7. Program Description
Provide a brief narrative description of the program, including a list of its central academic objectives. Explain how the curriculum is structured to meet the program’s stated objectives.

The College of Science proposes a progressive, interdisciplinary doctoral program in Geosciences to attract dynamic, talented graduate students to Southern Illinois University Carbondale. Although the program will be housed in the Department of Geology, faculty participating in the program from other departments in the College will have input into admissions, the curriculum, and student research mentoring. We note the strong track record of current Geology faculty in participating in inter-departmental research projects, including an 11-department collaboration on an Interdisciplinary Graduate Education Research and Training (IGERT) proposal led by a member of the geology faculty and now in the final round of competition with NSF. Appendix A lists specific faculty with backgrounds relevant to the Geosciences doctoral program, along with courses offered from across campus appropriate to the program.

8. Admissions Requirements
Provide a brief narrative description of minimum admission requirements.

An admissions committee composed of faculty participating in the doctoral program in Geosciences will make decisions concerning the admission of students to, and retention of students in the doctoral program, subject to the requirements of the Graduate School. At least half of the members of the admissions committee will be from the Department of Geology. Admission is based on an evaluation of the preparation, ability, and promise of the applicant. Admission requirements include GRE test scores; a transcript of all collegiate course work; and three letters of recommendation from professors, academic advisors, or others familiar with the student’s academic performance and promise for research. The evaluation of applicants for admission is based primarily on the student’s academic record, although additional evidence of scholarly ability or achievement will also be considered in the admission process.

Students entering the doctoral program in Geosciences should meet, as a minimum, the requirements of a Masters degree program in a physical or biological science, mathematics, or engineering. However, exceptional students may be considered for post-baccalaureate accelerated entry into the doctoral program. This requires approval by a majority vote of the faculty participating in the doctoral program in Geosciences.

Upon entering the program, students will have a preliminary counseling conference. The purpose of this conference is to allow the students and their advisors to establish a suitable curriculum and research program commensurate with the students’ backgrounds, interests, and career goals.

9. Graduation Requirements
Provide a brief narrative description of all graduation requirements, including, but not limited to, credit hour requirements.

Requirements
The primary objective of the doctoral program in Geosciences is to develop a student capable of successfully conducting original research and the presentation of an acceptable dissertation describing the results, analysis, and implications of that research. To achieve this goal, the
student must meet the criteria established by the University, the Graduate School, and the faculty participating in the doctoral program in Geosciences. The program of study will be flexible, to allow students to take courses offered by departments within the College of Science, and across campus. Each student is expected to take graduate level courses (excluding readings, independent studies, and internship) of at least 3 credits each from at least four different faculty members at SIUC. The program requires a minimum of 48 semester hours, 24 of which may be 600-level dissertation credits.

Before the end of their second year in the program, students shall have (1) established an advisory committee including their dissertation adviser and four additional members (any member of the graduate faculty in the University can serve on the committee, but at least one member must be from a department other than the Department of Geology); (2) demonstrated competence in at least one research tool (the student’s advisory committee will determine the requirements and research tool competence); and (3) presented themselves to the advisory committee for a comprehensive written and oral examination. At this time, the student must also select from one of the program concentrations:

- Biogeochemistry
- Earth Surface Processes
- Energy and Mineral Resources
- Geophysics and Tectonics
- Paleobiology

The format of the comprehensive examinations shall be established by the faculty participating in the doctoral program in Geosciences. Students who fail the comprehensive examinations and wish to remain in the program may, with faculty consent, retake the examinations. Students who fail the second written-oral examination will be dropped from the program. After successful completion of the comprehensive exams, the student must prepare and defend a dissertation proposal. If a student successfully defends the dissertation proposal, he or she is admitted to candidacy for the Ph.D. degree. The comprehensive examinations and dissertation proposal defense are part of the formal assessment process.

As a candidate for the degree of Doctor of Philosophy in Geosciences, the student is expected to make normal progress toward the successful completion and presentation of original research. Ordinarily, the doctoral student should expect to spend a minimum of two years beyond the Masters degree, or its equivalent, in residence. Students will be required to present an acceptable dissertation describing original research performed with minimal supervision and deemed by the advisory committee to be of such quality as to merit publication in appropriate professional journals. A final oral examination will be held after completion of the doctoral dissertation. This examination will concentrate on the defense of the dissertation but is not restricted to the dissertation topic or area. The dissertation will be accepted provided the dissertation advisor and at least three of the other four members of the committee so agree.

Degree requirements, graduation, and time limits are subject to the general guidelines of the Graduate School.

**Course Listing**

While faculty from different departments in the College of Science are expected to add courses appropriate for the doctoral program in geosciences, the addition of a Ph.D. program will not require specific changes to the course listings. The College, and Department of Geology already
have a wide range of advanced graduate courses listed in the catalog. The addition of a Ph.D. program will make it possible to offer many of these as well as new courses on a more regular basis.

Appendix A lists graduate courses from across campus appropriate for the individual tracks. Appendix B lists the graduate courses within the Department of Geology.

<table>
<thead>
<tr>
<th>10. Student Outcomes</th>
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<tbody>
<tr>
<td>Explain what students are expected to know and/or be able to do upon completing the program.</td>
</tr>
</tbody>
</table>

The doctoral program in geosciences has three main learning objectives:

1) Students will have further developed their fundamental knowledge of the Geosciences beyond the Masters degree, gaining additional theoretical and practical knowledge of the subject matter in one of the following concentrations:

- Biogeochemistry
- Earth Surface Processes
- Energy and Mineral Resources
- Geophysics and Tectonics
- Paleobiology

2) Students will be able to conduct independent, original research; creating new knowledge that can pass rigorous peer review. By completion of the degree the students will be expected to have published in, or produced papers for submission to, respected journals appropriate to their research. They will also gain additional competence by presenting the results of their research at seminars and at professional meetings and conferences.

3) Students will obtain an interdisciplinary education, by completing graduate coursework from departments across campus, within the Colleges of Science, Engineering, Agriculture, and Liberal Arts. The proposed program complements existing doctoral programs in engineering, chemistry and biochemistry, plant biology, physics, mathematics, and zoology within the College of Science.

Students completing the program would possess the knowledge and skills to seek academic and industry positions which focus on basic and applied research.

The dissertation advisor and members of the advisory committee will mentor the student by offering continued guidance and support in the selection of courses. Prior to selection of their advisory committee, the Graduate Program Director in the Department of Geology will mentor the student. Student-to-faculty and student-to-student interaction will be promoted by the use of seminars within the College. By its very nature, a doctoral program promotes independent learning; students are required to draft research papers, attend and present papers at seminars and conferences, participate in discussion groups, and assist in teaching and the development of introductory courses.

<table>
<thead>
<tr>
<th>11. Assessment of Student Learning</th>
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<tbody>
<tr>
<td>Describe how the realization of student outcomes identified above will be measured. Measures may include end- or near-end-of-program assessment of student learning, in addition to course</td>
</tr>
</tbody>
</table>
by-course assessment such as: (1) evaluation of capstone experiences (senior projects, recitals, exhibits, portfolios, etc.); (2) pre- and post-testing (value-added assessment).

Section 14, Program Assessment provides details on assessment measures. Assessment is mainly based on the written and oral comprehensive exams, the dissertation proposal defense, and the dissertation defense. Detailed evaluations associated with these exams will track the student’s progress throughout the degree program and allow the faculty to examine each of the student outcomes.

12. Program Accreditation
Describe the institution’s plans for seeking programmatic accreditation if applicable.

Geosciences does not have an accreditation body.

13. Graduate Licensure
Indicate if this program prepares graduates for entry into a career or profession that is regulated by the state of Illinois. If so, indicate how the program is aligned with licensure/certification and/or entitlement requirements.

Although the State of Illinois regulates the profession of geology, this mainly impacts graduates with a masters degree, not those holding a doctorate.
Appendix A
Geoscience Doctoral Program Tracks

Biogeochemistry

Description:
The Biogeochemistry track of the proposed doctoral program in geosciences will focus on the interdisciplinary interfaces between traditional geosciences and the chemical, biochemical, chemodynamic, biological, ecological and engineering phenomena which are implicit in both natural and anthropogenic processes occurring in the lithosphere, hydrosphere, atmosphere and biosphere. This track will create a unique option for graduate education and research in advanced geosciences for students with degrees and expertise in the areas of chemistry, atmospheric sciences, terrestrial and aquatic ecology, microbiology, and engineering. The interdisciplinary research conducted by these individuals will prepare them for cross-disciplinary careers in resource utilization and management, environmental impact assessment and remediation, and future energy development. The goal of this track of the Ph.D. program will be to prepare a unique cadre of geoscientists with a broad understanding of biological processes.

Faculty outside of the Department of Geology who could participate in this track:
Jay Means, Chemistry (chemodynamics)/Pharmacology (toxicology) and Dean of COS
Boyd Goodson, Chemistry (protein interactions)
Brian Lee, Chemistry (structural biochemistry)
Matt McCarroll, Chemistry (fluorescence, spectroscopy)
Gabriela Perez-Alvarado, Chemistry (NMR, protein interactions)
Gary Kinsel, Chemistry (MALDI, proteomics)
Luke Tolley, Chemistry (instrumentation development, biological applications)
Qingfeng Ge, Chemistry (materials science and biology, enzyme catalysis)
Lichang Wang, Chemistry (fluorescence sensors)
Dunren Che, Computer Science (bioinformatics)
Michelle Zhu, Computer Science (bioinformatics)
Laurie Achenbach, Microbiology (bioremediation)
Kelly Bender, Microbiology (environmental stress response)
John Haddock, Microbiology (biodegradation)
Sara Baer, Plant Biology (biogeochemistry, restoration)
Loretta Battaglia, Plant Biology (restoration)
Stephen Ebbs, Plant Biology (remediation)
Matt Geisler, Plant Biology (bioinformatics)
David Gibson, Plant Biology (restoration, global environmental change)
Karen Renzaglia, Plant Biology (hornwort biogeography)
Dave Vitt, Plant Biology (biogeochemistry of peatlands)
Richard Halbrook, Zoology (wildlife toxicology)
Mike Lydy, Zoology (aquatic toxicology)
Brian Klubek, Plant Soil Science & Ag Systems, Agriculture (soil microbiology)
Lizette Chevalier, Civil and Environmental Engineering, Engineering (contaminant hydrology)
James Blackburn, Civil and Environmental Engineering, Engineering (environmental processes)
Sanjeev Kumar, Civil and Environmental Engineering, Engineering (soil-structure interactions)
John Nicklow, Civil and Environmental Engineering, Engineering (applied hydrology)
Rolando Bravo, Civil and Environmental Engineering, Engineering (hydrology)
Bruce DeVantier, Civil and Environmental Engineering, Engineering (remediation)
Yanna Liang, Civil and Environmental Engineering, Engineering (bioremediation)
Xingmao (Samuel) Ma, Civil and Environmental Engineering, Engineering (bioremediation)
James Blackburn, Mechanical Engineering Energy Processes, Engineering (bioremediation)
Kanchan Mondal, Mechanical Engineering Energy Processes, Engineering (bioremediation)

Relevant Courses in Geology:
- GEOL 413 Quantitative Methods in Geology
- GEOL 414 Paleobotany
- GEOL 417 Isotope Geochemistry
- GEOL 418 Low Temperature Geochemistry
- GEOL 419 Ore Deposits
- GEOL 420 Petroleum Geology
- GEOL 421 Organic Geochemistry
- GEOL 425 Invertebrate Paleontology and Paleoecology
- GEOL 428 Paleocology and Environments of Deposition
- GEOL 440 Advanced Topics in Geological Sciences
- GEOL 454 Field Geology
- GEOL 470 Hydrogeology
- GEOL 478 Advanced Environmental Geology
- GEOL 480 Coal Geology
- GEOL 483 Forensic Geology
- GEOL 510 Advanced Sedimentology
- GEOL 515 Instrumental Analysis in Geology
- GEOL 517 Advanced Topics in Geochemistry
- GEOL 518 Clay Mineralogy
- GEOL 523 Carbonates
- GEOL 524 Advanced Topics in Sedimentary Geology
- GEOL 525 Advanced Topics in Invertebrate Paleontology
- GEOL 526 Advanced Topics in Applied Paleocology
- GEOL 527 Micropaleontology
- GEOL 550 Advanced Economic Geology
- GEOL 551 Advanced Topics in Economic Geology
- GEOL 570 Advanced Hydrogeology
- GEOL 576 Coastal Geomorphology and Sedimentology
- GEOL 577 Advanced Topics in Surface Geology
- GEOL 578 Fluvial Geomorphology
- GEOL 579 Soil Geomorphology

Relevant Courses outside of Geology:
- CHEM 431 Environmental Chemistry
- CHEM 434 Instrumental Analytical Chemistry
- CHEM 451 (a and b) Biochemistry
- MBMB 456 (CHEM 456, BIOCHEM 456) Biophysical Chemistry
- CHEM 462 Classical Physical Chemistry
- CHEM 466 Physical Chemistry Laboratory
- CHEM 531 Introduction to Analytical Separations
- CHEM 532 Analytical Chemistry Instrumentation
- CHEM 536 Principles of Mass Spectrometry
- CHEM 537 Fluorescence Spectroscopy
- CS 438 Bioinformatics Algorithms
- MBMB 425 Biochemistry and Physiology of Microorganisms
- PLB 426 Plant Genomics and Bioinformatics
- PLB 427 Plant Biochemistry
PLB 443  Restoration Ecology
PLB 450  Plant Geography
PLB 471  Bioinformatics
PLB 501  Research Transmission Electron Microscopy
PLB 502  Research Scanning Electron Microscopy
PLB 545  Ecosystem Ecology
PLB 546  Nutrient Cycling Methods
PLB 557  Biostatistics
PLB 558  (ZOOL 558) - Advanced Biostatistics
MBMB 545  Soil Microbiology
ZOOL 411  Environmental Risk Assessment
ZOOL 532  Wildlife Toxicology
ZOOL 534  Wildlife Habitat Analysis
CE 412  Contaminant Flow, Transport and Remediation
CE 418  Water and Wastewater Treatment
CE 471  Groundwater Hydrology
CE 500  Environmental Remediation Technologies
CE 512  Aqueous Systems Analysis

Earth Surface Processes

Description:
The Earth Surface Processes track of the doctoral program in geosciences will focus on geologic processes active at, and relevant to the earth-surface system. This system lies at the nexus of several sub-systems, including lithospheric dynamics, the surface and subsurface hydrosphere, the atmosphere, and the biosphere. Geological forms and processes at the Earth’s surface reflect the combined and overlapping influences of all these sub-systems. The earth-surface system is also particularly applicable to a broad range of human issues, including natural hazards, natural resources, and pollution and remediation issues. The goal of this track of the PhD program will be to train top-flight geological researchers in the complex and multidisciplinary scientific fields vital to the study of the earth surface.

Faculty outside of the Department of Geology who could participate in this track:
Andrew Balkansky, Anthropology
Prudence Rice, Anthropology
Izumi Shimada, Anthropology
Paul Welch, Anthropology
John Nicklow, Civil and Environmental Engineering
Lizette Chevalier, Civil and Environmental Engineering
Rolando Bravo, Civil and Environmental Engineering, Engineering (hydrology)
Bruce Devantier, Civil and Environmental Engineering, Engineering (remediation)
Yanna Liang, Civil Environ Eng, Engineering (bioremediation)
Christopher Lant, Geography
Tonny Oyana, Geography
Justin Schoof, Geography
Matthew Therrell, Geography
Guangxing Wang, Geography
Matthew Whiles, Zoology
James Garvey, Zoology
Sara Baer, Plant Biology
Karl Williard, Forestry
Charles Ruffner, Forestry
Jon Schoonover, Forestry

Relevant Courses in Geology:
GEOL 474 Geomorphology
GEOL 478 Advanced Environmental Geology
GEOL 576 Coastal Geomorphology
GEOL 578 Advanced Fluvial Geomorphology
GEOL 421 Organic Geochemistry
GEOL 425 Invertebrate Paleontology
GEOL 428 Paleoecology and Environments of Deposition
GEOL 470 Hydrogeology
GEOL 484 Geologic Remote Sensing
GEOL 510 Advanced Sedimentology
GEOL 517 Advanced Topics in Geochemistry
GEOL 522 Sedimentary Petrology -- Siliciclastics
GEOL 523 Sedimentary Petrology -- Carbonates
GEOL 526 Advanced Topics in Applied Paleoecology
GEOL 570 Advanced Hydrogeology
GEOL 579 Soil Geomorphology

Relevant Courses outside of Geology:
ANTH 410K Ecological Anthropology
CE 410 Solid Waste Engineering
CE 412 Contaminant Flow, Transport and Remediation in Porous Media
CE 472 Open Channel Hydraulics
CE 473 Hydrologic Analysis and Design
CE 512 Aqueous Systems Analysis
CE 516 Water Quality Modeling
CE 523 Soil Dynamics
CE 572 Advanced Hydraulic Design
CE 573 Modeling of Hydrosystems
FOR 402 Forest Hydrology
FOR 502 Advanced Watershed Hydrology and Management
GEOG 401 Introduction to Geographic Information Systems
GEOG 404 Spatial Analysis
GEOG 406 Introduction to Remote Sensing
GEOG 408 Advanced Remote Sensing
GEOG 425 Integrated Water Management
GEOG 434 Water Resources Hydrology
PLB 440 Grassland Ecology
PLB 443 Restoration Ecology
PLB 444 Quantitative Ecology (Ecology and Analysis of Communities)
PLB 445 Wetland Plant Ecology
PSAS 441 Soil Morphology and Classification
PSAS 442 Soil Physics
PSAS 547 Soils and Environmental Quality
Zool 415 Limnology
Zool 458 Issues in Aquatic Ecology
Zool 521 Stream Ecology
Zool 557  Biostatistics
Zool 558  Advanced Biostatistics

Energy and Mineral Resources

Description:
Exploitable concentrations of energy and mineral resources result from complex interrelated natural processes. Advancing our understanding of energy and mineral resource systems and meeting the unprecedented demands of supplying adequate resources for the global economy will require innovative basic and applied research in the geosciences. The Energy and Mineral Resources track of the proposed doctoral program in geosciences will provide for interdisciplinary studies focusing on the geological, chemical, biological and physical processes relevant to the origin, accumulation, discovery and recovery of energy and mineral resources that are essential for sustaining the world's growing population and rising standards of living. The goal of this track of the proposed PhD program is to provide the cutting-edge, intermultidisciplinary and technology-based training that will prepare and inspire emerging geoscientists to meet future challenges in the study and discovery of mineral and energy resources.

Faculty outside of the Department of Geology who could participate in this track:
Yoginder P. Chugh, Mining and Mineral Resources Engineering
Satya Harpalani, Mining and Mineral Resources Engineering
Manoj Mohanty, Mining and Mineral Resources Engineering
Bradley Paul, Mining and Mineral Resources Engineering
Tomasz Wiltowski, Mechanical Engineering and Energy Processes
Kanchan Mondal, Mechanical Engineering and Energy Processes
Tonny J. Oyana, Geography and Environmental Resources
Guangxing Wang, Geography and Environmental Resources
Gary R. Kinsel, Chemistry
Ling Zang, Chemistry
Luke T. Tolley, Chemistry
Matthew E. McCarroll, Chemistry

Relevant Courses in Geology:
GEOL 414  Paleobotany
GEOL 417  Isotope Geochemistry
GEOL 418  Low Temperature Geochemistry
GEOL 419  Ore Deposits
GEOL 420  Petroleum Geology
GEOL 421  Organic Geochemistry
GEOL 423  Geomicrobiology
GEOL 425  Invertebrate Paleontology and Paleoecology
GEOL 428  Paleoecology and Environments of Deposition
GEOL 435  Solid-Earth Geophysics
GEOL 436  Exploration Geophysics
GEOL 437  Field Geophysics
GEOL 454  Field Geology
GEOL 462  Fundamentals of Structural Geology II
GEOL 466  Tectonics
GEOL 470  Hydrogeology
GEOL 480  Geology of Coal
GEOL 481  Sedimentary Basin Analysis
GEOL 482  Coal Petrology
GEOL 484  Geologic Remote Sensing
GEOL 510  Advanced Sedimentology
GEOL 517  Advanced Topics in Geochemistry
GEOL 522  Sedimentary Petrology – Siliciclastics
GEOL 523  Sedimentary Petrology – Carbonates
GEOL 524  Advanced Topics in Sedimentary Geology
GEOL 525  Advanced Topics in Invertebrate Paleontology
GEOL 526  Advanced Topics in Applied Paleocoeology
GEOL 527  Micropaleontology
GEOL 535  Advanced Topics in Geophysics
GEOL 536  Earthquake Seismology
GEOL 537  Applied Seismology
GEOL 538  Gravity and Magnetism
GEOL 550  Advanced Economic Geology
GEOL 565  Rock Deformation and Structural Systems
GEOL 566  Advanced Topics in Structural Geology
GEOL 551  Advanced Topics in Economic Geology
GEOL 570  Advanced Hydrogeology
GEOL 576  Coastal Geomorphology and Sedimentology
GEOL 578  Fluvial Geomorphology
GEOL 582  Advanced Coal Petrology
GEOL 591  Individual Research in Geology

Relevant Courses outside of Geology:
MNGE 401  Mining Environmental Impacts and Permits.
MNGE 420  Mineral and Coal Processing
MNGE 430  Economics of Mineral Resources
MNGE 431  Rock Mechanics: Principles and Design
MNGE 440  Material Handling Systems
MNGE 455  Mine Environment, Health and Safety Engineering
MNGE 530  Mine Management
MNGE 540  Production Engineering in Coal Mines
MNGE 550  Industrial Minerals
ME 568  Alternative Fuel & Energy
ME 408  Energy Conversion Systems
ME 446  Energy Production & Management
GEOG 401  Introduction to Geographic Information Systems.
GEOG 404  Spatial Analysis.
GEOG 406  Introduction to Remote Sensing
GEOG 408  Advanced Remote Sensing
GEOG 417  GIS Programming and Customization
GEOG 420  Advanced Geographic Information Systems (GIS) Studies
CHEM 411  Intermediate Inorganic Chemistry
CHEM 434  Instrumental Analytical Chemistry
CHEM 444  Intermediate Organic Chemistry
CHEM 451  Biochemistry
CHEM 462  Classical Physical Chemistry
CHEM 511  Advanced Inorganic Chemistry
CHEM 532 Analytical Chemistry Instrumentation
CHEM 533 Analytical Spectroscopy
CHEM 536 Principles of Mass Spectrometry
CHEM 537 Fluorescence Spectroscopy
CHEM 541 Organic Structure and Reactivity
CHEM 549 Advanced Topics in Organic Chemistry
CHEM 552 Biomolecular Structure and Function
CHEM 559 Advanced Topics in Biological Chemistry

**Geophysics and Tectonics**

*Description:*
The Geophysics and Tectonics track of the doctoral program in geosciences will offer advanced training in the quantitative physical methods to study the Earth and the forces and movements that cause plate tectonics. The program will provide both a theoretical and applied foundation in exploration and applied geophysics, seismology, geodynamics, gravity and geomagnetism. Applications include fossil fuel and mineral exploration, archaeological geophysics, seismic hazard studies, planetary geology and solid earth deformation studies as well as coupling at multiple time scales between the lithosphere and global climate. The goal of this track of the PhD program is to train the young generation of geoscientists in the geophysical and modeling techniques used today and tomorrow in industrial and academic research.

*Faculty outside of the Department of Geology who could participate in this track:*
Sanjeev Kumar, Civil and Environmental Engineering
Vijay Puri, Civil and Environmental Engineering
Gary Butson, Civil and Environmental Engineering
Bruce DeVantier, Civil and Environmental Engineering
Kent Hsiao, Civil and Environmental Engineering
Tony Oyana, Geography and Environmental Resources
Justin Schoof, Geography and Environmental Resources
Matthew Therrell, Geography and Environmental Resources
Guangxing Wang, Geography and Environmental Resources
Yoginder Chugh, Mining and Mineral Resources Engineering
Manoj Mohanty, Mining and Mineral Resources Engineering
Bradley Paul, Mining and Mineral Resources Engineering
Naushad Ali, Physics
Andrei Kolmanov, Physics
Aldo Migone, Physics
Leo Silbert, Physics
Mesfin Tsige, Physics

*Relevant Courses in Geology:*
GEOL 420 Petroleum Geology
GEOL 435 Solid-Earth Geophysics
GEOL 436 Elementary Exploration Geophysics
GEOL 437 Field Course in Geophysics
GEOL 460 Geological Data Processing
GEOL 462 Fundamentals of Structural Geology
GEOL 466 Tectonics
GEOL 470 Hydrogeology
GEOL 474  Geomorphology
GEOL 484  Geologic Remote Sensing
GEOL 535  Advanced Topics in Geophysics
GEOL 536  Earthquake Seismology/Observational seismology
GEOL 537  Applied Seismology
GEOL 538a Gravity
GEOL 538b Magnetism
GEOL 565  Rock Deformation and Structural Systems
GEOL 591  Advanced topics in Geophysics

Relevant Courses outside of Geology:
CE 445  Fundamental Theory of Earthquake Engineering
CE 447  Seismic Design of Structures
CE 551  Finite Element Analysis
CE 554  Experimental Mechanics
CS 306  Basic Linux/Unix Programming
CS 406  Basic Linux Systems Administration
CS 471  Optimization Techniques
ECE 355  Systems and signals
ECE 468  Digital Signal Processing
ECE 558  Digital Image Processing
GEOG 404  Spatial Analysis
GEOG 406  Introduction to Remote Sensing
GEOG 408  Advanced Remote Sensing
GEOG 417  GIS Programming & Customization
GEOG 428  GIS and Environmental Modeling
GEOG 431  Climatology
GEOG 436  Natural Hazards
MATH 405  Intermediate Differential Equations
MATH 409  Fourier Analysis
MATH 455  Complex Analysis with Applications
MATH 483  Mathematical Statistics in Engineering and the Sciences
MATH 475  Numerical Analysis
MATH 450  Methods of Advanced Calculus
MATH 406  Linear analysis
MATH 407  Introduction to PDE
MATH 421  Linear algebra
MATH 505  ODE
MATH 507  PDE
MATH 508  Integral Equations
MATH 575  Matrix computations
MATH 566  Continuum mechanics
MNGE 400  Principles of Mining Engineering
MNGE 418  Mining of Ore Deposits
MNGE 430  Economics of Mineral Resources
MNGE 431  Rock Mechanics: Principles and Design
MNGE 535  Rock Fragmentation
PHYS 410  Mechanics II
PHYS 420  Electricity and Magnetism II
PHYS 425  Solid State Physics I
PHYS 500  Mathematical Methods in Physics
**Paleobiology**

*Description:*
The Paleobiology track of the proposed doctoral program in geosciences will focus on the study and use of paleontological data in earth systems science. This system represents the dynamic interaction between the geosphere and biosphere. The geosphere plays a significant role in shaping the biosphere. Geologic processes and biotic interactions have been major evolutionary driving forces changing the organic landscape through time. The application of Paleobiological principles is also particularly relevant to a broad range of human issues, including climate change, pollution and our understanding of evolution. The goal of this track of the PhD program will be to train highly talented intellectuals in the field of applied Paleobiology that will be competitive for positions that engage in the complex aspects of paleobiology and the Earth’s systems.

*Faculty outside of the Department of Geology who could participate in this track:*
Robert Corruccini, Anthropology  
Susan Ford, Anthropology  
Ulrich Reichard, Anthropology  
Frank Anderson, Zoology  
Roger Thomas, Zoology  
Matthew Whiles, Zoology  
David King, Zoology  
Carey Krajewski, Zoology  
Brooks Burr, Zoology  
David King, Zoology  
Dale Vitt, Plant Biology  
Sedonia Sipes, Plant Biology

*Relevant Courses in Geology:*
- GEOL 417 Isotope Geochemistry  
- GEOL 418 Low Temperature Geochemistry  
- GEOL 425 Paleontology  
- GEOL 428 Paleocology and Depositional Environments  
- GEOL 476 Quaternary Geology  
- GEOL 481 Sedimentary Basin Analysis  
- GEOL 510 Advanced Sedimentology  
- GEOL 517 Advanced Topics in Geochemistry  
- GEOL 522 Sedimentary Petrology -- Siliciclastics  
- GEOL 523 Sedimentary Petrology – Carbonates  
- GEOL 525 Advanced Topics in Invertebrate Paleontology  
- GEOL 526 Advanced Topics in Applied Paleocology

*Relevant Courses outside of Geology:*
- ANTH 410K Ecological Anthropology  
- ANTH 440A Fossil Evidence for Human Evolution  
- ANTH 440C Context of Human Evolution
ANTH 500A  Theory and Method in Biological Anthropology
ANTH 530  Seminar in Paleoanthropology
ANTH 534  Seminar in Evolutionary Theory
ANTH 538  Seminar in Primate Evolution
ZOOL 402  Natural History of Invertebrates
ZOOL 404  Evolutionary Biology
ZOOL 405  Systematic Zoology
ZOOL 413  The Invertebrates
ZOOL 415  Limnology
ZOOL 458  Issues in Aquatic Ecology
ZOOL 510  Evolutionary Biology
ZOOL 520  Advanced Invertebrates
ZOOL 521  Stream Ecology
ZOOL 554  Systematic Biology Seminar
ZOOL 557  Biostatistics
ZOOL 558  Advanced Biostatistics
ZOOL 577  Population Ecology
ZOOL 578  Population Genetics
PLB 444  Quantitative Ecology (Ecology and Analysis of Communities)
PLB 445  Wetland Plant Ecology
PLB 450  Plant Geography
PLB 545  Ecosystem Ecology
Appendix B
Catalog Description of Existing Geoscience Courses Included in the Curriculum

412-3 Advanced Petrology. In-depth study of the rock forming processes. The relations of rock forming processes to petrographic analysis will be emphasized. Laboratories will deal with hand-specimen and thin-section analysis from selected rock suites with genetic modeling of the resulting data. Prerequisite: 310, 315.

413-3 Quantitative Methods of Geology. An introduction to quantitative methods in a geological and earth sciences context. Topics introduced include sampling plans for geologic studies, non-parametric test of geological data, comparisons of geological samples, analysis of sequential geological data. Laboratories will deal with numerical examples from all areas of geology. Prerequisite: advanced standing and consent of instructor.

415-3 Optical Mineralogy. The optical properties of minerals and the use of the petrographic microscope for identification of crystals by the immersion method and by thin section. Lecture, laboratory. Prerequisite: 310, Physics 203b or 205b.

417-3 Isotope Geochemistry. Stable and radioactive isotopes and the applications of isotopic studies to igneous and metamorphic petrology, ore deposits, sedimentology, surface processes, geothermometry and geochronology. Introduction to isotopic techniques and mass spectroscopy. Laboratory or research project required. Pre-requisite: 310, 315 and 325 or consent. Recommended: Physics 203, Mathematics 150 and Geology 419.

418-3 Low Temperature Geochemistry. The application of chemical principles to geologic processes that occur on and near the earth’s surface. Lecture, laboratory. Prerequisite: 310, Chemistry 200, 201, 210, 211 or equivalent.

419-3 Ore Deposits. Overview of the occurrence, geology and origin of metalliferous mineral deposits. Geologic principles and research techniques important to the understanding of mineral deposits. Introduction to exploration and mining methods. Lectures, laboratories, and field trips. Up to one or two day field trips may be required on weekends. Lab fee: $15. Prerequisite: 302, 315 or consent of instructor.

420-3 Petroleum Geology. The geological occurrences of petroleum including origin, migration and accumulation; a survey of exploration methods, and production problems and techniques. Laboratory study applies geological knowledge to the search for and production of petroleum and natural gas. Prerequisite: 221, 224.

421-3 Organic Geochemistry. The nature, origin and fate of natural and artificial organic materials in rocks and sediments. Topics include characterization of fossil fuels using biological marker compounds, petroleum source rock evaluation, and organic pollutants in the environment. Prerequisite: 325 or consent of instructor.

425-3 Invertebrate Paleontology and Paleoecology. Concepts of paleontology and paleoecology. Emphasis on functional morphology, lifestyles and habitats of fossil invertebrates and algae. The nature and evolution of marine and coastal paleocommunities. The effects of extinction events on paleocommunities and biodiversity. Laboratory. Up to 3 one- or two-day field trips may be required on weekends. Field trips required. Field trip fee = $85. Lab fee: $15. Prerequisite: 325 or a biology course.
428-3 Paleoenecology and Environments of Deposition. Characteristics, distribution, and classification of recent and ancient environments. Criteria for recognizing ancient environments. Sedimentological and paleoecological approaches. Recognition of ancient environments and environmental associations. Laboratory. Up to 3 one- or two-day fields trips may be required on weekends. Prerequisite: 425, 325, or concurrent enrollment.

434-3 Engineering and Environmental Geophysics. Geophysical methods used in engineering and environmental site characterization and assessment and the geophysical detection of environmental hazards. Up to 3 one- or two-day field trips may be required on the weekends. Prerequisite: Physics 203a or 205a, 203b or 205b, Mathematics 150.

435-3 Solid-Earth Geophysics. Earth’s size, shape, mass, age, composition, and internal structure are re-viewed in detail as understood from its volcanism, gravity and magnetic fields, seismicity and motion of continents and ocean basins; plate tectonics. Up to 3 one- or two-day field trips may be required on weekends. Pre-requisite: 302, Mathematics 150 or consent of instructor.

436-4 Elementary Exploration Geophysics. Theory and practice of geophysics as applied to the exploration and development of natural resources. Laboratory involves use of geophysical instruments and interpretation of data. Up to 3 one- or two-day field trips may be required on the weekends. Prerequisite: 220 or 222; 223, Mathematics 150.

437-3 Field Course in Geophysics. Use of geophysical equipment for collection, analysis and interpretation of seismic, gravity, magnetic, electrical and other types of geophysical data. Up to 10 Saturday field trips may be required. Lab fee: $10 Prerequisite: 436 or consent.

440-1 to 8 Advanced Topics in the Geological Sciences. Individual study or research or advanced studies in various topics. Prerequisite: advanced standing and consent of instructor.

445-3 Museum Studies in Geology. History, nature and purpose of geology in museums, relationships of geology to other museum disciplines, application of geologic methods to museum functions, preparation and preservation of specimens; nature, acquisition and utilization of geologic collections in museums, role of research in museums.

450-2 Introduction to Field Geology. Introduction to field techniques, principles of geologic mapping and map interpretation. Field trip fee $5.00. Prerequisite: 302, 315 or concurrent enrollment.

451-1 to 12 Field Experience in Geology. Preparation for and participation in academically rigorous field trips guided by faculty members. Trips will be to areas of geological interest and will occur during official breaks within or between semesters. Expenses will vary in proportion to the distance traveled and duration of trip and will be determined before each trip. A student may only take a specific trip once for credit. Prerequisite: consent of instructor.

454-6 Field Geology. Advanced field mapping in the Rocky Mountains, including problems in stratigraphy, structure, petrology, paleontology, geomorphology, and economic geology. Lab fee $250. Prerequisite: 302, 315, 325; 450 recommended.

460-3 Geological Data Processing. Computer applications to geological problems including the processing and programming of data and the interpretation and evaluation of results. Lecture, laboratory. Prerequisite: Engineering 222 or Computer Science 202.
462-3 **Fundamentals of Structural Geology II.** Intermediate topics in structural geology including strain theory, field strain analysis, geometry of complex mesoscopic structures and introduction to dislocations, deformation history and microfabric analysis. Hypotheses and orogenesis are discussed and evaluated. Lecture and assigned problems only. Prerequisite: 302 or equivalent.

466-3 **Tectonics.** Fundamentals of geodynamics applied to plate tectonics: mantle composition and rheology, deformation of the lithosphere, structural characteristics of plate margins, stability of triple junctions, diachronous tectonics, and orogenesis will be examined in detail. Up to 3 one or two day field trips may be required on weekends. Prerequisite: 302, Mathematics 150 or consent of instructor.

470-3 **Hydrogeology.** Study of the distribution, origin and movement of groundwater and the properties of geologic materials that control groundwater flow and contaminant transport. Geology majors must also take 471 concurrently. Prerequisite: 220 or 222; 223; Mathematics 150, or consent of instructor.

471-1 **Hydrogeology Laboratory.** Problem sets, laboratory experiments, and field exercises in hydrogeology. Geology majors must take this course concurrently with 470. Prerequisite: 220 or 222; 223; Mathematics 150; or consent of instructor.

474-3 **Geomorphology.** Study of erosional and depositional processes operating at the earth’s surface and landforms resulting from these processes. Relationship of processes and landforms to the geologic framework is examined. Laboratory. Up to 3 one- or two-day field trips may be required on weekends. Prerequisite: 220 or 222; 223.

476-3 **Quaternary Geology.** Methods used to identify, map, date and correlate Quaternary deposits and interpret Quaternary history. Covers glacial, fluvial, coastal, lacustrine and eolian chronologies, oxygen-isotope re-cords from ocean sediments and continental ice cores, volcanic activity and Quaternary climate change. Field trips required. Prerequisite: 220 or 222; 223, 221, 224; or consent of instructor; 474 recommended.

478-3 **Advanced Environmental Geology.** Application of principles of geomorphology and Quaternary geology to environmental problems and geologic hazards. Lectures and case studies emphasize neotectonics, volcanic hazards, landslides and other mass movements, floods, river channel changes and coastal erosion. Up to 3 one- or two-day field trips may be required on weekends. Prerequisite: 474; 476 recommended.

480-3 **Geology of Coal.** Geology as related to exploration, development and mining of coal; stratigraphy, sedimentation and structure of coal deposits; type of coal basins and their tectonic setting; concepts of cyclical deposition in coal basins; origin of splits and partings in coal seams; relationship of modern environments and ancient coal-forming environments; structural problems relevant to exploration and mining of coal; methods of resource evaluation. Three 1-hour lectures week; five half-day field trips. Prerequisite: 220 or 222; 223, 221, 224, 302, 325, or consent of instructor.

481-3 **Sedimentary Basin Analysis.** The use of stratigraphy, structure, sedimentology and geophysics to determine the paleogeographic evolution of sedimentary basins. Topics include the study of the relationships between host strata and both primary and post-depositional non-
renewable resources, plate tectonics and basin evolution and subsurface geologic methods. Prerequisite: consent of instructor.

482-3 **Coal Petrology.** Structural features and microscopy of coal seams. Origin and alteration of coal constituents. Includes field trips, study of coal specimens and techniques. Prerequisite: 220 or 222, 223, 221, 224; or consent of instructor.

483-3 **Forensic Geology.** An introduction to the use of geological materials and techniques in criminal investigation. Details from actual criminal cases will be used as examples in all the topics covered which include rock and mineral types, geological and topographic maps, fossils, sand, soils, spores and pollen, geological building materials, art fraud and gemstones. Techniques covered will include optical microscopy, scanning electron microscopy, and x-ray diffraction.

484-3 **Geologic Remote Sensing.** Applications of remote sensing using aerial photographs, multi-spectral imagery, hyperspectral imagery, thermal infrared imagery, and radar imagery, in structural geology, stratigraphy, geomorphology, oil and mineral exploration, geologic hazard analysis, and planetary exploration. Prerequisite: 220 or consent of the instructor.

500-1 to 2 **Teaching for Geology Graduate Students.** To help teaching assistants develop skills in conducting laboratory work and leading discussions. One hour required for all teaching assistants in geology. Graded S/U only.

510-2 **Advanced Sedimentology.** Basic principles of field observation, field and laboratory sampling, and data analysis of clastic sedimentary rocks; introduction to laboratory techniques; introduction to statistical, physical and empirical models in sedimentary geology. Field trips required. Prerequisite: 325 or 474.

515-3 **Instrumental Analysis in Geology.** An introduction to modern methods of instrumental inorganic geo-chemical analysis that are particularly important in the geology sciences. This includes both operational theory and practical application of methods for the analysis of minerals, rocks and aqueous solutions. Lecture, laboratory. Prerequisite: 310, Chemistry 222 or equivalent, and consent of instructor; 418 recommended.

517-2 to 9 (2 to 6 per semester) **Advanced Topics in Geochemistry.** Specialized topics in geochemistry. Topics covered might include thermodynamic modeling of mineral-solution equilibria, the role of kinetics in mineral-solution reactions, experimental hydrothermal geochemistry or other topics to be announced by the department. Maximum credit nine semester hours. Prerequisite: 418 or consent of instructor.

518-3 **Clay Mineralogy.** Study of the structure, chemistry, origin, and geologic importance of clay minerals. Industrial and other applications of clays. Lecture, laboratory. Prerequisite: 310 or consent.

520-2 to 9 (2 to 6 per semester) **Advanced Topics in Igneous and Metamorphic Petrology.** Petrologic principles and their relationships and other selected topics to be announced by the department. Prerequisite: consent of instructor.

522-3 **Sedimentary Petrology—Siliciclastics.** The petrography and petrology of siliciclastic rocks, emphasizing sandstone. Microscopic studies of composition and components of detrital clastic rocks, their origin, provenance, characteristics, diagenesis, cementation and lithification. Prerequisite: 325 or 415 or consent; 520 or 521 recommended.
523-3 Sedimentary Petrology—Carbonates. The origin, classification, diagenesis, and geochemistry of carbonate rocks, with emphasis on petrographic analysis. Study of recent carbonate depositional environments. Laboratory required. Prerequisite: 325, 418 recommended.

524-2 to 9 (2 to 6 per semester) Advanced Topics in Sedimentary Geology. Advanced topics in sedimentary geology. Topics may include clastic depositional environments, carbonate depositional environments; diagenesis of sedimentary rocks, and other topics to be announced by the department. Up to 3 one- or two-day field trips may be required on the weekends. Prerequisite: 428 or 522 or 523 or consent of instructor.

525-2 to 6 (2 to 3 per semester) Advanced Topics in Invertebrate Paleontology. Lectures, readings, field and laboratory studies, including techniques and quantitative methods of study. Preparation for research in paleontology. Topics may include corals, bryozoans, brachiopods, mollusks, echinoderms, biostratigraphy, tempo and mode of invertebrate evolution and other topics to be announced by the department. Maximum credit six semester hours. Prerequisite: 425 or consent of instructor.

526-3 Advanced Topics in Applied Paleocology. Lectures, field, and laboratory studies, including techniques and quantitative methods. Preparation for research in paleoecology. Emphasis on using fossil marine invertebrates and trace fossils to interpret ancient sedimentary environments. Prerequisite: 428 or consent.

527-3 Micropaleontology. Structure, classification, paleoecology, stratigraphic distribution, and evolution of microfossils. Laboratory work in techniques of collection, preparation and study of microfossils. Identification and use of microfossils in solving stratigraphic and paleoenvironmental problems. Preparation for research in micropaleontology. Up to 3 one- or two-day field trips required on weekends. Field trips required. Field trip fee=$85. Prerequisite: 425 or consent of instructor.

535-1 to 9 (1 to 6 per semester) Advanced Topics in Geophysics. Specialized topics in geophysics. Examples include but are not limited to seismic stratigraphy, mid-continent seismicity, isostacy, data processing techniques. The topic to be covered is announced by the department. Maximum credit nine semester hours. Up to 3 one- or two-day field trips may be required on weekends. Prerequisite: 435 or 436 or consent of instructor.

536-3 Earthquake Seismology. Observational seismology. Topics include earthquake source mechanisms; propagation, reflection and refraction of elastic waves; ray theory; dispersion of surface waves; the effect of earth structure on the seismogram; and the seismograph. Research projects will be conducted using data from the SIU Geophysical Observatory. Up to 3 one- or two-day field trips may be required on weekends. Prerequisite: 435 or 436, Mathematics 150 or consent of instructor.

537-3 Applied Seismology. Study of the seismic reflection techniques, including theory and methods of collection and analysis of seismic reflection data, the seismic method, waveform analysis, and digital filtering with computer applications and seismic instrument characteristics. Up to 3 one- or two-day field trips may be required on weekends. Prerequisite: Mathematics 150 or consent.

538-6 (3,3) Gravity and Magnetism. (a) Gravity. Study of gravitational methods used in the solution of geo-logical problems; topics include theory, field operations, data reduction, anomaly
separation, two and three-dimensional analysis, and interpretation. Up to 5 one- or two-day field trips may be required on the weekends. (b) Magnetism. Study of magnetic methods used in the solution of geological problems; topics include theory, origin, time variations and induction, paleomagnetism, magnetic properties of earth materials. Field operations, anomaly separation, and interpretation. Up to 5 one- or two-day field trips may be required on the weekends. Prerequisite: 435 or 436, Mathematics 150 or consent of instructor.

550-4 Advanced Economic Geology. In-depth examination of the geologic characteristics, classification and origin of metallic mineral deposits. Aspects of mineral exploration and mining techniques are also discussed. Laboratory exercises emphasize hand specimen and petrographic study of ore and host rock suites. Up to 3 one- or two-day field trips may be required on the weekends.

555-1 to 6 (1 to 3 per semester) Advanced Topics in Economic Geology. Advanced study in a specific area of economic geology to be determined by course participants. Course content may focus on a specific type of mineral deposit or such topical areas as field characteristics, mineral exploration techniques, stable isotope geo-chemistry, fluid inclusion studies and hydrothermal processes. Maximum six credit hours. Field trips may be required on up to 3 weekends and possibly over Spring vacation. Prerequisite: 550.

565-3 Rock Deformation and Structural Systems. Advanced topics in structural geology with emphasis on theoretical and experimental study of rock deformation and analysis of complex structural systems. Lecture and assigned problems only. Prerequisite: 462.

566-3 Advanced Topics in Structural Geology. Lectures, readings, and discussion of advanced aspects of rock deformation: dislocation theory and its applications to flow processes of rocks; experimental rock deformation; incremental and finite strain theory and analysis; and recent developments in structural geology. Prerequisite: 565.

570-3 Advanced Hydrogeology. A combination of lectures, seminars, and independent studies of advanced topics in hydrogeology, particularly geochemistry and the response of aquifers to stresses such as tides, recharge and saline intrusion. Prerequisite: 470.

576-3 Coastal Geomorphology and Sedimentology. Detailed examination of coastal processes and clastic coastal depositional systems. Coastal storms, wave processes, tidal systems, sea level changes, coastal sediment transport, deltaic, barrier island strandplain, estuarine depositional systems and coastal stratigraphic sequences. Field trip to Louisiana and Texas Gulf Coast required. Field trip fee: $35. Up to 3 one- or two-day field trips may be required on weekends. Prerequisite: 474 or consent of instructor.

577-2 to 9 (2 to 6 per semester) Advanced Topics in Surficial Geology. Studies of processes, landforms, and deposits in the surface or near surface geologic setting. Selected topics to be announced by the department. Maximum credit nine semester hours. Prerequisite: consent of instructor.

578-3 Fluvial Geomorphology. Detailed study of fluvial processes and landforms within the context of major concepts in geology and geomorphology. Topics include drainage basins, hydroclimatology and surface water hydrology, channel processes, fluvial depositional systems, paleohydrology and changes in fluvial systems through time. Field trips required. Field trip fee: $35. Prerequisite: 474 and consent instructor.
579-3 Soil Geomorphology. Study of geomorphologic applications of soils. Covers the effects of time, climate, parent material, topography, eolian additions on soil development, classification and chemistry; soil indices; pedogenic thresholds; paleosols; use of soils to evaluate landform age, landform stability, Quaternary stratigraphy, faulting and climate fluctuations. Field trips required. Prerequisite: 474 or consent of instructor.

582-1 to 6 (1 to 3 per semester) Advanced Coal Petrology. Microscopy, source materials, coalification, constitution, and classification of peats, lignites, bituminous coal, anthracite; applications to industrial problems. Prerequisite: 482.

585-3 Earth and Space Science for Teachers. Class designed to help teachers gain an understanding of some of the earth science concepts they need to teach today’s standards-based curricula. Develops an understanding of earth materials, how the earth works, earth resources, the causes of natural disasters, and the exploration of the bodies of our solar system. Prerequisites: A general physical science course or equivalent and consent of the department.

591-1 to 6 Individual Research in Geology. Investigations in geology other than those for theses or dissertations.

599-1 to 6 Thesis. Minimum of three hours to be counted toward a Master’s degree.

600-1 to 30 (1 to 16 per semester) Dissertation. Research for and writing of the doctoral dissertation. Pre-requisite: consent of instructor.

601-1 per semester Continuing Enrollment. For those graduate students who have not finished their degree programs and who are in the process of working on their dissertation, thesis, or research paper. The student must have completed a minimum of 24 hours of dissertation research, or the minimum thesis, or research hours before being eligible to register for this course. Concurrent enrollment in any other course is not permitted. Graded S/U or DEF only.