

GEOGRAPHY

454*. **Spatial Aspects of Regional Development**
 Spring of odd-numbered years. 3(3-0)
 P: GEO 113, or GEO 151, or GEO 230,
 or GEO 233, or GEO 335, or GEO 336, or GEO 337.

Spatial patterns and processes associated with regional development in selected world areas.
 QP: GEO 201 GEO 213GEO 300GEO 315GEO 316
 GEO 364 OR GEO 365 QA: GEO 440

459*. **Tourism in Development**
 Fall. 3(3-0)

Analysis of the distribution, nature, and impacts of tourism. Environmental considerations and the role of tourism in regional development. Examples from Michigan, the United States and other nations.

465*. **Introduction to Quantitative Methods for Geographers and Planners**

Fall. 3(03-00) Interdisciplinary with the Department(s) of Urban Planning.
 R: GEO, UP, LA
 Basic quantitative techniques in the analysis and classification of geographic data.
 QA: GEO 427

480*. **Senior Seminar**
 Spring. 3(3-0)

R: Open only to seniors in Geography.
 History, philosophy, and methodology of the geographic discipline as it has evolved within academic and social contexts.
 QA: GEO 425

491*. **Readings in Geography**
 Fall, Spring, Summer. 1 to 4 credits.
 May reenroll for a maximum of 12 credits.

492*. **Geographic Research Problems**
 Fall, Spring, Summer. 1 to 4 credits.
 May reenroll for a maximum of 16 credits.

Research on selected aspects of Geography.

495*. **Field Study**
 Fall, Spring, Summer. 1 to 4 credits.
 May reenroll for a maximum of 8 credits.

Supervised field study in Geography.

498*. **Internship in Geography**
 Fall, Spring, Summer. 1 to 4 credits.
 May reenroll for a maximum of 8 credits.
 P: Approval of Department R: juniors and

above
 Individual experience in Geography at an approved agency, firm, or other entity.

809*. **Seminar in Physical Geography**
 Fall, Spring, Summer. 3(3-0) May
 reenroll for a maximum of 9 credits.
 P: Consent of instructor R: graduate

standing
 Research on topics in physical geography, specifically climatology, geomorphology, soils, and plant geography.
 QA: GEO 834

813*. **Seminar in Urban and Economic Geography**
 Fall. 3(3-0)
 P: Two of GEO 413, GEO 414, GEO 415,
 GEO 416, GEO 417, GEO 418 or equivalent.

Research on selected topics in urban and economic geography.
 QP: TWO OF GEO 401GEO 403GEO 435
 QA: GEO 805

815*. **Seminar in Location Theory and Transportation Geography**
 Spring. 3(3-0)
 P: Two of GEO 413, GEO 414, GEO 415,
 GEO 416, GEO 417, GEO 418

Research on selected topics in location theory and transportation geography.
 QP: TWO OF GEO 401GEO 403GEO 435
 QA: GEO 835

823*. **Map Automation**
 Fall. 3(02-02)
 P: GEO 223 R: Graduate Students

The use of computers in cartography. Cartographic algorithms, interpolation, line generalization, program intelligence, cartographic data bases.
 QP: GEO 223 QA: GEO 449

825*. **Geoprocessing**
 Spring of even-numbered years.
 4(04-00)
 P: GEO 225, GEO 424.

Integration of digital remote sensing data, geographic information systems, spatial analysis, and expert systems in solving research problems. Class research project.
 QP: GEO 424

826*. **Seminar in Cartography and Geoprocessing**
 Spring. 3(03-00)
 R: Graduate students
 Research in cartography, geographic information systems, and remote sensing.
 QA: GEO 846

850*. **Regional Seminar**
 Fall, Spring. 3(3-0)
 P: Approval of department R: Graduate students
 Research on contemporary geographic issues in different world regions.
 QA: GEO 840

860*. **Methods and Modeling in Regional Science**
 Spring of even-numbered years. 3(3-0)
 Interdepartmental with the Department(s) of Resource Development.
 P: multivariate statistics R: graduate status

Advanced methods for regional scientists including spatial aspects of linear programming, input-output methods, spatial forecasting and simulation models.

865*. **Advanced Quantitative Methods in Geography**
 Spring. 4(4-0)
 P: GEO 465

Advanced methods applied to geographic data. Multiple regression, principle components and factor analysis, discriminant analysis, and related taxonomic methods.
 QP: GEO 427 QA: GEO 811

886*. **Research Design in Geography**
 Spring. 3(3-0)
 R: graduate students GEO and UP Approval of the Dept
 Research and writing in geography. Identification of geographic problems and their relative importance. Structuring and stating hypotheses. Data acquisition and tests for validity.
 QA: GEO 826

891*. **Advanced Readings in Geography**
 Fall, Spring, Summer. 1 to 8 credits.
 May reenroll for a maximum of 12 credits.
 R: Graduate Students Geography

QA: GEO 818

892*. **Advanced Geographic Research**
 Fall, Spring, Summer. 1 to 4 credits.
 May reenroll for a maximum of 16 credits.
 R: graduate status
 Advanced research on selected aspects of geography.

899*. **Master's Thesis Research**
 Fall, Spring, Summer. 1 to 12 credits.
 May reenroll for a maximum of 30 credits.
 R: Open only to graduate students in Geography.

QA: GEO 899

986*. **Theory and Methods in Geography**
 Spring. 3(3-0)
 R: Ph.D. GEO
 Historical development of the geographic discipline within social and intellectual contexts. Current methodological and philosophical approaches to geographic research.
 QA: GEO 926 GEO 825

999*. **Doctoral Dissertation Research**
 Fall, Spring, Summer. 1 to 12 credits.
 May reenroll for a maximum of 36 credits.
 R: Phd students only Geography

QA: GEO 999

GEOLOGY GLG

201. **Earth Processes and History**
 Fall, Spring. 4(3-2)
 Physical, chemical and biological processes related to the evolution of the Earth. The roles of solar energy, Earth's internal heat and the process of natural selection in controlling these processes.
 QA: GLG 201 GLG 202 GLG 306

301. **Engineering Geology**
 Fall. 4(3-2)
 R: Not open to freshmen. Open only to College of Engineering students. Not open to students with credit in GLG 201.
 Principles of geology as applied to civil engineering practice. Minerals, rocks, surficial and internal processes, mitigation of destructive geological processes. Air photos, topographic-geologic maps, cross sections.
 QA: GLG 200 GLG 201 GLG 306

321. **Mineralogy and Geochemistry**
 Fall. 4(3-2)
 P: CEM 142 or CEM 152.
 Geochemical properties and processes in the origin, modification, structure, dynamics and history of Earth materials. Crystallography and crystal chemistry. Mineral classification and identification.
 QP: CEM 141 ORCEM 151ORLBS 161 QA: GLG 321 GLG 323 GLG 327

331. **Vertebrate Life of the Past**
 Spring. 3(3-0) Interdepartmental with the Department(s) of Zoology.
 P: BS 110 or BS 111 or juniors and above.
 R: Not open to students with credit in GLG 433.
 Evolution and diversity of fossil vertebrates from fish to humans with emphasis on dinosaurs and Pleistocene events.
 QA: GLG 302

GEOLOGY

- 351*.** **Structural Geology**
Fall. 4(3-2)
P: GLG 201 or GLG 301; GLG 321, MTH 116.
Structural geology. 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.
QP: GLG 202 MTH 111 QA: GLG 351
- 371.** **Introduction to Geodynamics and Geophysics**
Spring. 3(4-0)
P: MTH 132; PHY 183 or PHY 183B or PHY 231 or PHY 231B.
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.
QP: GLG 201 MTH 112 QA: GLG 375 GLG 479
- 411*.** **Hydrogeology**
Fall. 4(3-2)
P: MTH 116 R: Not open to freshmen and sophomores.
Principles of the source, occurrence and movement of groundwater emphasizing geologic factors and controls.
QP: MTH 109 ORMTH 111. QA: GLG 411
- 412*.** **Glacial and Quaternary Geology**
Spring of odd-numbered years. 3(2-2)
Interdepartmental with the Department(s) of Geography.
P: GLG 201 OR GLG 301 OR GEO 406
R: Jrs and above
Glacial and Quaternary geology of the world with emphasis on the midwestern United States. Laboratory studies stress glacial processes. One weekend field trip required.
QP: GLG 201 QA: GLG 413
- 421*.** **Environmental Geochemistry**
Spring. 3(3-0)
P: GLG 201 or GLG 301; CEM 141 or CEM 151.
Natural and anthropogenic processes affecting environmental chemistry with emphasis on the water cycle. Chemical equilibria, kinetics, geochemical cycling, acid rain, carbon dioxide and the greenhouse effect. Historical perspectives and future concerns.
QP: GLG 200 OR GLG 201 CEM 151 QA: GLG 412
- 422*.** **Organic Geochemistry**
Fall. 3(3-0)
P: CEM 152; GLG 201 or GLG 301; PHY 183 or PHY 183B or PHY 231 or PHY 231B
Organic geochemistry applied to global cycling of organic matter and diagenesis. Evaluation of the fate of bulk organic matter and individual compounds in the environment.
QP: CEM 152 GLG 201 OR GLG 301 PHY 237
- 423*.** **Survey of Environmental Geosciences**
Spring. 1(1-0)
P: GLG 201 or GLG 301.
Application of geological sciences to environmental issues ranging from global warming to geological hazards such as earthquakes.
QP: GLG 201 OR GLG 306
- 431*.** **Stratigraphy and Paleontology**
Spring. 4(3-2)
P: GLG 201 or GLG 301.
Depositional environments through geologic time; facies, events, correlation. Historical paleontology and evolution: biostratigraphy, biogeography and paleogeology.
QP: GLG 202 GLG 338 GLG 392 QA: GLG 338 GLG 346
- 433.** **Vertebrate Paleontology**
Fall of even-numbered years. 4(3-2)
Interdepartmental with the Department(s) of Zoology.
P: ZOL 228. R: Not open to students with credit in GLG 331. Approval of department.
Fossil vertebrates with emphasis on evolution of major groups. Modern techniques of collection, identification and interpretation of fossils.
QP: ZOL 428 QA: GLG 430
- 434*.** **Evolutionary Paleobiology**
Fall of odd-numbered years. 4(3-2)
Interdepartmental with the Department(s) of Zoology.
P: BS 110 or GLG 201.
Patterns and processes of evolution known from the fossil record including speciation, phylogeny, extinction, heterochrony and biogeography.
QP: GLG 338 ZOL 389 ZOL 445 QA: GLG 438 GLG 836
- 461*.** **Petrology**
Spring. 4(3-2)
P: GLG 321.
Petrology of igneous, metamorphic and sedimentary rocks. Thin section studies of rocks and rock suites from classic areas.
QP: GLG 323 AND GLG 327 AND GLG 351 QA: GLG 363 GLG 392
- 471*.** **Applied Geophysics**
Fall of odd-numbered years. 4(3-2)
P: MTH 133 or concurrently; PHY 184 or PHY 184B or PHY 232 or PHY 232B or concurrently.
R: Not open to freshmen and sophomores.
Application of seismic, gravitational, magnetic resistivity and electromagnetic methods to problems in engineering studies. Mineral and oil exploration. Groundwater, subsurface mapping, pollution and hazardous waste.
QP: GLG 375 MTH 214 PHY 239 OR PHY 289 QA: GLG 474
- 472*.** **Principles of Modern Geophysics**
Fall of even-numbered years. 3(3-0)
P: MTH 235; PHY 184 or PHY 184B.
Theory of solid-earth geophysics including geochronology, geothermics, geomagnetism and paleomagnetism, geodesy and gravity, rheology, and travel-time seismology.
QP: MTH 310 PHY 289 QA: GLG 477 GLG 877
- 481*.** **Reservoirs and Aquifers**
Spring of even-numbered years. 4(3-2)
P: GLG 431 or concurrently; GLG 461.
Principles of the origin and evolution of porous media. Porosity and permeability of sediments and sedimentary rocks. Computing techniques for evaluating reservoirs and aquifers.
QP: GLG 392 QA: GLG 485
- 491*.** **Field Geology - Summer Camp**
Summer. 9(-)
P: GLG 351, GLG 431, GLG 461. R: Open only to Geology majors.
Field analysis of rock types: igneous, metamorphic, sedimentary. Structural analysis. Preparation of stratigraphic sections, geologic maps and cross sections. Air photo analysis.
QP: GLG 351 GLG 392 GLG 338 GLG 346 QA: GLG 344 GLG 344A GLG 344B GLG 344C
- 499*.** **Independent Study in Geological Sciences**
Fall, Spring, Summer. 1 to 3 credits.
May reenroll for a maximum of 6 credits.
R: Open only to Geology juniors and seniors. Approval of department.
Advanced individual study of special topics in the geological sciences.
QA: GLG 400H
- 801*.** **Seminar in Geological Sciences(MTC)**
Fall, Spring. 1 to 6 credits. May reenroll for a maximum of 9 credits.
R: Masters and Ph.D. only
Seminar relating to current research in geochemistry, geophysics, geodynamics, hydrogeology, paleobiology, petrology, sedimentology, structural geology and tectonics.
QA: GLG 810
- 801A*.** **Seminar in Geochemistry**
Fall, Spring. 1 to 4 credits. May reenroll for a maximum of 9 credits.
R: Masters and Ph.D. only
Seminar relating to specific areas and recent developments in geochemistry, including aqueous, biologic and mineralogical aspects.
QA: GLG 824
- 801B*.** **Seminar in Geophysics and Geodynamics**
Fall, Spring. 1 to 4 credits. May reenroll for a maximum of 9 credits.
P: GLG 371 OR GLG 471 OR GLG 472
R: Masters and Ph.D. only
Seminar relating to applied, solid-earth, and theoretical geophysics, global and regional geodynamics, and recent developments in plate tectonics, marine geophysics, and polar earth sciences.
QP: GLG 474 GLG 479 QA: GLG 811 GLG 813 GLG 815
- 801C*.** **Seminar in Hydrogeology**
Fall, Spring. 1 to 4 credits. May reenroll for a maximum of 9 credits.
P: GLG 411 OR GLG 421 R: Masters and Ph.D. only
Seminar relating to the occurrence, movement and composition of groundwater in various geologic settings.
- 801D*.** **Seminar in Paleobiology**
Fall, Spring. 1 to 4 credits. May reenroll for a maximum of 9 credits.
R: Masters and Ph.D. only OR approval of department
Seminar relating to invertebrate, vertebrate and plant paleobiology.
QA: GLG 816
- 801E*.** **Seminar in Petrology**
Fall, Spring. 1 to 4 credits. May reenroll for a maximum of 9 credits.
P: GLG 461 R: Masters and Ph.D. only
Seminar relating to current topics in igneous petrology.
QA: GLG 823
- 801F*.** **Seminar in Sedimentology**
Fall, Spring. 1 to 4 credits. May reenroll for a maximum of 9 credits.
R: Masters and Ph.D. only
Seminar relating to recent developments in deposition and diagenesis of sedimentary rocks.
QP: GLG 491 GLG 898 QA: GLG 817 GLG 818 GLG 819 GLG 820 GLG 821
- 801G*.** **Seminar in Structural Geology and Tectonics**
Fall, Spring. 1 to 4 credits. May reenroll for a maximum of 9 credits.
R: Masters and Ph.D. only
Seminar relating to rock deformation and major lithospheric structure.
QA: GLG 814 GLG 822
- 821*.** **Aqueous Geochemistry**
Fall of odd-numbered years. 3(3-0)
P: GLG 421 OR GLG 422 OR CEM 383 OR CE 481 OR CSS 455 OR FW 472. R: Masters and Ph.D. only
Controls on the chemical and isotopic nature of water (fresh, marine, brine) and its solutes. Data acquisition and synthesis, chemical modeling and the evolution of water masses.
QP: GLG 497 QA: GLG 894

GEOLOGY

822*. **Biogeochemistry**
 Fall of even-numbered years. 3(3-0)
 P: 12 credits in CEM or BS; 6 credits in
 GLG R: Masters and Ph.D. only OR approval of
 department
 Carbon and nutrient cycling in the natural environ-
 ment; oxic and anoxic processes; flows of carbon in
 lacustrine, marine, terrestrial and global ecosystems;
 development of the carbon cycle over geologic time.

823*. **Isotope Geochemistry**
 Spring of even-numbered years. 3(3-0)
 P: CEM 151 and 152; PHY 183 and 184,
 OR PHY 231 and 232. R: Masters and Ph.D. only
 Fundamentals of isotope behavior, fractionation, and
 interpretation and application of isotope data (C, O,
 S, N, H). Radiogenic isotopes include geochronology
 (ex: Rb/Sr) and environmental tracing.

831*. **Quantitative Paleobiology**
 Spring of even-numbered years. 3(2-2)
 Interdepartmental with the
 Department(s) of Zoology.
 P: GLG 431 OR ZOL 345 R: Masters and
 Ph.D. only
 Analysis of selected paleobiological problems using
 quantitative techniques. Examples may include
 cladistics, morphometrics, ordination techniques and
 stereology.

861*. **Evolution of the Crust and Mantle**
 Fall of even-numbered years. 3(3-0)
 P: GLG 461 R: Masters and Ph.D. only
 Origin and evolution of the Earth's crust and mantle.
 Petrology, tectonics and geophysics of the Earth.
 QP: GLG 462 QA: GLG 861

862*. **Igneous Petrology**
 Fall of odd-numbered years. 4(3-2)
 P: GLG 461 R: Masters and Ph.D. only
 Origin and evolution of magmatic systems. Relation-
 ship of igneous activity to tectonic setting.
 QP: GLG 462 QA: GLG 862

863*. **Mineral-Water Interactions**
 Spring of odd-numbered years. 4(3-2)
 Interdepartmental with the
 Department(s) of Crop and Soil
 Sciences.
 R: Masters and Ph.D. only GLG OR CSS
 Mineralogy, petrology and geochemistry of fluid-rock
 reactions in geologic, sedimentary and geochemical
 cycles, including rock and mineral weathering, soil
 formation, genesis and burial diagenesis of sediments
 and sedimentary rocks, and metamorphism.
 QA: GLG 898

871*. **Seismology and
 Geodynamics(MTC)**
 Fall of odd-numbered years, Spring of
 odd-numbered years. 3(3-0) May
 reenroll for a maximum of 6 credits.
 P: MTH 234, PHY 184 R: Masters and
 Ph.D. only
 Seismological theory, earthquakes, quantitative mod-
 eling of the applications to Earth structure, seismic
 source mechanisms and geodynamics. Behavior and
 deformation of the lithosphere.
 QP: MTH 215 PHY 289 QA: GLG 873 GLG
 877

871A*. **Seismology: Theory, Observation
 and Computation**
 Spring of odd-numbered years. 3(3-0)
 P: MTH 234, PHY 184 R: Masters and
 Ph.D. only
 Seismology of the Earth, earthquakes and Earth
 structure. The use of seismogram inversion to model
 the Earth's interior and earthquake source mecha-
 nisms.
 QP: MTH 215 PHY 289 QA: GLG 873

871B*. **Geodynamics of the Lithosphere**
 Fall of odd-numbered years. 3(3-0)
 P: MTH 234, PHY 184 R: Masters and
 Ph.D. only
 Application of seismological studies and numerical
 modeling to the study of geodynamic processes occur-
 ring within the lithosphere.
 QP: GLG 477 MTH 310PHY 289 QA: GLG
 877

881*. **Sedimentary Petrology**
 Fall of odd-numbered years. 4(3-2)
 P: GLG 431, GLG 461 R: Masters and
 Ph.D. only
 The origin of sedimentary particles and their chemical
 and physical alterations after deposition. Geochemical
 cycles in Earth history.

898*. **Special Problems in Geological
 Sciences(MTC)**
 Fall, Spring, Summer. 1 to 4 credits.
 May reenroll for a maximum of 6
 credits.
 R: Masters and Ph.D. only
 Individual study on problems in geochemistry, geo-
 physics, geodynamics, hydrogeology, paleobiology,
 petrology, sedimentology, structural geology and
 tectonics.
 QA: GLG 800

898A*. **Special Problems in Geochemistry**
 Fall, Spring, Summer. 1 to 4 credits.
 May reenroll for a maximum of 6
 credits.
 R: Masters and Ph.D. only
 Individual study on problems in geochemistry, includ-
 ing aqueous, biologic, and mineralogic aspects.
 QA: GLG 809

898B*. **Special Problems in Geophysics
 and Geodynamics**
 Fall, Spring, Summer. 1 to 4 credits.
 May reenroll for a maximum of 6
 credits.
 P: GLG 371 OR GLG 471 OR GLG 472
 R: Masters and Ph.D. only
 Individual study on problems in applied and
 solid-earth geophysics, global and regional geo-
 dynamics, and polar earth sciences.
 QP: GLG 375 GLG 474GLG 477 QA: GLG
 803 GLG 808

898C*. **Special Problems in Hydrogeology**
 Fall, Spring, Summer. 1 to 4 credits.
 May reenroll for a maximum of 6
 credits.
 P: GLG 411 OR GLG 421 R: Masters and
 Ph.D. only
 Individual study on the movement, occurrence and
 composition of groundwater in various geologic envi-
 ronments.

898D*. **Special Problems in Paleobiology**
 Fall, Spring, Summer. 1 to 4 credits.
 May reenroll for a maximum of 6
 credits.
 R: Masters and Ph.D. only OR approval
 of department
 Individual study on invertebrate, vertebrate and plant
 paleobiology.
 QA: GLG 807

898E*. **Special Problems in Petrology**
 Fall, Spring, Summer. 1 to 4 credits.
 May reenroll for a maximum of 6
 credits.
 P: GLG 461 R: Masters and Ph.D. only
 Individual study on current problems in petrology.
 QP: GLG 462 QA: GLG 802

898F*. **Special Problems in Sedimentology**
 Fall, Spring, Summer. 1 to 4 credits.
 May reenroll for a maximum of 6
 credits.
 R: Masters and Ph.D. only
 Individual study on problems in sedimentology.
 QP: GLG 491 GLG 898 QA: GLG 804 GLG
 805 GLG 806

898G*. **Special Problems in Structural
 Geology and Tectonics**
 Fall, Spring, Summer. 1 to 4 credits.
 May reenroll for a maximum of 6
 credits.
 P: GLG 351 R: Masters and Ph.D. only
 Individual study on rock deformation or major expres-
 sions of deformation. Two-seven weeks of field study
 during term breaks may be required.
 QA: GLG 801

899*. **Master's Thesis Research**
 Fall, Spring, Summer. 1 to 10 credits.
 May reenroll for a maximum of 10
 credits.
 R: Masters only Geological Sciences
 QA: GLG 899

999*. **Doctoral Dissertation Research**
 Fall, Spring, Summer. 1 to 36 credits.
 May reenroll for a maximum of 36
 credits.
 R: Ph.D. only Geological Sciences

QA: GLG 999

GERMAN

GRM

101*. **Elementary German I**
 Fall. 4(4-1)

German language, civilization, and culture for stu-
 dents without prior exposure to German. Develop-
 ment of all language skills in modern German. Em-
 phasis on speaking German.
 QA: GRM 101 GRM 102

102*. **Elementary German II**
 Fall, Spring. 4(4-1)
 P: GRM 101 or placement

Continuation of GRM 101. German language, civiliza-
 tion, and culture. Development of all language skills
 in modern German. Emphasis on speaking German.
 QP: GRM 101 QA: GRM 102 GRM 103

200*. **Second Year German Review**
 Fall, Spring. 4(4-1)
 P: Placement or approval of department.

R: Placement or approval of department
 Rapid review and strengthening of vocabulary, gram-
 mar, and communication skills for incoming freshmen
 and transfer students. Reading, viewing, and discus-
 sion of a broad range of cultural texts and materials
 from the German-speaking world.
 QA: GRM 200

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

Further development of language skills acquired at
 the first-year level. Reading, viewing, and discussion
 of a broad range of cultural texts and materials from
 the German-speaking world.
 QP: GRM 103 QA: GRM 201 GRM 202

202*. **Second Year German II**
 Fall, Spring. 4(4-0)
 P: GRM 200 or GRM 201 or placement

Strengthening of vocabulary, grammar, and oral and
 written communication skills. Special topics such as
 popular music, literature, film, current events, cul-
 ture. Transition course to advanced work in German
 studies.
 QP: GRM 201 QA: GRM 202 GRM 203