INDIANA UNIVERSITY

University Graduate School
2007-2008
Academic Bulletin

University Graduate School
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Indiana University
Bloomington, IN 47405
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Geological Sciences

College of Arts and Sciences
Bloomington

Chairperson
Herman B. Wells Professor Abhijit Basu*

Malcolm and Sylvia Boyce Chair
Mark A. Person*

Haydn H. Murray Chair
David L. Bish*

Robert R. Shrock Professor of Sedimentary Geology
Bradley Ritts

Departmental E-mail
geograd@indiana.edu

Departmental URL
www.indiana.edu/~geosci/

Graduate Faculty

(An asterisk [*] denotes membership in the University Graduate School faculty with the endorsement to direct doctoral dissertations.)

Distinguished Professor
Peter Ortoleva* (Chemistry)

Professors
Abhijit Basu*, David L. Bish*, Simon Christopher Brassell*, Jeremy D. Dunning*, Hendrik Haitjema* (Public and Environmental Affairs), Michael W. Hamburger*, Gary Lee Pavlis*, Mark Austin Person*, Lisa M. Pratt*, Edward M. Ripley*, Jeffrey White* (Public and Environmental Affairs), Robert P. Wintsch*

Associate Professors
James Gerald Brophy*, Claudia Christina Johnson, Gregory Allan Olyphant*, Bradley Ritts, Juergen Schieber*, Chen Zhu*

Professors Emeriti
J. Robert Dodd*, Donald Hattin*, Norman Hester*, Erle Kauffman*, Noel Krothe*, Judson Mead*, Haydn Murray*, Albert J. Rudman*, Lee J. Suttner*

Associate Professor Emeritus
David Towell*

Senior Scientists
John Comer*, Bruce Douglas*, Chusi Li*, Arndt Schimmelmann*, John Steinmetz*

Assistant Scientist
Erika Elswick

Associated Research Faculty
Brian Keith*, Maria Mastalerz, Todd Thompson*

Graduate Advisor
Professor Mark A. Person*, Geology Building 429, (812) 855-4404 or (800) 553-2592

Degrees Offered

Master of Science and Doctor of Philosophy

Special Departmental Requirements

(See also general University Graduate School requirements.)

Admission Requirements
An undergraduate degree in the physical or natural sciences. It is expected that students will have an undergraduate background that includes course work in allied sciences/mathematics, equivalent to one year of chemistry and physics or biology, mathematics through differential and integral calculus, plus at least 6 credit hours of higher-level courses. A substantive foundation course in field geology or comparable independent field experience is also expected. Students with degrees in engineering or other related fields are also encouraged to apply. The general Graduate Record Examination is required.

Master of Science Degree

Course Requirements
A minimum of 30 graduate credit hours, including at least 20 credit hours in geological sciences.

Doctor of Philosophy Degree

Course Requirements
A total of 90 credit hours, including dissertation and 35 credit hours of course work approved for graduate credit (excluding G600, G700, and G810), of which a minimum of 20 credit hours must be taken within the Department of Geological Sciences.

Minor
Outside minor in a related field (including chemistry, physics, biology, mathematics, and environmental sciences), or, under certain conditions, in geochemistry, geophysics, or geobiology.

Foreign Language/Research-Skill Requirement
Reading proficiency in one foreign language (French, German, Russian, or Spanish) or a research skill in mathematics, computer science, chemistry, or physics. Courses taken to satisfy this requirement do not necessarily carry graduate credit. For specific details concerning approved research-skill courses, consult the graduate advisor.

Preliminary Examination
Comprehensive: written.

Qualifying Examination
Written and oral.

Final Examination
Oral defense of the dissertation.

Courses

Courses offered at Bloomington are organized around the department's major disciplines: astrobiology, environmental geoscience, geobiology, geochemistry, geohydrology, geophysics, mineralogy, sedimentary systems, and solid-earth dynamics. Advanced topics in specialized subdisciplines and seminars in interdisciplinary themes have included the courses Chemical Oceanography and Cenozoic Climate Change as well as courses covering topics such as invertebrate paleontology, paleoecology, stratigraphy, sedimentology, and coal geology.

The courses available in Bloomington are:

G404 Geobiology (3 cr.) P: BIOL L105 and G334. Application of biological principles and use of fossils in the study of earth history. Origin of life and the early fossil record; evolution; approaches of taxonomy; chemistry of fossils; ecology of ancient life; use of fossils to measure geologic time.

G406 Introduction to Geochemistry (3 cr.) P: G222, MATH M212 or M216, and CHEM C106. Chemistry in the study of the earth, employing elementary chemical thermodynamics, the phase rule, chemical equilibria, redox, reactions, the radioactive decay law, and organic chemistry.

G411 Invertebrate Paleontology (3 cr.) P: BIOL L105 or S105; and one 300-400-level course in biology or geology. Structure, classification, habitats, and geological history and significance of the invertebrate phyla. Laboratory study of fossils.

G413 Introduction to Earth Physics (3 cr.)

G415 Geomorphology (3 cr.) P: G222, college chemistry and mathematics or consent of instructor. Natural processes that form landscapes, surficial, geologic materials, and soils. Physics and chemistry of weathering. Dynamics of streams, wind, waves, glacier ice, and mass movement. Interactions of geomorphology and environment.

G416 Economic Geology (3 cr.) P: G334; CHEM C106-C126 or consent of instructor. Geologic occurrence and genesis of economic mineral deposits, including petroleum and coal. Introduction to mining, processing, and exploration methods. Two lectures and one 2-hour laboratory meeting per week.

G417 Optical Mineralogy (3 cr.) P: G222. Theory and use of optics in the identification and classification of rock-forming minerals in fragments and thin sections. One lecture and two 2-hour laboratory meetings per week.

G418 Igneous and Metamorphic Petrology (3 cr.) P: G222 or equivalent. The petrogenesis of igneous and metamorphic rocks. Both the lecture and laboratory portions of the course will stress the application of modern petrographic, mineralogic, geochemical and phase equilibria techniques to the solution of relevant petrologic problems. Two lectures and one 2-hour laboratory meeting per week.

G420 Regional Geology Field Trip (1-2 cr.) P: consent of instructor. Field investigation of selected regions of North America for study of mineralogical, lithological, stratigraphic, structural, paleontological, geomorphological, or other geological relationships. Six to ten days in the field. May be repeated.

G423 Methods in Applied Geophysics (4 cr.) P: G413 or equivalent. Application of geophysical principles to field and laboratory experiments, with emphasis on data acquisition, analysis, and geologic interpretation. Experiments include earthquake seismology, electrical resistivity, magnetic and gravity surveys, and reflection and refraction seismology.

G427 Introduction to X-Ray Mineralogy (2-3 cr.) P: G221. Theory and practice of X-ray powder diffraction. Measurement and analysis of digital diffractometer data, including profile fitting and Rietveld refinement, with applications to geological, environmental, and structural-chemical problems.

G429 Field Geology in the Rocky Mountains (6 cr.)
G451 Principles of Hydrogeology (3 cr.)

G501 Sedimentary Processes and Environments (3 cr.) P: graduate standing. Origin and controls of facies distribution in sedimentary systems. Field study of selected ancient facies systems.

G503 Phase Equilibria (3 cr.) P or C: C360, G406, or consent of instructor. Thermodynamic functions and conditions of equilibria in unary, binary, ternary, and multicomponent systems. Mixing properties of crystalline solutions. Chemical potential and activity diagrams.

G504 Metamorphic Petrology (3 cr.) P: G418, G503. The evolution of mineral assemblages and compositions during prograde metamorphism. Reaction mechanisms. Effect of fluid composition on mineral assemblages. Theoretical basis and description of various projection schemes. Appraisal of selected experimental studies.

G506 Principles of Igneous Petrology (3 cr.) P: G418. Origin, composition, classification, phase relationships, and distribution of igneous rocks; economic considerations. Emphasis on province, associations, and facies type.

G509 Theoretical Geochemistry (4 cr.) P: C360, C361, P340, or G406 or the equivalent; consent of instructor. Thermodynamics and solution chemistry as tools in geochemistry; designed for students planning advanced work or research in geochemistry.

G513 Seismology I (3 cr.) P: MATH M343 or M313; PHYS P222. Earthquakes, propagation of elastic waves, interpretation of seismological data, theory of seismological instruments. Core: solid-earth dynamics.

G514 Geophysical Signal Analysis (3 cr.) P: PHYS P222; MATH M343 or M313. Construction, analysis, and interpretation of geophysical signals. Filter theory, spectral analysis, signal-to-noise enhancement, transform theory, seismic wave propagation, computer applications.

G515 Analysis of Earthquake Seismograms (1 cr.) P: G413. Analysis of local, regional, and teleseismic phases recorded on the Indiana University long- and short-period seismographs. Use of seismic records to determine earthquake source parameters, deep earth structure, and near-station structure. Surface wave dispersion and structure of the lithosphere.

G521 Micropaleontology (3 cr.) P: G404 or G411 or advanced standing in biological sciences. Morphology, biology, ecology, biostratigraphy, and phylogenetic relationships of microfossils. Course will survey the common fossil groups, including cyanobacteria, diatoms, dinoflagellates, acritarchs, foraminifera, and radiolaria.

G524 Carbonate Facies and Environments (2 cr.) P: graduate standing. Carbonate environments from modern and ancient examples (including subsurface). Various ramp and platform margin depositional models. Emphasis on types and origin of facies. Current and classical literature on carbonates.

G535 Quaternary Geology (3 cr.) P: G415 or consent of instructor. Characteristics, distribution, and origin of Pleistocene and recent deposits; stratigraphy and chronology; formation of associated landforms, landscapes, paleosols, and soils; quaternary environments. Core: Environmental Geoscience.

G550 Surface Water Hydrology (3 cr.) P: G451 and M216, or consent of instructor. Mechanics of surface runoff and open channel flow. Rainfall-runoff equations, probability analysis of stream flow, and watershed simulation models. Chemistry of surface waters and stream pollution. Core: environmental geoscience.

G551 Advanced Hydrogeology (3 cr.) P: G451. Basic principles and quantitative aspects of physical flow systems and chemistry of ground water and surface water. The relationships between water and geologic materials. Core: environmental geoscience.

G553 Gravitational and Magnetic Field Analysis (2 cr.) P: G413; MATH M343 or M313; PHYS P222. Potential field theory and its application in interpretation of gravity and magnetic fields. Core: solid-earth dynamics.

G554 Fundamentals of Plate Tectonics (3 cr.) P: graduate standing in geology or consent of instructor. Synthesis of observations from diverse disciplines of geology leading to the development of modern plate tectonic theory. Applications of plate tectonic principles to fundamental problems of continental and marine geology. Core: solid-earth dynamics.

G561 Paleoecology (3 cr.) P: G334 and G404 or G411. Relationships between modern and fossil organisms and their physical, chemical, and biological environments; emphasis on techniques for interpreting past environmental conditions.

G571 Principles of Petroleum Geology (3 cr.) P: G323. Origin, geochemistry, migration, and accumulation of petroleum; reservoir rocks; types of entrapment; exploration procedures and their rationale; methods and devices for data gathering and detection.

G572 Basin Analysis and Hydrocarbons (3 cr.) P: G323 and G334. Modern concepts of tectonics and sedimentary basin analysis. Geologic application of geophysical logs and seismic stratigraphy to basin analysis, facies distribution, and structural style in a variety of basin types with specific examples from around the world. Techniques of hydrocarbon assessment in basinal settings.

G581 Surficial Geology (3 cr.) Study of earth surface process, landforms, and unconsolidated deposits is fundamental to several subdisciplines of geology, especially hydrogeology and environmental geology.

G582 Computational Methods for Earth Scientists (3 cr.) P: M211-M212 or equivalent. Students will develop numerical solutions to ordinary and partial differential equations which describe a wide variety of geologic processes which could include fluid flow, heat transfer, sediment transport, seismic wave propagation through elastic solids, isotopic fluid-rock interactions.

G583 Isotope Geochemistry (3 cr.) Introduction to the theory and application of radiogenic and stable isotopes to a variety of subdisciplines in the earth sciences. Topics include geochronology, tracers, mass balance and mixing, hydrology and environmental applications, water-rock interaction, and biogeochemical cycles.

G584 Elements of Geospatial Data Analysis (3 cr.) P: experience in GIS or map reading. Application of Geographic Information System (GIS) and Global Positioning System (GPS) technologies address problems in the geosciences. Field mapping using GPS and other methods is undertaken to develop GIS layers and attributed features that are analyzed to support or refute specific research hypotheses.

G586 Geochemical Modeling (3 cr.) P: C360, C361, P340, or G406 or the equivalent; consent of instructor. Introduces students to the theories and applications of geochemical modeling. Students will have the opportunity to acquire hands-on experience with popular geochemical codes.

G587 Organic Geochemistry (3 cr.) P: consent of instructor. Application of organic geochemical methods in determining origins of fossil fuels and in defining biological and environmental histories of rocks.

G588 Paleobiogeography (3 cr.) P: L318; G404 or L374; G561 or L473. Introduction to the theory and practice of analyzing the spatial and temporal distribution of past life, with consideration of the biostratigraphic evolution of major life forms. Models of dispersion patterns are analyzed within a plate tectonic and paleoclimate context.

G591 Physical Sedimentology (3 cr.) P: G415, G501 or equivalent. Dynamics of fluid flow, hydraulics of sediment transport, interaction of physical processes in depositional environments. Field study of selected modern depositional environments.

G592 Chemical Sedimentology (3 cr.) P: G509, G418, or consent of instructor. Study of low-temperature (< 300 degrees C) mineral assemblages in order to infer their chemical conditions of formation.

G600 Advanced Techniques (cr. arr.)** P: consent of instructor. Training in special geologic methods such as exploration seismology, experimental petrology, X-ray spectroscopy, electron probe microanalysis, isotopic and organic mass spectrometry.

G601 Clay Mineralogy (3 cr.) P: consent of instructor. Composition, structure, properties, methods of identification, and origin and distribution of clay minerals. Core: sedimentary systems.

G612 Inverse Methods in Geophysics (2 cr.) P: MATH M301, M303, or equivalent. Mathematical techniques to infer the properties of the deep interior of the earth from geophysical data and to appraise the reliability of the results. Theory of generalized inverses in finite dimensional vector spaces and Hilbert space. Resolving power of data. Nonlinear inverse methods.

G613 Seismology II (3 cr.) P: G513. Theory of wave propagation in layered elastic media: Lamb's problem, Cagnaird's method, and propagator matrices. Body force equivalents and the moment tensor representation of seismic sources. Additional selected topics.

G616 Metalliferous Mineral Deposits (3 cr.) P: G416 and G406, or equivalent. Geological processes controlling ore deposition. Application of stable and radioactive isotopes, fluid inclusions, and thermodynamics to the study of ore deposits. Laboratory study of opaque minerals using reflected light microscopy.

G617 Geochemical Exploration (3 cr.) P: G416. Application of geochemical methods in the search for mineral deposits, including analytical techniques, migration of elements, data interpretation, and field problems. Lecture and laboratory.

G626 Industrial Minerals (3 cr.) P: G416. Origin, mode of occurrence, distribution, and uses of mineral commodities other than ores and fuels. Geology of the rocks and minerals used for building materials, chemical raw materials, refractories, fillers, abrasives, fertilizers, fluxes, insulation, filtering agents, and pigments.

G633 Advanced Geophysics Seminar (1-3 cr.) P: consent of instructor. Selected topics in earth physics. S/F grading.

G637 Seminar in Tectonics (1 cr.) P: consent of instructor. Multidisciplinary seminar focusing on regional-scale deformation of the earth's lithosphere.

G685 Evolution of Ecosystems (3 cr.) P: G561 or L575; Isotope Systemics; statistical methods. Advanced analysis of large-scale, cohesive environmental influences on ecosystem development and persistence through the rock record. Emphasis on paleoecologic grouping at community and higher levels. Analytical methods include advanced statistics and synthesis of published numerical, geochemical, and sedimentologic models.

G690 Advanced Geology Seminar (cr. arr.) P: consent of instructor. Seminars on critical research issues and topical themes. S/F grading.

G700 Geologic Problems (1-5 cr.)** P: consent of instructor. Consideration of special geological problems.

G810 Research (cr. arr.)**

**These courses are eligible for a deferred grade.