

# GEOLOGICAL SCIENCES

## GLG

### Department of Geological 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) SA: GLG 302 Not open to students with credit in GLG 201 or GLG 304.

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

#### 303 Oceanography

Fall. 4(4-0) Interdepartmental with Zoology. Administered by Zoology. P: (CEM 141 or CEM 142 or CEM 151 or CEM 152 or CEM 181H or CEM 182H or LB 171 or LB 172) and (PHY 183 or PHY 183B or PHY 193H or PHY 231 or PHY 231B or PHY 231C or LB 271)

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

Spring of odd 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 Plant Biology and Sociology and Zoology. 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 or concurrently) and (CEM 142 or CEM 152 or CEM 182H or LB 172) and (MTH 132 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.

#### 335 Plants Through Time

Spring of odd years. 3(3-0) Interdepartmental with Plant Biology. Administered by Plant Biology. P: BS 110 or PLB 105 or GLG 201 or LB 144 or BS 148H R: Open to juniors or seniors. SA: BOT 335

Evolutionary history of plants, development of ecosystems, and use of plant fossils in the reconstruction of ancient environments and climate.

#### 351 Structural Geology and Tectonics

Fall. 4(3-2) P: GLG 304 and (PHY 231 or PHY 183 or LB 271) and (MTH 132 or MTH 133 or LB 118 or LB 119)

Mechanical behavior and kinematic history of the lithosphere. Stress and strain, folding, faulting. Introduction to reflection seismology, plate tectonics, and geodynamics of fold belts. Methods of analysis and interpretation. One weekend field trip required.

#### 361 Petrology (W)

Spring. 4(3-2) P: (GLG 321) and completion of Tier I writing requirement 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.

#### 401 Plate Tectonics (W)

Spring. 4(3-2) P: ((GLG 304) and completion of Tier I writing requirement) and (MTH 114 or MTH 116 or MTH 124 or MTH 126 or MTH 132 or MTH 133 or LB 118 or LB 119) and (PHY 183 or PHY 183B or PHY 231 or PHY 231C or LB 271) SA: GLG 371

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.

#### 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 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 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. Laboratory focuses on glacial processes. One weekend field trip required.

#### 413 Groundwater Contamination

Spring of odd years. 3(3-0) P: GLG 411 or approval of department RB: MTH 114 or MTH 116 or MTH 124 or MTH 126 or MTH 132 or MTH 133 or LB 118 or LB 119 R: Not open to freshmen or sophomores.

Occurrence, transport, and fate of contaminants in groundwater, hydrogeologic controls, and remediation technologies.

#### 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 environmental chemistry with emphasis on the water cycle. Chemical equilibria, kinetics, geochemical cycling, acid rain, carbon dioxide, heavy metals, toxic organics, global change and the greenhouse effect.

#### 426 Biogeochemistry

Summer. 3 credits. Interdepartmental with Crop and Soil Sciences and Microbiology and Molecular Genetics and Zoology. Administered by Microbiology and Molecular Genetics. RB: (BS 110 or LBS 144 or LBS 148H or BS 111 or LBS 145 or LBS 149H) and (CEM 143 or CEM 251) SA: MPH 426

Integration of the principles of ecology, microbiology, geochemistry, and environmental chemistry. Societal applications of research in aquatic and terrestrial habitats.

#### 431 Sedimentology and Stratigraphy (W)

Spring. 4(3-2) P: (GLG 321) and completion of Tier I writing requirement

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

#### 433 Vertebrate Paleontology

Fall of even years. 4(3-2) Interdepartmental with Zoology. Administered by Geological Sciences. P: ZOL 328 or GLG 304

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

#### 434 Evolutionary Paleobiology

Fall. 4(3-2) Interdepartmental with Zoology. Administered by Geological Sciences. RB: BS 110 or GLG 304 or LB 144 or BS 148H

Patterns and processes of evolution known from the fossil record including speciation, phylogeny, extinction, heterochrony and biogeography.

#### 440 Planetary Geology

Spring. 3(2-2) P: GLG 201 and GLG 304 and GLG 321 or approval of department RB: PHY 232 and MTH 132

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.

#### 470 Principles of Modern Geophysics

Fall of odd years. 3(3-0) P: GLG 201 and ((MTH 234 or concurrently) or (MTH 254H or concurrently) or (LB 220 or concurrently)) and (PHY 183 or PHY 183B or PHY 193H or PHY 233B or LB 271) SA: GLG 472

Theory of solid-earth geophysics including geochronology, geothermics, geomagnetism and paleomagnetism, geodesy and gravity, rheology, and travel-time seismology.

## Geological Sciences—GLG

- 471 Applied Geophysics**  
Spring. 4(3-2) P: ((MTH 133 or concurrently) or (LB 119 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 272 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**  
Spring of odd years. 3(3-0) 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.
- 491 Field Geology - Summer Camp (W)**  
Summer. 6 credits. P: (GLG 431) and completion of Tier I writing requirement. R: Open only to students in the Department of Geological Sciences. 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.
- 492 Senior Experience in Earth Sciences (W)**  
Spring. 1(1-0) P: GLG 201 R: Open to students in the Department of Geological Sciences or approval of department.  
Evaluation of knowledge and engagement in in-depth review of fundamental areas of geological sciences.
- 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 only to juniors or seniors in the Department of Geological Sciences. Approval of department; application required.  
Advanced individual study of special topics in the geological sciences.
- 801 Seminar in Geochemistry**  
Fall, Spring. 1 to 4 credits. A student may earn a maximum of 9 credits in all enrollments for this course. R: Open only to graduate students in the Department of Geological 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 only to graduate students in the Department of Geological 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 only to graduate students in the Department of Geological Sciences.  
Occurrence, movement and composition of groundwater in geologic settings.
- 804 Seminar in Paleobiology**  
Fall, Spring. 1 to 4 credits. A student may earn a maximum of 9 credits in all enrollments for this course. R: Open only to graduate students in the Department of Geological 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 only to graduate students in the Department of Geological Sciences.  
Current topics in igneous petrology.
- 806 Seminar in Sedimentology and Stratigraphy**  
Fall, Spring. 1 to 4 credits. A student may earn a maximum of 9 credits in all enrollments for this course. R: Open only to graduate students in the Department of Geological Sciences.  
Recent developments in stratigraphy and deposition, and diagenesis of sedimentary rocks.
- 807 Seminar in Structural Geology and Tectonics**  
Fall, Spring. 1 to 4 credits. A student may earn a maximum of 9 credits in all enrollments for this course. R: Open only to graduate students in the Department of Geological 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 Geological Sciences. Approval of department.  
Current topics in planetary geology and astromaterials, including meteorites and returned samples.
- 811 Advanced Hydrogeology**  
Spring. 3(3-0) Interdepartmental with Civil Engineering. Administered by Geological Sciences. RB: CE 821  
Processes influencing groundwater flow and solute transport. Mathematical equations and numerical methods to describe these processes.
- 821 Aqueous Geochemistry**  
Fall of odd years. 3(2-2) RB: CE 481 or CEM 383 or CSS 455 or FW 472 or GLG 421 or GLG 422 R: Open only 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 Zoology. Administered by Zoology. RB: CEM 142 or CEM 152 or CEM 182H or LB 171  
Principles of stable isotope chemistry applied to biogeochemical problems: climate change, ecology, contaminants, oceanography, limnology, and paleobiology.
- 825 Clay Mineralogy and Soils Genesis**  
Spring of even years. 4(3-2) Interdepartmental with Crop and Soil Sciences. Administered by Crop and Soil Sciences. R: Open only to graduate students in the College of Agriculture and Natural Resources or College of Engineering or College of Natural Science.  
Mineral structures. X-ray diffraction, pedogenic processes, and mineral transformations and stability.
- 831 Quantitative Paleobiology**  
Spring of odd years. 3(2-2) Interdepartmental with Zoology. Administered by Geological Sciences. RB: GLG 431  
Analysis of paleobiological problems using quantitative techniques such as cladistics, morphometrics, ordination, and stereology.
- 861 Evolution of the Crust and Mantle**  
Fall of odd years. 3(3-0) RB: GLG 361 R: Open to graduate students.  
Origin and evolution of the Earth's crust and mantle. Petrology, tectonics and geophysics of the Earth.
- 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 Geology.  
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.
- 882 Basin Analysis**  
Spring of even years. 3(3-0) RB: GLG 351 and GLG 431  
Paleogeographic evolution of sedimentary basins. Principles of facies analysis, subsidence history, thermal history and diagenesis. Methods of stratigraphic analysis.
- 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 Geological Sciences. Approval of department.  
Individual study on current topics in planetary geology and astromaterials, including meteorites and returned samples.

**891 Special Problems in Geochemistry**  
 Fall, Spring, Summer. 1 to 4 credits. A student may earn a maximum of 6 credits in all enrollments for this course. R: Open only to graduate students in the Department of Geological 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 only to graduate students in the Department of Geological 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 only to graduate students in the Department of Geological Sciences. Approval of department.

Individual study on the movement, occurrence and composition of groundwater in geologic environments.

**894 Special Problems in Paleobiology**

Fall, Spring, Summer. 1 to 4 credits. A student may earn a maximum of 6 credits in all enrollments for this course. R: Open only to graduate students in the Department of Geological 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 only to graduate students in the Department of Geological Sciences. Approval of department.

Individual study on current problems in petrology.

**896 Special Problems in Sedimentology and Stratigraphy**

Fall, Spring, Summer. 1 to 4 credits. A student may earn a maximum of 6 credits in all enrollments for this course. R: Open only to graduate students in the Department of Geological 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. RB: GLG 351 R: Open only to graduate students in the Department of Geological 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**

Fall, Spring, Summer. 1 to 4 credits. A student may earn a maximum of 6 credits in all enrollments for this course. R: Open only to graduate students in the Department of Geological Sciences. Approval of department.

Individual study on problems in environmental geosciences.

**899 Master's Thesis Research**

Fall, Spring, Summer. 1 to 10 credits. A student may earn a maximum of 36 credits in all enrollments for this course. R: Open only to master's students in the Department of Geological Sciences. Approval of department.

Master's thesis research.

**999 Doctoral Dissertation Research**

Fall, Spring, Summer. 1 to 24 credits. A student may earn a maximum of 120 credits in all enrollments for this course. R: Open only to doctoral students in the Department of Geological Sciences. Approval of department.

Doctoral dissertation research.