammar, reading, and conversation. Laboratory required. (One extra hour per week.) Prerequisite: Entrance requirements.

2. Elementary German II (LEC 4.0) A continuation of German 1. Prerequisite: German 1.

80. Classical And Modern German Readings (LEC 4.0) Readings in German narrative literature. Prerequisite: German 2.

100. Special Problems (IND 0.0-6.0) Problems or readings on specific subjects or projects in the department. Consent of instructor required.

101. Special Topics (Variable 0.0-6.0) This course is designed to give the department an opportunity to test a new course. Variable title.

110. Basic German Conversation (LEC 2.0) Conversation and oral practice. Prerequisite: German 2.

170. Masterpieces Of German Literature (LEC 3.0) A study of selected major works and movements in German literature. Prerequisite: German 70.

200. Special Problems (IND 0.0-6.0) Problems or readings on specific subjects or projects in the department. Consent of instructor required.

201. Special Topics (Variable 0.0-6.0) This course is designed to give the department an opportunity to test a new course. Variable title.

300. Special Problems (IND 0.0-6.0) Problems or readings on specific subjects or projects in the department. Consent of instructor required.

301. Special Topics (Variable 0.0-6.0) This course is designed to give the department an opportunity to test a new course. Variable title.

310. Seminar (RSD 0.0-6.0) Discussion of current topics. Prerequisite: Senior standing.

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Global Studies

Global Studies Minor

Global Studies is a multi-disciplinary undergraduate minor program designed to aid in the preparation of Missouri S&T students to be successful in an increasingly global workforce. Students who complete the Global Studies minor will have an increased awareness of the society, culture, technical issues, and/or language of at least one country other than the United States prior to the completion of their Missouri S&T undergraduate experience. Any Missouri S&T student enrolled in an undergraduate degree program is eligible for the Global Studies minor program, which consists of 12 credit hours from an approved list of classes and at least 2 weeks (14 days) of experience in a foreign country acquired during an approved Missouri S&T class or research project, Missouri S&T extracurricular activity, and/or Missouri S&T study abroad activity.