

## Geography—GEO

- 999 Doctoral Dissertation Research**  
Fall, Spring, Summer. 1 to 24 credits. A student may earn a maximum of 99 credits in all enrollments for this course.  
Doctoral dissertation research.

## 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.
- 302 Geology of Michigan**  
Spring. 3(3-0) P:M: (GLG 201 or ISP 203)  
Integration of the geological evolution of Michigan with its social and economic development.
- 303 Oceanography**  
Fall. 4(4-0) P:M: (CEM 141 or CEM 142 or CEM 151 or CEM 152 or CEM 181H or CEM 182H or LBS 171) and (PHY 183 or PHY 183B or PHY 193H or PHY 231 or PHY 231B or PHY 231C or LBS 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**  
Fall, Spring. 4(3-2) P:M: (GLG 201 or ISP 203) 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. 3(3-0) Interdepartmental with Geography. Administered by Department of Geography. P:M: (CSS 210 or GEO 203 or GEO 206 or GEO 330 or GEO 333 or GEO 259 or GLG 201 or GLG 304 or ISP 203A or ISS 310 or RD 201 or ISP 203B) and completion of Tier I writing requirement.  
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; Plant Biology; Zoology; Sociology. Administered by Department of 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**  
Spring. 4(3-2) P:M: (GLG 201 or concurrently) and (CEM 142 or CEM 152 or CEM 182H or LBS 172) and (MTH 132 or LBS 118)  
Geochemical properties and processes in the origin, modification, structure, dynamics and history of earth materials. Crystallography and crystal chemistry. Mineral classification and identification.

- 335 Plants Through Time**  
Spring of odd years. 3(3-0) Interdepartmental with Plant Biology. Administered by Department of Plant Biology. P:M: (BS 110 or PLB 105 or GLG 201 or LBS 144 or LBS 148H) R: Open only 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**  
Fall. 4(3-2) P:M: (GLG 304 and GLG 361 or concurrently) and (MTH 114 or MTH 116 or LBS 117 or MTH 124 or MTH 126 or MTH 132 or MTH 133 or LBS 118 or LBS 119) RB: Introductory physics.  
Mechanical behavior and kinematic history of the lithosphere. Stress and strain. Deformation features such as folds, faults and microstructure. Methods of analysis and interpretation. One weekend field trip required.

- 361 Petrology (W)**  
Fall. 4(3-2) P:M: (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:M: (GLG 304) and (MTH 114 or MTH 116 or LBS 117 or MTH 124 or MTH 126 or MTH 132 or MTH 133 or LBS 118 or LBS 119) and (PHY 183 or PHY 183B or PHY 231 or PHY 231B or PHY 231C or LBS 271) and completion of Tier I writing requirement. R: Not open to graduate students in the Department of Geological Sciences. 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 LBS 117 or MTH 124 or MTH 126 or MTH 132 or MTH 133 or LBS 118 or LBS 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. 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.

- 419 Advanced Earth System Science**  
Spring. 3(2-2) Interdepartmental with Entomology; Plant Biology; Zoology; Sociology. Administered by Department of Entomology. P:M: (ENT 319)  
Systems science theory applied to analysis of the biological, geological, physical, and social causes and consequences of global changes. Issues of sustaining the Earth system.

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

- 422 Aquatic and Marine Organic Geochemistry (W)**  
Fall. 3(3-0) P:M: (CEM 141 or CEM 142 or CEM 151 or CEM 152 or CEM 181H or CEM 182H or LBS 171) and completion of Tier I writing requirement. RB: (GLG 201 or GLG 304)  
Organic geochemistry applied to global cycling of organic matter and diagenesis in aquatic and marine environments. Use of stable isotopes and molecular analyses to trace the fate of bulk organic matter and individual compounds in the environment.

- 426 Biogeochemistry**  
Summer. 3 credits. Summer: Given only at W.K. Kellogg Biological Station. Interdepartmental with Microbiology and Molecular Genetics; Crop and Soil Sciences; Zoology. Administered by Department of 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:M: (GLG 351) 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. P:M: (ZOL 328)  
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. RB: (BS 110 or GLG 304 or LBS 144 or LBS 148H)  
Patterns and processes of evolution known from the fossil record including speciation, phylogeny, extinction, heterochrony and biogeography.

- 470 Principles of Modern Geophysics**  
Fall of odd years. 3(3-0) P:M: (GLG 201 and (MTH 234 or concurrently or MTH 254H or concurrently or LBS 220 or concurrently) and (PHY 183 or PHY 183B or PHY 193H or PHY 233B or LBS 271) SA: GLG 472  
Theory of solid-earth geophysics including geochronology, geothermics, geomagnetism and paleomagnetism, geodesy and gravity, rheology, and travel-time seismology.
- 471 Applied Geophysics**  
Spring. 4(3-2) P:M: (MTH 133 or concurrently or LBS 119 or concurrently) and (PHY 184 or concurrently or PHY 184B or concurrently or PHY 232 or concurrently or PHY 232B or concurrently or PHY 232C or concurrently or PHY 294H or concurrently or LBS 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:M: (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. Summer: Park City, Utah. P:M: (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.
- 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 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 Geological Sciences.  
Rock deformation and major lithospheric structure.
- 811 Advanced Hydrogeology**  
Spring. 3(3-0) Interdepartmental with Civil Engineering. 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.
- 823 Isotope Geochemistry**  
Spring of even years. 3(3-0) RB: (CEM 152) and (PHY 184 or PHY 232)  
Fundamentals of isotope behavior, fractionation, and interpretation and application of isotope data. Radiogenic isotopes including geochronology and environmental tracing.
- 824 Stable Isotope Biogeochemistry**  
Spring. 2(1-2) RB: (CEM 142 or CEM 152 or CEM 182H or LBS 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 Department of Crop and Soil Sciences. R: Open only to graduate students in College of Agriculture and Natural Resources, 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. RB: (GLG 431)  
Analysis of paleobiological problems using quantitative techniques such as cladistics, morphometrics, ordination, and stereology.
- 861 Evolution of the Crust and Mantle**  
Spring of odd years. 3(3-0) RB: (GLG 361) R: Open only to graduate students.  
Origin and evolution of the Earth's crust and mantle. Petrology, tectonics and geophysics of the Earth.
- 862 Igneous Petrology**  
Spring of even years. 4(3-2) RB: (GLG 361) R: Open only 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. R: Open only to graduate students in Crop and Soil Sciences or Geological Sciences or 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.
- 881 Sedimentary Petrology**  
Fall of even years. 4(3-2) RB: (GLG 361 and GLG 431)  
Origin of sedimentary particles and their chemical and physical alterations after deposition. Geochemical cycles in Earth history.
- 882 Basin Analysis**  
Fall of odd 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.
- 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 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.

## Geological Sciences—GLG

- 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 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 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.

## GERMAN

### Department of Linguistics and Germanic, Slavic, Asian and African Languages College of Arts and Letters

- 101 Elementary German I**  
Fall, Spring, Summer. 4(4-1) R: No previous experience in German or designated score on German Placement Test. Not open to students with credit in GRM 150.

German language, civilization, and culture for beginning students. Work on all language skills with emphasis on speaking.

- 102 Elementary German II**  
Fall, Spring, Summer. 4(4-1) P:M: (GRM 101) or designated score on German placement test. Not open to students with credit in GRM 150.

Further study of German language, civilization, and culture for beginning students. Continued work on all language skills with emphasis on speaking.

- 103 Self-Paced Elementary German I**  
Fall, Spring, Summer. 2 to 4 credits. A student may earn a maximum of 4 credits in all enrollments for this course. RB: Some German coursework in High School. Not open to students with credit in GRM 101.

Self-paced introduction to German language, civilization and culture including web-based activities.

- 104 Self-Paced Elementary German II**  
Fall, Spring, Summer. 2 to 4 credits. A student may earn a maximum of 4 credits in all enrollments for this course. P:M: (GRM 101 or GRM 103) or designated score on German placement test. RB: Some German coursework in High School. Not open to students with credit in GRM 102.

Further self-paced study of German language, civilization, and culture for beginning students including web-based activities.

- 201 Second-Year German I**  
Fall, Spring. 4(4-0) P:M: (GRM 102) or designated score on German placement test. Not open to students with credit in GRM 200.

Intermediate-level development of all language skills. Reading, viewing, and discussion of a broad range of cultural materials from the German-speaking world.

- 202 Second-Year German II**  
Fall, Spring. 4(4-0) P:M: (GRM 201) or designated score on German placement test.

Further intermediate-level work on all language skills, based on topics such as popular music, literature, film, current events, and culture. Transition course to advanced work in German studies.

- 250 German Literature and Culture in English**  
Fall. 3(3-0) A student may earn a maximum of 9 credits in all enrollments for this course. Selected representative texts or themes in the cultures of German-speaking countries.

- 290 Independent Study**  
Fall, Spring. 1 to 4 credits. A student may earn a maximum of 8 credits in all enrollments for this course. R: Approval of department.

Special projects arranged by an individual student and a faculty member in areas supplementing regular course offerings.

- 301 Third-Year German I**  
Fall, Spring. 3(3-0) P:M: (GRM 202) or designated score on German placement test.

Advanced speaking, listening comprehension, reading, and writing skills. Intensive work with authentic texts dealing with contemporary issues in the German-speaking world. Selected review of grammar and syntax.

- 302 Third-Year German II**  
Fall, Spring. 3(3-0) P:M: (GRM 301)

Continuation of GRM 301. Intensive work with original texts dealing with contemporary issues in the German-speaking world.

- 311 Business German I**  
Fall. 3(3-0) P:M: (GRM 202) or designated score on German placement test. R: Not open to freshmen.

Development of proficiency through readings, discussions, and assignments based on materials dealing with the German economic system and Germany in world trade. Taught in German.

- 312 Business German II**  
Spring. 3(3-0) P:M: (GRM 311) R: Not open to freshmen.

Further readings, discussions, and assignments based on materials dealing with key areas of German business such as management and corporate hierarchies. Taught in German. Research paper required.

- 325 Third-Year German: Oral Communication**  
Spring, Summer. 3(3-0) P:M: (GRM 202) or designated score on German placement test.

Development of listening comprehension and oral communication in German beyond the intermediate level. Expansion of vocabulary, use of idiomatic expressions and review of grammatical structures relevant for speaking.

- 341 German Literature and Culture Before 1918**  
Spring. 3(3-0) P:M: (GRM 202) or designated score on German placement test.

Historical, social, and cultural developments in the German-speaking world before 1918 as revealed in textual material in German, including literature, essays, and film.

- 342 German Literature and Culture since 1918**  
Fall. 3(3-0) P:M: (GRM 202) or designated score on German placement test. SA: GRM 340

Historical, social, and cultural developments in the German-speaking world since 1918 as revealed in textual material in German, including literature, essays, and film.