935. Seminar in Location Theory
Fall, 3(3-0) Approval of department.
GEO 435. Recent developments and research in location analysis and regional science.

939. African Research
(3ID 525.) Fall, Winter, Spring, 2 to 4 credits. May reenroll for a maximum of 8 credits. Graduate standing or approval of instructor. Interdepartmental with African Languages and the departments of Administration and Curriculum, Anthropology, History, Political Science, and Sociology. Administered by the Department of Anthropology. African related archival and field research topics and methodologies viewed from perspective of relevant social science and humanities disciplines associated with the African Studies Center.

846. Seminar in Cartography
Winter, 3(3-0) May reenroll for a maximum of 12 credits. Approval of department.
Selected research topics in cartographic theory and map design.

850. Advanced Field Techniques
Fall, Winter, Spring, Summer, 1 to 4 credits. May reenroll for a maximum of 8 credits.
Instruction and practical training in the selection, data-gathering, on-site analysis, and presentation of geographic field problems.

870. Seminar in Medical Geography
Winter, 3(3-0) Spatio-environmental analysis of selected health problems.

899. Master's Thesis Research
Fall, Winter, Spring, Summer. Variable credit. Approval of department.

901. Problems in Cultural Geography
Fall, Winter, Spring, 1 to 3 credits. May reenroll for a maximum of 6 credits. Approval of department.

902. Problems in Physical Geography
Fall, Winter, Spring, Summer, 1 to 3 credits. May reenroll for a maximum of 6 credits. Supervised research in specific topics of physical geography.

906. Problems in Economic Geography
Fall, Winter, Spring, Summer, 1 to 3 credits. May reenroll for a maximum of 6 credits. Approval of department.
Special research problems.

910. Problems in Historical Geography
Fall, Winter, Spring, Summer, 1 to 3 credits. May reenroll for a maximum of 6 credits. Approval of department.
Special research problems in historical geography.

912. Independent Study in Regional Geography
Fall, Winter, Spring, Summer, 1 to 3 credits. May reenroll for a maximum of 15 credits. Approval of department. Individual studies in regional geography.

918. Problems in Geography
Fall, Winter, Spring, Summer, 1 to 3 credits. May reenroll for a maximum of 9 credits. Approval of department. Research on specific geographical problems.

934. Problems in Population
Fall, Winter, Spring, Summer, 1 to 3 credits. May reenroll for a maximum of 9 credits. Approval of department. Special research problems.

999. Doctoral Dissertation Research
Fall, Winter, Spring, Summer. Variable credit. Approval of department.

GEOLOGICAL SCIENCES
(Name changed effective July 1, 1983. Formerly the Department of Geology.)

College of Natural Science

Geology

200. The Geology of Our Environment
Fall, Winter, Spring, Summer, 3(3-0) Not open to Geology majors. Credit will be given in only one of the following: GLG 200, GLG 201, GLG 206.
Our geological environment: earthquakes, volcanoes, landslides, subsidence, flooding, coastal erosion, hydrology and human use, waste disposal, geologic aspects of environmental health, resources and energy, environmental law.

2001. Laboratory-Geology of Our Environment
Fall, Winter, Spring, Summer, 1(0-3) GLG 201 or concurrently.
Laboratory study of geologic processes associated with environmental hazards. Emphasis placed on land-use planning, applying geologic criteria to evaluate land potentials.

201. Earth Processes
Fall, Winter, Spring, 4(4-2) Credit will be given in only one of the following: GLG 200, GLG 201, GLG 206.
Physical processes concerning evolution of Earth and its environments. Conservation and interaction of energy and matter through time. Laboratory stresses interpretation of process through studies of geologic data.

202. Evolution of the Earth
Fall, Winter, Spring, 4(4-2) GLG 200, or GLG 201, or GLG 206.
Integration of physical, chemical and biological processes from which our present environment has evolved; problems and controversies in the development of ideas of geologic and organic evolution.

205. Oceanology-The Marine Environment
Fall, 3(3-0)
Physical oceanography, including origin, hydrologic, chemical, geologic and biologic processes; and environmental quality of the oceans. Human-sea interactions are emphasized including resource utilization and pollution.

252. Energy Resources of the Earth
Winter, 3(3-0)
World energy resources of petroleum, coal, and atomic fuel. Social, political, economic and environmental problems of fuels.

300. Solar System Geology
Winter, 4(4-0) AST 119 or AST 121 or AST 122, GLC 200 or GLC 201.
The origin, relationships, make-up and features of the bodies in the solar system emphasizing recent space exploration results and developing theories.

302. Vertebrate Life of the Past
Fall, 3(3-0) One course in a physical or biological science or Juniors. Interdepartmental with the Department of Zoology.
Fossil vertebrates from fish to humans.

304. Geology of Michigan
Fall, 3(3-0) GLC 200 or GLC 201 and/or GLG 202, or approval of department.
A historical accounting of the physical, historical and economic geology of Michigan and its environs; a course designed for students seeking an overall picture of the rather unique Michigan geological environment.

305. Engineering Geology
Fall, Spring, 3(3-2) Credit will be given for only one of the following: GLG 200, GLG 201, GLG 206. Sophomore Engineering students.
Fundamental principles of geology as applied to civil engineering practice. Minerals and rocks, aerial photographs, topographic and aerial geologic maps and geologic cross sections studied in laboratory. Source of geologic literature and maps.

307. Geology Central Appalachians
Winter, 1(0-2) GLC 200, or GLG 201, or GLG 202, or concurrently.

308. Field Excursion-Central Appalachians
Spring, 2 or 3 credits. GLG 307.
Training in stratigraphic, sedimentological, paleontologic, and structural principles as applied to field methods.

321. Mineralogy
Fall, 3(4-0) One term of chemistry.

323. Introduction to Optical Mineralogy
Winter, 3(3-0) GLG 221.
Basic principles underlying the use of the polarizing microscope. Recognition and understanding of fundamental optical properties. Identification of minerals and textures in thin sections of rocks.

327. Introduction to Geochemistry
(405.) Winter, 3(3-0) CEM 152, GLG 321.
335. Fossil Plants, Their History and Paleocology
Spring; 3(3-0) One course in geology or botany or biology or approval of department. Interdepartmental with the Department of Botany and Plant Pathology.

History of plants through geologic time; their form and evolution; how and where found; identified and reconstituted; their use in determining ancient geographic patterns, paleoenvironments, paleoclimates and community structure. Field trips.

337. The Fossil Record of Organic Evolution
Spring; 3(3-0) One course in a natural science; Juniors. Interdepartmental with the Department of Zoology.


344. Field Geology—Summer Camp
Summer, 9 credits. GLG 351, GLG 363, GLG 382. Trigonometry, GLG 427, GLG 446 recommended.

Methods and techniques of geological surveying and mapping. Field interpretation of geological phenomena in igneous, metamorphic and sedimentary rocks in northern Michigan and Wisconsin.

A. Introduction to Field Techniques 3 credits
Introduction to field techniques with stress in those that apply to sedimentary rocks. Stratigraphic correlation.

B. Methods of Geological Mapping 4 credits
Plane table surveys, aerial photo and reconnaissance mapping. Examination and interpretation of structural and textural relationships in igneous and metamorphic rocks.

C. Geologic Interpretation of Selected Areas 2 credits
Independent mapping and interpretation.

351. Structural Geology
(451) Fall; 4(3-6) GLG 202, MTH 111.

Descriptive, classification, and origin of secondary structures such as folds, faults, joints, cleavages, foliations, and lineations. Three-dimensional visualization stressed in economic laboratory problems involving descriptive geometry, stereographic projections, areal, and structural geologic maps.

363. Lithology
Spring; 4(3-4) GLG 321, GLG 323, GLG 397.

Processes that form igneous and metamorphic rocks; origin, distribution, variation and occurrence of rock. Study of rock properties in the field, laboratory, and with the microscope.

375. Introduction to Geophysics
Winter; 3(3-0) GLG 201; MTH 111; PHYS 209 or PHYS 295.

Earth's interior, lithospheric tectonics, and geophysical exploration including: refraction seismology, gravity, magnetism, earth's internal structure, global seismicity, plate tectonics, structure of plate margins, and planetary geology.

382. Sedimentology
Spring; 3(2-3) GLG 323, GLG 327.

Grain and aggregate properties of sediments; relationships of these properties to processes in the environment of deposition and to the pre depositional and post-depositional history.

400H. Honors Work
Fall, Winter, Spring; 1 to 3 credits. May enroll for a maximum of 9 credits. Honors College student, or 3.00 grade-point average, or approval of chairperson; written proposal approved by faculty sponsor and chairperson.

401. Hydrogeology
Winter; 3(3-2) One term of geology and trigonometry.

Principles of the sources, occurrence, and movement of ground water. Surface and subsurface investigations of ground water and elementary ground water hydrology.

411. Hydrogeology
Spring; 4(3-4) GLG 321.

Geological aspects of glaciers and glaciation. Theories of ice ages through geologic time. Origin and development of glacial geomorphic features. Character and chronology of the Pleistocene. Laboratory techniques, with field trips to observe glacial materials and features of Michigan.

426. Optical and X-ray Mineralogy
Fall; 4(3-4) GLG 321, PHY 339 or PHY 389.

Theory, principle and application of the polarizing microscope and X-ray diffractometer in mineral analysis.

430. Vertebrate Paleontology
Winter; 4(3-3) ZOL 128 or approval of department. Interdepartmental with the Department of Zoology.

Fossil vertebrates with emphasis on the evolution of major groups. Laboratories on modern techniques and on the identification and interpretation of fossils.

433. Invertebrate Paleontology
Fall; 4(3-4) GLG 202 or ZOL 303 or approval of department. Interdepartmental with the Department of Zoology.

Systematics and evolution of marine invertebrates, uses of fossils in correlation and delineation of geologic time; structure and morphology of fossils as related to evolutionary development.

438. Paleocology
Spring; 4(3-4) GLG 202 or ZOL 389 or approval of department. Interdepartmental with the Department of Zoology.

Distribution and abundance of marine fossils; response of skeletal morphology to environmental conditions; uses of fossils in reconstructing ancient climates and depositional environments.

445. Field Studies
Fall, Winter, Spring; Summer. 1 to 3 credits. May enroll for a maximum of 9 credits. Approval of department.

Advanced geologic or geophysical field studies.

446. Principles of Stratigraphy
Fall; 3(3-0) GLG 347, GLG 392 or approval of department.

Covers principles of stratigraphy and application and exemplification of these principles to known geologic occurrences.

447. Exploration Geophysics
Fall; 4(3-2) GLG 201 or GLG 306; GLG 375; MTH 214; PHY 289 or PHY 299.

Techniques used in geophysical exploration, with application in petroleum prospecting, minerals exploration, and engineering. Includes gravity, magnetic, seismic, electrical and other methods, and well logging. Interpretation of geophysical data.

455. Exploration Seismology
Fall; 3(3-4) GLG 351; GLG 474 or GLG 475.

Theory and technique of field seismic exploration methods. An associated geophysical survey will be conducted and a report prepared.

479. Tectonophysics
Spring; 3(3-0) GLG 351; GLG 474 or GLG 475.

Tectonics of crustal plates emphasizing seafloor spreading and continental drift. Tectonics of plate margins, plate kinematics, observational seismology, inter and intra-plat stresses, and paleo-continental reconstructions.

482A. Mineral Resources Evaluation
Spring of odd-numbered years. (4-0) GLG 321, GLG 351.


482B. Mineral Resources Evaluation
Spring of even-numbered years. 3(3-0) GLG 321, GLG 351, approval of department.

Emphasis on practical applications of geoscientific mineral resources and the extractive industries. Aspects of exploration and development of reserves including evaluation, grade estimation, drilling, recovery, and beneficiation.

483. Petroleum Geology
Fall; 4(3-2) Approval of department.

Fundamental principles of the origin, migration and accumulation of petroleum. Exploration techniques to include well drilling, electric and radioactivity well logging, surface and subsurface exploration methods, seismic surveys, land leasing and oil field development. Laboratory study of well log plotting and subsurface mapping technique.

484. Applied Petroleum Geology
Winter; 4(1-1) GLG 483.

Microscopic examination of well cuttings, practices in the use of electric and radioactivity logs, exploration for petroleum in selected areas by subsurface mapping techniques, economics of petroleum exploration. Field trips.
### Geological Sciences – Descriptions of Courses

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title</th>
<th>Credits</th>
<th>Prerequisites</th>
</tr>
</thead>
<tbody>
<tr>
<td>GLG 327</td>
<td>Carbonate Sedimentology</td>
<td>Fall, 3-3</td>
<td>GLG 82, GLG 392.</td>
</tr>
<tr>
<td>GLG 833</td>
<td>Developmental Paleontology</td>
<td>Fall, 3-3</td>
<td>GLG 437 or GLG 438, ZOL 317 or approval of department. Interdepartmental with the Department of Zoology. Application of the principles of development to the ontogeny and phylogeny of fossil invertebrates as known from skeletal morphology.</td>
</tr>
<tr>
<td>GLG 834</td>
<td>Advanced Invertebrate Paleontology</td>
<td>Winter of even-numbered years, 3-0</td>
<td>GLG 430 or approval of department. Interdepartmental with the Department of Zoology. Recent advances and controversial issues in invertebrate paleontology including origin, classification, phylogeny, and stratigraphic relationships of fossil invertebrates.</td>
</tr>
<tr>
<td>GLG 835</td>
<td>Advanced Paleobotany</td>
<td>Winter, 3-3</td>
<td>GLG 346, GLG 392. Morphology, anatomy, phylogenetic relationships and classification of fossil plants. Microscopic analysis of tissues and organs prepared by thin section, transfers, peels, polished and etched surfaces, and macerations.</td>
</tr>
<tr>
<td>GLG 836</td>
<td>Paleozoic Stratigraphy</td>
<td>Winter of even-numbered years, 4-0</td>
<td>GLG 446, GLG 392. Classification, distribution, palaeogeography, palaeoecology, interrelation, and structural setting of stratigraphic units within the Paleozoic system. Laboratory work involves construction of correlation charts, structure and restored sections, palaeogeographic, palaeoecological, and lithofacies maps, and study of certain key fossils.</td>
</tr>
<tr>
<td>GLG 837</td>
<td>Mesozoic and Cenozoic Stratigraphy</td>
<td>Winter of odd-numbered years, 3-0</td>
<td>GLG 446. Stratigraphy and paleontology with emphasis on tectonics and sedimentation.</td>
</tr>
<tr>
<td>GLG 838</td>
<td>Structure of Ore Bodies</td>
<td>Winter of even-numbered years, 3-0</td>
<td>GLG 451, MTH 214. Mathematics and physics applied to problems in structural geology.</td>
</tr>
<tr>
<td>GLG 839</td>
<td>Evolution of the Earth's Crust and Mantle</td>
<td>Fall, 3-0</td>
<td>GLG 402. The composition, mineralogy and petrology of the Earth's mantle and crust. Plate tectonics and its relationship to earlier models of geosynclines, orogenic cycles, continental drift, etc.</td>
</tr>
<tr>
<td>GLG 840</td>
<td>Petrology–Igneous</td>
<td>Spring of even-numbered years, 2 to 4</td>
<td>GLG 437 or GLG 438, ZOL 317 or approval of department. Interdepartmental with the Department of Zoology. Physical and chemical principles involved in the origin of igneous rocks. Application of experimental techniques in petrology.</td>
</tr>
<tr>
<td>GLG 841</td>
<td>Petrology–Metamorphic</td>
<td>Spring of odd-numbered years, 2 to 4</td>
<td>GLG 437 or GLG 438, ZOL 317 or approval of department. Interdepartmental with the Department of Zoology. Application of the principles of development to the ontogeny and phylogeny of fossil invertebrates as known from skeletal morphology.</td>
</tr>
<tr>
<td>GLG 842</td>
<td>Advanced Geophysical Exploration I</td>
<td>Fall of even-numbered years, 4-3</td>
<td>GLG 474. Theory and technique of gravity and magnetic methods, and their use in geophysical exploration. Associated practical exercises.</td>
</tr>
<tr>
<td>GLG 843</td>
<td>Geophysics of the Lithosphere I</td>
<td>Fall of even-numbered years, 3-0</td>
<td>GLG 475, GLG 479. Structure and tectonic processes at convergent and divergent plate margins. Earthquake location and prediction, thermal modelling of slabs, origin of back-arc basins, and inter- and intra-plate stresses. Regional tectonic analyses.</td>
</tr>
<tr>
<td>GLG 844</td>
<td>Dynamic Processes in the Earth</td>
<td>Fall of odd-numbered years, 3-0</td>
<td>GLG 451, GLG 475, MTH 310 or approval of department. Stress and strain analysis, rheology of materials, buckling and bending of strata, lithospheric stresses, geofluid dynamics, surface waves, attenuation, and other seismological topics.</td>
</tr>
<tr>
<td>GLG 845</td>
<td>Regional Petroleum Geology</td>
<td>Spring, 3-0</td>
<td>Approval of department. Regional study of tectonics, stratigraphy and sedimentation in the U.S. and their relationship to petroleum occurrences in sedimentary basins. Analysis of petroleum distribution with emphasis on creative thinking in petroleum exploration. Practice in the analysis of petroleum possibilities in selected foreign areas.</td>
</tr>
<tr>
<td>GLG 846</td>
<td>Aqueous Geochemistry</td>
<td>Spring, 3-0</td>
<td>GLG 497 or a course in physical chemistry or approval of department. Nature and regulation of electrolytes in solution (fresh water, seawater, brine); activity, complexation, and redox effects. Trace metals in solution. Carbonate, siliceous, aluminous systems. Chemical weathering and mobility of elements.</td>
</tr>
</tbody>
</table>
905. Topics in Geochemistry: Analytical Geochemistry
Fall of even-numbered years. 1 to 3 credits. May reenroll for a maximum of 12 credits. GLG 495. Instrumental techniques for the analysis of geological materials. Topics on application of X-ray diffraction, X-ray fluorescence, neutron activation analysis, and atomic absorption spectrophotometry. Biochemical techniques in geochemistry will be discussed.

896. Applied Geochemistry
Spring of even-numbered years. 3 credits. GLG 495 or GLG 894. Migrations of elements in the near surface environment. Prediction of mineral deposits, hydrocarbon traps and harmful concentrations of both naturally occurring and artificially introduced hazardous elements and compounds.

899. Master's Thesis Research
Fall, Winter, Spring, Summer. Variable credit. Approval of department.

900. Special Problems
Fall, Winter, Spring, Summer. 1 to 3 credits. May reenroll for a maximum of 9 credits. Approval of department. Special problems in hydrogeology, geomorphology and glacial geology, mineralogy and crystallography, petrology, paleontology, structural geology and petrofabrics, stratigraphy, aerogeology, geophysics, economic geology, petroleum geology, sedimentation, and geochemistry.

999. Doctoral Dissertation Research
Fall, Winter, Spring, Summer. Variable credit. Approval of department.

Descriptions – Geological Sciences

Greek
See Romance and Classical Languages.

Health and Physical Education

HPE 104. Individual Sports (HPR 106.) Fall, Winter, Spring, Summer. 1 to 3 credits. May reenroll for a maximum of 12 credits if different activities or the same activities at higher levels are involved. Students are limited to a combined total of 12 credits in HPE 104 through HPE 111. Development of sports skills and physical fitness through participation in individual sports activities.

HPE 105. Individual Sports II (HPR 107.) Fall, Winter, Spring. 1 to 3 credits. May reenroll for a maximum of 12 credits if different activities or the same activities at higher levels are involved. Students are limited to a combined total of 12 credits in HPE 104 through HPE 111. Development of sports skills and physical fitness through participation in individual sports activities.

HPE 106. Dual Sports I (HPR 108.) Fall, Winter, Spring. 1 to 3 credits. May reenroll for a maximum of 12 credits if different activities or the same activities at higher levels are involved. Students are limited to a combined total of 12 credits in HPE 104 through HPE 111. Development of sports skills and physical fitness through participation in dual sports activities.

HPE 107. Dual Sports II (HPR 109.) Fall, Winter, Spring. 1 to 3 credits. May reenroll for a maximum of 12 credits if different activities or the same activities at higher levels are involved. Students are limited to a combined total of 12 credits in HPE 104 through HPE 111. Development of sports skills and physical fitness through participation in dual sports activities.

HPE 108. Team Sports (HPR 110.) Fall, Winter, Spring. 1 to 3 credits. May reenroll for a maximum of 12 credits if different activities or the same activities at higher levels are involved. Students are limited to a combined total of 12 credits in HPE 104 through HPE 111. Team sports skills and physical fitness through participation in group activities.

German
See Linguistics and Germanic, Slavic, Asian and African Languages.

German and Russian
See Linguistics and Germanic, Slavic, Asian and African Languages.

A-100