

**GEOLOGICAL SCIENCES**

**GLG**

**Department of Earth and Environmental Sciences  
College of Natural Science**

**201 The Dynamic Earth**  
Fall, Spring. 4(3-2) Not open to students with credit in GLG 301.

Physical and chemical processes related to the past, present and future behavior of the earth system, and the energy systems that drive these processes. A study of the earth's materials, the earth's surface and the earth's interior.

**202 Geology of Michigan**  
Fall. 3(2-2) P: Completion of Tier I Writing Requirement R: Not open to students in the Department of Earth and Environmental Sciences or in the Lyman Briggs Earth Science Major or in the Lyman Briggs Earth Science-Interdepartmental Coordinate Major or in the Lyman Briggs Environmental Geosciences Coordinate Major or in the Lyman Briggs Geological Sciences Coordinate Major. SA: GLG 302 Not open to students with credit in GLG 304 or GLG 201.

Integration of the geological evolution of Michigan with its social and economic development. Field trips are required.

**301 Geology of the Great Lakes Region**  
Spring. 3(3-0) P: (PHY 231 or PHY 183 or LB 273 or PHY 193H) and (CEM 141 or CEM 151 or LB 171 or CEM 181H) RB: Physical science, environmental engineering, civil engineering R: Open to undergraduate students in the Department of Civil and Environmental Engineering. Not open to students with credit in GLG 201.

Geological, physical and chemical processes related to the origin and evolution of the Earth, North American continent, and the Great Lakes environment. Soils, hydrology, Earth structure and materials, geologic hazards.

**303 Oceanography**  
Fall. 4(4-0) Interdepartmental with Integrative Biology. Administered by Integrative Biology. P: (CEM 141 or CEM 181H or LB 171 or CEM 151) and (PHY 231 or PHY 183 or PHY 193H or LB 273 or PHY 183B or PHY 231C or PHY 241) SA: ZOL 303

Physical, chemical, biological, and geological aspects of oceanography: ocean circulation, waves, tides, air-sea interactions, chemical properties of ocean water, ocean productivity, shoreline processes, and sediments.

**304 Physical and Biological History of the Earth**  
Spring. 4(3-2) P: GLG 201 or ISP 203A SA: GLG 202

Origin of the Earth. Differentiation of the Earth's core, mantle, and crust. Lithospheric tectonics over geologic time. Origin and evolution of the Earth's hydrosphere, atmosphere and climate. Origin and evolutionary history of biological life. Interactions of life with the Earth's endogenic and exogenic systems.

**306 Environmental Geomorphology**  
Fall of even years. 3(3-0) Interdepartmental with Geography. Administered by Geography. P: CSS 210 or GEO 206 or GEO 333 or GLG 201 or GLG 304 or ISP 203A

Relationships of running water, weathering, gravity, ice, waves, wind, and biota (including humans) to terrain and soils. Evolution of landscapes. Classical and modern interpretations.

**319 Introduction to Earth System Science**  
Fall. 3(3-0) Interdepartmental with Entomology and Integrative Biology and Plant Biology and Sociology. Administered by Entomology. RB: Completion of one course in biological or physical science.

Systems approach to Earth as an integration of geochemical, geophysical, biological and social components. Global dynamics at a variety of spatio-temporal scales. Sustainability of the Earth system.

**321 Mineralogy and Geochemistry**  
Fall. 4(3-2) P: GLG 201 and (CEM 142 or CEM 152 or CEM 182H or LB 172) and (MTH 132 or MTH 152H or LB 118)

Earth materials and their origin, modification, structure, dynamics and history. Crystallography and crystal chemistry, and geochemical properties and processes in mineral crystallization and recrystallization. Analytical identification and characterization of minerals in their lithologic context.

**361 Igneous and Metamorphic Geochemistry and Petrology**  
Spring. 4(3-2) P: GLG 321 SA: GLG 461

Evolution, origin, occurrence and tectonic setting of igneous and metamorphic rocks. Phase relations of igneous and metamorphic systems. Studies of rocks in thin sections. Field trip required.

**401 Global Tectonics and Earth Structure (W)**  
Fall. 4(3-2) P: ((GLG 304) and completion of Tier I writing requirement) and (MTH 114 or MTH 116 or MTH 124 or MTH 132 or MTH 152H or LB 118) and (PHY 183 or PHY 183B or PHY 231 or PHY 231C or LB 273 or PHY 193H) R: Open to seniors or graduate students. SA: GLG 371

Structural geology, geological and geophysical methods of studying the structure and dynamics of the earth and planets. Plate kinematics and global geodynamic processes, plate margin processes and evolution, marine geology. Field trip required.

**411 Hydrogeology**  
Fall. 3(3-0) RB: MTH 114 or MTH 116 or MTH 124 or MTH 126 or MTH 132 or MTH 133 or LB 118 or LB 119 or MTH 152H or MTH 153H R: Not open to freshmen or sophomores.

Source, occurrence, and movement of groundwater emphasizing geologic factors and controls.

**412 Glacial Geology and the Record of Climate Change**  
Spring. 4(3-2) Interdepartmental with Geography. Administered by Geological Sciences. RB: GLG 201 or GEO 306 or GEO 408 or GLG 301 R: Not open to freshmen or sophomores.

In-depth analysis of glacial geology and the record of climate change, with emphasis on North America and Europe. Field trip required.

**421 Environmental Geochemistry**  
Spring. 4(3-2) RB: GLG 201 and (CEM 141 or CEM 151 or CEM 181H or LB 171)

Natural and anthropogenic processes affecting the chemistry of the environment with an emphasis on the water cycle. Equilibria and kinetic balances, biogeochemical cycling, contaminant chemicals, chemical origins, environmental health.

**431 Sedimentology and Stratigraphy**  
Spring. 4(3-2) P: GLG 321 and GLG 304

Sediments, sedimentary rocks, sedimentary processes, and depositional environments through geologic time. Facies event correlation. Fossils as tools in stratigraphy and environmental analysis. Biostratigraphy, paleoecology and taphonomy. Field trip required.

**433 Vertebrate Paleontology**  
Fall of even years. 4(3-2) Interdepartmental with Integrative Biology. Administered by Geological Sciences. P: IBIO 328 or GLG 304 or IBIO 360 or IBIO 365 or IBIO 384 or IBIO 445 or GLG 434 or FW 471

Fossil vertebrates with emphasis on evolution and interrelationships of major groups. Modern techniques of identification and interpretation of fossils.

**434 Evolutionary Paleobiology**  
Fall of odd years. 4(3-2) Interdepartmental with Integrative Biology. Administered by Geological Sciences. RB: BS 162 or GLG 304 or LB 144 or BS 182H

Patterns and processes of evolution known from the fossil record

**435 Geomicrobiology**  
Fall. 4(3-2) Interdepartmental with Microbiology and Molecular Genetics. Administered by Geological Sciences. RB: GLG 201 or MMG 201 or BS 161 or LB 145 R: Open to juniors or seniors or graduate students in the College of Natural Science or in the Lyman Briggs College.

Geological and microbiological perspectives on microbial activities in diverse environmental settings, including geological change mediated by microorganisms, microbial evolution driven by geologically diverse habitats, including the evolution of life on Earth, the search for life on other planets, the study of life in extreme environments, and industrial applications of geomicrobiology.

**440 Planetary Geology**  
Spring. 3(2-2) P: GLG 201 and GLG 304 and GLG 321 or approval of department RB: (PHY 232 or PHY 184 or PHY 294H or LB 274) and (MTH 132 or MTH 152H or LB 118)

Surficial and internal properties and processes of planets and their natural satellites, asteroids, comets, and meteorites. Origin, composition, structure, tectonics, volcanism, impact phenomena, atmospheric evolution, atmosphere-surface interactions, and history of solar system bodies. Results of recent space exploration programs, projects and missions.

**446 Ecosystems Modeling, Water and Food Security**  
Fall. 3(3-0) R: Open to juniors or seniors or approval of department.

Impacts of climate variability and change on water availability, food security and global environmental change. Integrated models to identify adaptation and mitigation strategies to such changes and to enhance the efficiency of natural resources use.

## GLG—Geological Sciences

- 470 Solid Earth Geophysics and Geodynamics**  
Spring of odd years. 3(3-0) P: GLG 201 and (MTH 133 or LB 119 or MTH 153H) and (PHY 183 or PHY 183B or PHY 193H or PHY 233B or LB 273) RB: (MTH 234 or concurrently) or (LB 220 or concurrently) or (MTH 254H or concurrently) SA: GLG 472  
Theory and applications of solid-earth geophysics including geochronology, geothermics, geomagnetism and paleomagnetism, geodesy and gravity, rheology, and seismology.
- 471 Applied Geophysics**  
Spring. 4(3-2) P: ((MTH 133 or concurrently) or (LB 119 or concurrently) or (MTH 153H or concurrently)) and ((PHY 184 or concurrently) or (PHY 184B or concurrently) or (PHY 232 or concurrently) or (PHY 232C or concurrently) or (PHY 294H or concurrently) or (LB 274 or concurrently)) R: Not open to freshmen or sophomores.  
Application of seismic, gravity, magnetic, resistivity, and electromagnetic methods to problems related to engineering studies, mineral and oil exploration, groundwater, subsurface mapping, pollution, and hazardous waste.
- 481 Reservoirs and Aquifers**  
Fall. 3(2-2) P: GLG 431 or concurrently  
Principles of the origin and evolution of porous media. Porosity and permeability of sediments and sedimentary rocks. Computing techniques for evaluating reservoirs and aquifers. Field trip required.
- 491 Field Geology - Summer Camp (W)**  
Summer. 6 credits. P: (GLG 431 and GLG 361) or (GLG 431 and GLG 401) or ((GLG 361 and GLG 401) and completion of Tier I writing requirement) R: Open to students in the Department of Geological Sciences or in the Lyman Briggs Geological Sciences Coordinate Major or in the Lyman Briggs Environmental Geosciences Coordinate Major. Approval of department.  
Field analysis of rock types: igneous, metamorphic, sedimentary. Structural analysis. Preparation of stratigraphic sections, geologic maps and cross sections. Air photo analysis.
- 493 Field Studies in Geological Sciences**  
On Demand. 1 to 6 credits. A student may earn a maximum of 8 credits in all enrollments for this course. P: GLG 201 and GLG 304 RB: Specific programs may have additional prerequisites. R: Open to juniors or seniors or graduate students in the Department of Geological Sciences or in the Lyman Briggs Environmental Geosciences Coordinate Major or in the Lyman Briggs Geological Sciences Coordinate Major. Approval of department.  
Field experiences in solid earth and environmental geosciences within the US and abroad. Field trips required.
- 498 Topics in Geological Sciences**  
On Demand. 1 to 4 credits. A student may earn a maximum of 8 credits in all enrollments for this course. P: GLG 201 and GLG 304 or approval of department R: Open to juniors or seniors or graduate students in the Department of Geological Sciences or in the Lyman Briggs Environmental Geosciences Coordinate Major or in the Lyman Briggs Geological Sciences Coordinate Major.  
Selected topics in geological and geoenvironmental sciences supplementing or expanding specific topics, or examining topics not covered in regular courses.
- 499 Independent Study in Geological Sciences**  
Fall, Spring, Summer. 1 to 3 credits. A student may earn a maximum of 6 credits in all enrollments for this course. R: Open to seniors or juniors in the Department of Geological Sciences or in the Lyman Briggs Earth Science-Interdepartmental Coordinate Major or in the Lyman Briggs Environmental Geosciences Coordinate Major or in the Lyman Briggs Geological Sciences Coordinate Major. Approval of department; application required.  
Advanced individual study of special topics in the geological sciences.
- 801 Seminar in Geochemistry**  
On Demand. 1 to 4 credits. A student may earn a maximum of 9 credits in all enrollments for this course. R: Open to graduate students in the Department of Earth and Environmental Sciences.  
Recent developments in geochemistry, including aqueous, biologic and mineralogic aspects.
- 802 Seminar in Geophysics and Geodynamics**  
Fall, Spring. 1 to 4 credits. A student may earn a maximum of 9 credits in all enrollments for this course. RB: GLG 401 or GLG 470 or GLG 471 R: Open to graduate students in the Department of Earth and Environmental Sciences.  
Applied, solid-earth, and theoretical geophysics, global and regional geodynamics. Plate tectonics, marine geophysics, and polar earth sciences.
- 803 Seminar in Hydrogeology**  
Fall, Spring. 1 to 4 credits. A student may earn a maximum of 9 credits in all enrollments for this course. RB: GLG 411 or GLG 421 R: Open to graduate students in the Department of Earth and Environmental Sciences.  
Occurrence, movement and composition of groundwater in geologic settings.
- 804 Seminar in Paleobiology**  
On Demand. 1 to 4 credits. A student may earn a maximum of 9 credits in all enrollments for this course. R: Open to graduate students in the Department of Earth and Environmental Sciences.  
Invertebrate, vertebrate and plant paleobiology.
- 805 Seminar in Petrology**  
Fall, Spring. 1 to 4 credits. A student may earn a maximum of 9 credits in all enrollments for this course. RB: GLG 361 R: Open to graduate students in the Department of Earth and Environmental Sciences.  
Current topics in igneous petrology.
- 806 Seminar in Sedimentology and Stratigraphy**  
On Demand. 1 to 4 credits. A student may earn a maximum of 9 credits in all enrollments for this course. R: Open to graduate students in the Department of Earth and Environmental Sciences.  
Recent developments in stratigraphy and deposition, and diagenesis of sedimentary rocks.
- 807 Seminar in Structural Geology and Tectonics**  
On Demand. 1 to 4 credits. A student may earn a maximum of 9 credits in all enrollments for this course. R: Open to graduate students in the Department of Earth and Environmental Sciences.  
Rock deformation and major lithospheric structure.
- 808 Seminar in Planetary Geology and Astromaterials**  
Fall, Spring. 1 to 4 credits. A student may earn a maximum of 9 credits in all enrollments for this course. RB: Upper university-level coursework in GLG or AST. R: Open to graduate students in the Department of Earth and Environmental Sciences. Approval of department.  
Current topics in planetary geology and astromaterials, including meteorites and returned samples.
- 813 Watershed Hydrology**  
Spring. 4(3-1)  
Watershed hydrology covering the physical, chemical, and isotopic characteristics of river runoff generation from the pore to the catchment scale.
- 821 Aqueous Geochemistry**  
Fall of odd years. 3(2-2) RB: CEM 383 or CSS 455 or FW 472 or GLG 421 R: Open to graduate students.  
Controls on the chemical and isotopic nature of water (fresh, marine, brine) and its solutes. Data acquisition and synthesis. Chemical modeling and evolution of water masses.
- 824 Stable Isotope Biogeochemistry**  
Spring of even years. 2(1-2) Interdepartmental with Integrative Biology. Administered by Integrative Biology. RB: CEM 142 or CEM 152 or CEM 182H or LB 171 SA: ZOL 824  
Principles of stable isotope chemistry applied to biogeochemical problems: climate change, ecology, contaminants, oceanography, limnology, and paleobiology.
- 850 From Research to Publication**  
Fall. 3(3-0) RB: Experience with literature reviews and/or empirical research. Experience with courses requiring extensive writing. R: Open to graduate students and open to juniors or seniors. Approval of department.  
Moving research from data to publication including: ethics in publishing, identifying appropriate journals, writing manuscripts, and the publication process.
- 862 Igneous Petrology**  
Fall of even years. 4(3-2) RB: GLG 361 R: Open to graduate students.  
Origin and evolution of magmatic systems. Relationship of igneous activity to tectonic setting.
- 863 Mineral-Water Interactions**  
Fall of even years. 4(3-2) Interdepartmental with Crop and Soil Sciences. Administered by Geological Sciences. R: Open only to graduate students in the Department of Crop and Soil Sciences or Department of Geological Sciences or Department of Geography.  
Mineralogy, petrology and geochemistry of fluid-rock reactions in geologic, sedimentary and geochemical cycles. Rock and mineral weathering, soil formation, genesis and burial diagenesis of sediments and sedimentary rocks, and metamorphism.

- 864 Mineral and Rock Physics**  
Spring of even years. 4(3-2) P: GLG 321 RB: GLG 401 and MTH 235 and MTH 309  
Physical properties of rocks and minerals fundamental to understanding the structure and dynamics of the Earth and other planets for behavior, including elasticity, rheology, and thermal and electrical transport; theory, experimental measurement, and application to geophysical problems.
- 873 Introduction to Numerical Tools for Earth and Environmental Scientists**  
Fall of odd years. 3(3-0) RB: B.S. in the Earth Sciences or related field  
Introduction to Linux and C including numerical methods, integration, curve-fitting, and differential equations with an emphasis on applications to the geological sciences.
- 889 Special Problems in Geocognition**  
Fall, Spring, Summer. 1 to 4 credits. A student may earn a maximum of 9 credits in all enrollments for this course.  
Individual study on current problems in geocognition and geoscience education research
- 890 Special Problems in Planetary Geology and Astromaterials**  
Fall, Spring. 1 to 4 credits. A student may earn a maximum of 6 credits in all enrollments for this course. RB: Upper university-level coursework in GLG or AST R: Open to graduate students in the Department of Earth and Environmental Sciences. Approval of department.  
Individual study on current topics in planetary geology and astromaterials, including meteorites and returned samples.
- 891 Special Problems in Geochemistry**  
On Demand. 1 to 4 credits. A student may earn a maximum of 6 credits in all enrollments for this course. R: Open to graduate students in the Department of Earth and Environmental Sciences. Approval of department.  
Individual study on problems in geochemistry, including aqueous, biologic, and mineralogic aspects.
- 892 Special Problems in Geophysics and Geodynamics**  
Fall, Spring, Summer. 1 to 4 credits. A student may earn a maximum of 6 credits in all enrollments for this course. RB: GLG 401 or GLG 470 or GLG 471 R: Open to graduate students in the Department of Earth and Environmental Sciences. Approval of department.  
Individual study on problems in applied and solid-earth geophysics, global and regional geodynamics, and polar earth sciences.
- 893 Special Problems in Hydrogeology**  
Fall, Spring, Summer. 1 to 4 credits. A student may earn a maximum of 6 credits in all enrollments for this course. RB: GLG 411 or GLG 421 R: Open to graduate students in the Department of Earth and Environmental Sciences. Approval of department.  
Individual study on the movement, occurrence and composition of groundwater in geologic environments.
- 894 Special Problems in Paleobiology**  
On Demand. 1 to 4 credits. A student may earn a maximum of 6 credits in all enrollments for this course. R: Open to graduate students in the Department of Earth and Environmental Sciences. Approval of department.  
Individual study on invertebrate, vertebrate and plant paleobiology.
- 895 Special Problems in Petrology**  
Fall, Spring, Summer. 1 to 4 credits. A student may earn a maximum of 6 credits in all enrollments for this course. RB: GLG 361 R: Open to graduate students in the Department of Earth and Environmental Sciences. Approval of department.  
Individual study on current problems in petrology.
- 896 Special Problems in Sedimentology and Stratigraphy**  
On Demand. 1 to 4 credits. A student may earn a maximum of 6 credits in all enrollments for this course. R: Open to graduate students in the Department of Earth and Environmental Sciences. Approval of department.  
Individual study on problems in sedimentology and stratigraphy.
- 897 Special Problems in Structural Geology and Tectonics**  
Fall, Spring, Summer. 1 to 4 credits. A student may earn a maximum of 6 credits in all enrollments for this course. R: Open to graduate students in the Department of Earth and Environmental Sciences. Approval of department.  
Individual study on rock deformation or major expressions of deformation. From two to seven weeks of field study during semester breaks may be required for certain research projects.
- 898 Special Problems in Environmental Geosciences**  
On Demand. 1 to 4 credits. A student may earn a maximum of 6 credits in all enrollments for this course. R: Open to graduate students in the Department of Earth and Environmental Sciences. Approval of department.  
Individual study on problems in environmental geosciences.
- 899 Master's Thesis Research**  
On Demand. 1 to 10 credits. A student may earn a maximum of 36 credits in all enrollments for this course. R: Open to master's students in the Department of Earth and Environmental Sciences. Approval of department.  
Master's thesis research.
- 900 Research Strategies and Methods in Environmental Engineering and Science**  
Spring. 1(1-0) Interdepartmental with Environmental Engineering. Administered by Environmental Engineering. R: Open to graduate students in the Department of Civil and Environmental Engineering and open to graduate students in the Department of Geological Sciences. Not open to students with credit in CE 900.  
Criteria for quality research, scientific method, scientific arguments, statistical testing, critical thinking skills, reviewing journal articles, literature synthesis, writing proposals and papers, giving presentations, responsible conduct of research.
- 901 Research Strategies and Methods**  
Fall, Spring. 1(1-0) A student may earn a maximum of 3 credits in all enrollments for this course. RB: Undergraduate degree in Engineering or Sciences  
Selected topics in the earth and environmental sciences.
- 999 Doctoral Dissertation Research**  
Fall, Spring, Summer. 1 to 24 credits. A student may earn a maximum of 36 credits in all enrollments for this course. R: Open to doctoral students in the Department of Earth and Environmental Sciences. Approval of department.  
Doctoral dissertation research.